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Carbon emissions and global R&D patterns: a wavelet coherence perspective

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Abstract
This study examines the causality between Research and Development (R&D) and Carbon dioxide (CO_2) emissions at the global level, utilising data gathered from 2000 to 2020 across various countries categorised as developed, developing, economies in transition, and least-developed. The data collected for the study are analysed using the Wavelet coherence methodology. The findings reveal both bidirectional and unidirectional causality between the variables, which have evolved over time. Globally, a bidirectional relationship is present in the short-term, no causality in the medium-term and unidirectional causality in the long-term. Developed countries exhibit a two-way causality in the short-term, while no causality exists in the medium-term and long-term. Developing countries show a bidirectional relationship across all time frequencies. In economies in transition, a bidirectional relationship appears towards the end of the period over the short, medium, and long-term. The least developed countries show no causality in the short and long-term, but a one-way causality in the medium-term. Governments and the policymakers can implement environmental policies to mitigate carbon emissions through R&D. The findings suggest targeted and strategic strategies to enhance the impact of R&D on emissions reduction. Policymakers can use this analysis to prioritize funding for clean energy innovations, establish incentives for low-tech technologies, and promote international cooperation in green technology research. Additionally, focusing on these carbon mechanisms and aligning R&D efforts to support development goals can increase the effectiveness of climate policies, ensuring a balance between economic growth and environmental sustainability.

Keywords Bidirectional · CO_2 emissions · Research and development · Unidirectional · Wavelet coherence · Granger causality

1 Introduction

Global warming, defined as the sustained increase in the earth's surface temperature predominantly attributed to human activities since the pre-industrial era (1850–1900), poses a significant global threat due to the emission of greenhouse gases (NASA, 2023). Among the five major greenhouse gases, Carbon dioxide (CO_2) emissions stand out as a primary

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driver of worldwide climate change. CO_2 traps and re-radiates infrared radiation, making it a paramount concern for environmental stability (Environmental Protection Agency, 2024; Li et al., 2021). This study centers on CO_2 as a pivotal variable due to its prevalence compared to other greenhouse gases.

Addressing these sources is crucial in mitigating the adverse effects of CO_2 emissions and curbing climate change. Despite numerous global initiatives, there remains a critical research gap in understanding whether and how Research and Development (R&D) investments can simultaneously drive economic growth and decouple CO_2 emissions. While the intersection of innovation, technological advancement, and environmental sustainability has garnered significant attention, the potential for R&D to balance economic and environmental goals remains underexplored. Scholars have underscored the pivotal role of R&D expenditures in driving economic growth (Freimane & Bāliņa, 2016; Minniti & Venturini, 2017). Theoretically, R&D improves productivity, reduces costs, and increases efficiency, ultimately leading to higher economic growth. Moreover, R&D can increase the competitiveness of renewable energy technologies by lowering their costs or enhancing production efficiency, facilitating their widespread adoption.

Notably, higher income levels in developed countries, such as the UK, often correlate with more significant investments in R&D, facilitating the adoption of energy-efficient and carbon-reducing technologies (Awaworyi Churchill et al., 2019). This paradigm shift towards sustainable practices mitigates ecological degradation and indicates economic prosperity through resource conservation and pollution reduction (Dinda, 2004).

While R&D investments stimulate technological upgrades that may involuntarily escalate carbon emissions through expanded production scales. However, they also catalyse the development of low-carbon technologies, thereby curbing energy consumption and carbon emissions (Dinda, 2004). Thus, for BRICS nations, the nexus between R&D investment, economic growth, and carbon emission decoupling emerges as a critical area, warranting scholarly investigation and policy attention. To develop sustainable renewable energy innovations and reach the United Nations Sustainable Development Goals related to climate change, there currently needs to be more funding committed to R&D of renewable energy. Policymakers' ignorance of the possible advantages of energy R&D spending may contribute to the underfunding of the renewable energy industry. Providing policymakers with concrete evidence to support R&D investment in the renewable energy sector is crucial if it is apparent to them how each unit of R&D investment can decrease CO_2 emissions (per tonne).

Therefore, the main objective of this study is to explore the causality between CO_2 and R&D, considering variations over different periods across 21 years globally. This research contributes to the literature in four key ways: First, it employs a novel methodology, Wavelet Coherence, to examine the causality and correlation between CO_2 and R&D, allowing simultaneous consideration of time and frequency domains. This provides insights into the dynamic interactions between these variables over time. This methodology helps examine the linkage between the variables across short-term, medium-term, and long-term time scales with the direction of arrows from 2000 to 2020. Second, the study adopts a global approach, covering 81 countries grouped into categories based on economic development: developed, developing, economies in transition, and least developed. While existing literature has predominantly focused on individual countries, organisations, and different regions, this comprehensive global study groups countries based on economic conditions. Third, it provides comprehensive insights by plotting and summarizing time-scale graphs (short-term, medium-term, and long-term) for these groups over a 21-year period, allocating a five year time range. Finally, the research identifies R&D technologies that each

country can adopt to mitigate CO_2 emissions, offering actionable insights for policymakers and stakeholders in understanding and addressing the complex dynamics of CO_2 emissions and technological innovations.

The article is subsequently structured as follows: a literature review, data and methodology, the presentation of findings and discussion, and finally, the overall conclusion of the study, followed by policy implications, limitations and future research directions.

2 Literature review

The main reason for environmental degradation is the enormous changes taking place within industries. This is why policymakers heavily rely on investing in R&D and technological advancements. Empirical investigations undertaken by scholars have documented that environmental quality can be achieved by investing in R&D. Studies based on innovations in China investigated a positive impact on the environmental quality from 2006 to 2013, highlighting that ecological innovations will reduce CO_2 emissions (Zhang et al., 2017). The relationship between CO_2 emissions and investments in green technology innovation revealed that an increase in R&D decreases CO_2, while a decrease in R&D investments increase CO_2 emissions (Wang et al., 2024). A study examining the long-run relationship of 25 EU member countries from 1998 to 2014 shows, a growth in R&D expenditure supports reducing CO_2 emissions (Paramati et al., 2020). Additionally, technical progress and R&D positively affect environmental quality, with a bidirectional causality between CO_2 emission and R&D (Kahouli, 2018). Investment in green technology reduces CO_2 emissions by promoting cleaner production methods and reducing the ecological footprint in G-7 countries (Javed et al., 2024). The above studies showcase the impact of R&D and CO_2 emissions, while the current study displays the causality of R&D and CO_2 emissions in 81 countries categorized based on income level, making it easier for policy makers worldwide to take the necessary steps in reducing CO_2 emissions.

Similar research shows that R&D enormously helps in reducing CO_2 emission (Chang et al., 2023). The survey carried out in G7 countries from 1970 to 2017 using the Wavelet Coherence analysis represents a negative short-term relationship between R&D and CO_2 emission, revealing how increased investments in R&D mitigates CO_2 emissions in G7 countries. Compared to past literature, the current study explores the causality between R&D and CO_2 in over 80 countries.

From 1870 to 2020 reveal increased economic growth influences investment in new R&D projects to control CO_2 emissions. Developed countries' spending on R&D in controlling CO_2 shows renewable energy will not remain a continuously promising factor (Ndlovu & Inglesi-Lotz, 2020). The studies above reveal developed countries contribute significantly to CO_2 emissions but can reduce them by investing in R&D. The current study showcases the time scale in which period R&D has caused CO_2 and vice versa using Wavelet methodology.

In contrast, industries with high emissions often allocate significant resources toward R&D to meet regulatory standards and societal demands (Pérez-Suárez & López-Menéndez, 2015). Another study highlights the crucial role of technological innovation in reducing emissions, showing a unidirectional causality where R&D activities primarily drive reductions in CO_2 emissions (Kahouli, 2018). Moreover, environmental policies responding to rising emissions, such as the EU's Emissions Trading Scheme**,** have significantly spurred R&D investments aimed at reducing carbon emissions (European Union, 2016).

A study using data from 1990 to 2018 for both developed and developing countries investigates the relationship between innovation and emissions, where a 1% increase in innovation tends to result in a 0.549% increase in emissions (Dauda et al., 2019). Rising emissions in countries like China have led to large-scale investments in renewable energy research, showcasing the interplay between emissions and R&D contributing to global sustainability efforts (Yi et al., 2023). Developed and developing countries should highly concentrate on actions reducing emissions uplifting R&D investments.

Results from 1990 to 2019 show R&D and CO_2 emissions have a unidirectional causality as investors and shareholders push managers to create win–win situations (Shao et al., 2021). Data from 2004 to 2016 using Ordinary Least Square results shows R&D investments negatively impacts CO_2 emission (Alam et al., 2019). Another study in China reveals domestic R&D investments improve CO_2 emission efficiency (Yu & Xu, 2019). The Wavelet Coherence study 1990 to 2020 shows a bidirectional casual relationship between CO_2 and R&D in the USA (Tao et al., 2023). Sectoral developments are a major reason for increasing CO_2 emissions. Using a Panel econometric model, a study in China, gathering data from 2005 to 2014, shows a "U-shaped" relationship between the R&D technology and CO_2 emission (Jiao et al., 2018). A study employs R&D and CO_2 emission to discovers the interconnectedness is helpfully depicted on a worldwide scale, useful for policymakers and governments (Awaworyi Churchill et al., 2019). Many studies reveal a bidirectional relationship between CO_2 and R&D, and countries have begun investigations to reduce CO_2 emissions by investing in R&D. The study done using G-7 countries under the Wavelet Coherence approach shows negative correlation in reducing CO_2 emission through R&D investments, except in Japan (Yuan Huang et al., 2021a, 2021b). Compared to prior studies, the current study shows the causality of R&D and CO_2 emission for 20 years categorized by income.

3 Data and methodology

3.1 Data

The study consists of 81 countries for the years 2000 to 2020. Data has been collected through the World Bank and presented in Appendix 1, with the relevant country classification for each country, according to the UN.

The countries have been classified as 35 developed countries, 30 developing countries, 14 economies in transition, and 2 Least Developed Countries (LDCs) based on a report annexed to the World Economic Situation and Prospects 2022 by the United Nations (United Nations Department of Economic & Social Affairs, 2022). This report provides statistical data on global economic trends, including trade, employment, inflation, and GDP growth, across various regions and countries. It serves as a critical resource for policymakers and researchers to assess economic performance and outline sustainable development goals.

The CO_2 is measured in metric tons calculated per capita World Bank (2023a), and R&D is measured as a percentage of GDP (World Bank, 2023b).

3.2 Methodology

The study uses Wavelet Coherence to analyse the findings. Wavelet coherence is a sophisticated analytical method for discovering dynamic relationships between two series of variables over time and frequency. Unlike traditional techniques, it reveals not only the force but also the timing and scale of the interactions, making it particularly useful for complex systems, such as the relationship between carbon emissions and R&D investments. This approach identifies critical periods and frequencies where these variables are most closely linked, providing insights needed to design targeted interventions. It analyses causality between variables across different periods with varying frequencies. The initial development of wavelet coherence was conducted in 1984 (Goupillaud et al., 1984), and a meteorology study in 1998 popularized the methodology (Torrence & Compo, 1998). This methodology has been used in fields such as tourism, foreign direct investment, elderly population studies, medicine, and mechanical engineering (Galappaththi et al., 2023; Gao et al., 2019; Lakshani et al., 2023; Tan et al., 2015; Wijesekara et al., 2022).

Unlike previous empirical studies that predominantly explore the unidirectional impact of R&D on CO_2 emissions, this study utilises a more comprehensive approach by employing the wavelet coherence methodology. This advanced technique allows for an in-depth, year-by-year analysis of the directional relationship between the two variables, highlighting the periods as short-term, medium-term, and long-term. This approach provides a significant advantage by capturing the dynamic and evolving nature of the relationship over time.

Fourier analysis is used to obtain outputs with practical graphical representations, but it is inefficient at detecting sudden fluctuations. The Wavelet approach overcomes these limitations (Acquaah et al., 2021; Rhif et al., 2019). The Wavelet Coherence graphs are an advancement of the Wavelet analysis which is explained by the bivariate analysis and pointing out which variable leads to the other. The principal supremacy of the Wavelet Coherence is analysing the causality between the variables by the direction along different time considerations with different time scales as a short-term, medium-term, and long-term, aligning with varying frequencies of low, medium, and high which signifies the correlation. This technique is a flexible approach in real world data since it can evaluate signals such as abrupt changes or irregular patterns. Moreover, this methodology is suited for exploring nonstationary signals which is essential studying different fields and the visualisations allows to easily understand the significant regions and how the relationship and the correlation change over time and frequency.

A Wavelet, generated by the function $\psi^{a,b}(x)$, with contractions, a and translation, b can be statistically denoted as follows (ψ denotes Morlet Wavelet function), this is adapted by Goupillaud et al. (1984).

$$\psi^{a,b}(x) = |a|^{-\frac{1}{2}} \psi\left(\frac{x-b}{a}\right) \tag{1}$$

The Wavelet Coherence formula, with the smoothing factor as s, x the first variable, and y the second variable is explained as follows, this formula is derived based on (Torrence & Compo, 1998), capturing time–frequency relationships effectively.

$$Coherence = \frac{|sWave \cdot xy|^2}{sPowerx \cdot sPower \cdot y} \tag{2}$$

In the current study, based on the variables, CO_2 will be the first variable and R&D will be the second variable. The wavelet graphs were plotted using R as shown in the results section.

In addition to wavelet coherence analysis, Granger causality analysis strengthens our findings. Granger causality is a statistical hypothesis test that assesses whether one time series can predict another in fatigue data (Granger, 1969). Granger provides insights into directional dependencies by directly identifying predicted links between time series, as opposed to fluctuation analysis, which breaks down signals into time–frequency components. Granger integration causality analysis enables a more comprehensive understanding of the relationship between R&D investments and carbon emissions, aligning with established economic practices (Granger, 1969). The study encounters panel granger and cross country granger causality test. PVAR and VAR model is utilised by checking the stationary using Levin Lin chu and Dickey Fuller test respectively. The lag selection and the stability test is also done to obtain the results of granger causality. Granger causality test follows the standard methodology as introduced by Granger (1969).

$$Y_{i,t} = \sum_{k=1}^{p} \beta_i Y_{i,t-k} + \sum_{k=0}^{p} \theta_k X_{i,t-k} + u_{i,t} \tag{3}$$

There u is explained as distributed normally with $u_{i,t} = \alpha_i + \varepsilon_{i,t}$, where the number of lags is explained as p. Under the assumption of the autoregressive coefficients β_k and the regression coefficients θ_k's are constant for $k \in [1, N]$.

The study employs both Wavelet Coherence analysis and Panel Granger Causality analysis to cross-validate the findings and address potential uncertainties. Statistical significance was ensured through Monte Carlo simulations, and the Cone of Influence (COI) was carefully interpreted to minimize boundary effects. Parameters, including wavelet type (Morlet), frequency bands, and smoothing factors, were selected based on established methodological best practices.

The below contains a flowchart (See Fig. 1) that outlines the progression of the study from its inception to the final stage.

4 Results and discussion

4.1 Preliminary findings

The Table 1 depicts the descriptive statistics related to the variables pertaining to each country category and all nations. Globally, 1701 observations have been utilised in the study with 735, 630, 294, and 42 observations, subsequent to developed countries, developing countries, economies in transition, and LDCs.

The mean of CO_2 emissions and R&D for all the nations and the categories are visualised in below Fig. 2 from 2000 to 2020 which assists in recognising the trends and patterns. Compared to the global context, the LDC shows the lowest means for CO_2 and R&D both, with an average of 0.13 metric tons per capita and 0.19% of GDP respectively. Further, the highest average from developed countries for CO_2 and R&D are 8.33 metric tons per capita and 1.62% of GDP respectively. Considering the mean value of CO_2 the developing countries contain 8.33 metric tons per capita which is the highest and LDC's remains as the lowest which 0.127 metric tons per capita. Further, considering the variance, developed countries contain the highest with 5.021 metric tons per capita and LCD's contain 0.052 metric tons, which remains as the lowest. Moreover, in R&D, developing countries have a top % of mean, which is 1.622%, and LDC has the lowest of 0.186%. Variance of R&D

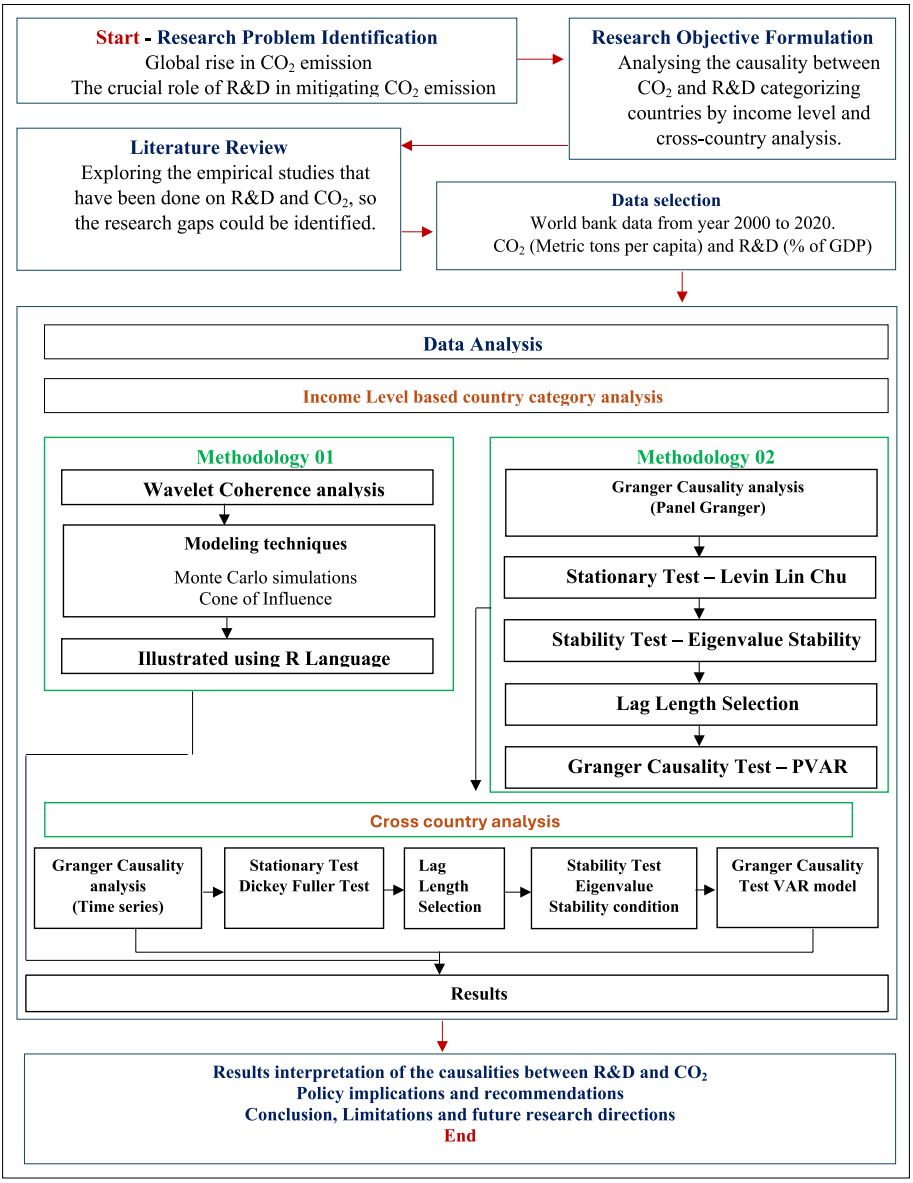

Fig. 1 Flowchart from inception to the final stage. *Source*: Authors' Compilation

consists of 0.965% and 0.115% for developed and LDCs respectively. Maximum value of CO_2 and R&D in developing countries and developed countries respectively.

This section discusses the wavelet coherence graphs for the world and four country categories with interpretations. Table 2 depicts the characteristics and elements of the graphs related to the respective interpretations.

The Cone of Influence, the white cone of the graphs, represents the time–frequency plane; the effects of the edges are significant. The black border illustrates the five

Table 1 Summary of descriptive statistics of variables. *Source*: Authors' Compilation

	Obs	Mean	SD	Min	Max
CO_2 (Metric tons per capita)					
World	1701	6.183	4.754	0.065	31.274
Developing	735	8.330	4.095	2.927	25.610
Developed	630	4.825	5.021	0.627	31.274
Economies in Transition	294	4.591	3.413	0.321	15.341
Least developed	42	0.127	0.052	0.065	0.270
R&D (% of GDP)					
World	1701	1.051	0.985	0.000	5.706
Developing	735	1.622	0.890	0.227	4.307
Developed	630	0.741	0.965	0.000	5.706
Economies in Transition	294	0.413	0.314	0.067	1.286
Least developed	42	0.186	0.115	0.013	0.614

Obs., SD, Min, and Max define Observation, Standard Deviation, Minimum, and Maximum, respectively

percent significance level, calculated using Monte Carlo simulations. The red and blue regions indicates the presence and absence of correlation, respectively. Arrows pointing right signify a positive correlation, and those pointing left, a negative correlation. If either the right or left arrows move upwards, it depicts that the second variable causes the first variable, which signifies a unidirectional causality, while, if the arrow is pointed to the right or left moving downwards, it explains that first variable causes the second variable. Moreover, if the arrows move up as well as down both, for a certain period, either being directed to right or left, it illustrates a bidirectional causality. The division of short-term, medium-term, and long-term periods in the study is based on the flexibility of wavelet analysis, which allows researchers to adapt scale ranges to the specific dynamics of the datasets and contexts being analysed. The variation in scale segmentation for developed countries versus developing countries and economies in transition reflects differences in the typical frequencies of economic cycles and structural stability.

In developed countries, economic cycles span longer periods due to stable institutions and predictable economic environments, necessitating broader scale ranges for each term. Conversely, in developing countries and economies in transition, economic cycles are shorter and more volatile, leading to narrower scale ranges to capture dynamics.

While no universally accepted criterion exists for wavelet scale segmentation, the approach taken in this study aligns with previous research, which emphasizes the need to tailor scale divisions to the characteristics of the data and research objectives. Studies by Torrence and Compo (1998) and Aguiar-Conraria et al. (2008) highlight this adaptability as a strength of wavelet analysis (Torrence & Compo, 1998).

In a global context as portrayed by Fig. 3, CO_2 and R&D displays bidirectional causality in short term (Scale 0–16) during 2000, 2001, 2004, 2008 to 2010, and 2013 to 2014 at high and medium frequencies. Economic and industrial activities increased, driving R&D investments, which caused high CO_2 emissions. To reduce damage, investments in green technologies were implemented.

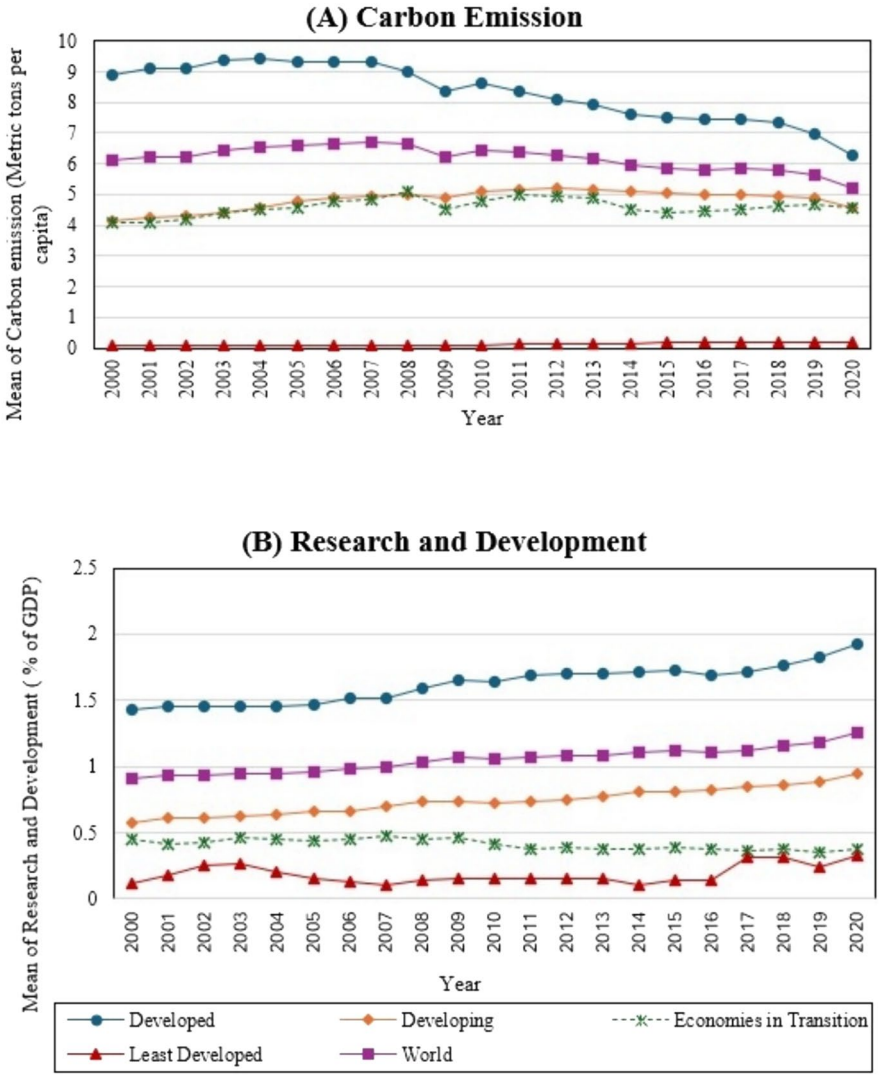

Fig. 2 Country group wise mean CO_2 and R&D, 2000–2020. *Source*: Authors' Compilation

In 2006 and 2011, a positive correlation with unidirectional relationships shows R&D caused CO_2, whereas in 2020, CO_2 caused R&D. In 2019, similar causality appears with negative correlations. This result is supported by the study on the USA, China, and 15 EU countries (1990 to 2013), found R&D spending reduced CO_2 emissions, except in China, where economic growth increased emissions through technology usage (Fernández Fernández et al., 2018). CO_2 influenced shallow emissions in 2012 and 2018 negatively but positively in 2020. Medium-term (Scale 16–64) portrays no causality with a shallow frequency. Long-term (Scale 64–256), displays unidirectional causality from 2006 to 2016, shows CO_2 caused R&D at a medium scale showing both positive and negative correlation.

Table 2 Interpretation of Wavelet Coherence. *Source*: Authors' Compilation

Attributes	Interpretation
Horizontal Axis	Time period
Vertical Axis	Scale
→	Positive relationship (In-Phase)
←	Negative relationship (Out-phase)
↗	Second variable (R&D) causes the first variable (CO_2)
↘	First Variable (CO_2) causes the second Variable (R&D)
↖	Second variable (R&D) causes the first variable (CO_2)
↙	First Variable (CO_2) causes the second Variable (R&D)

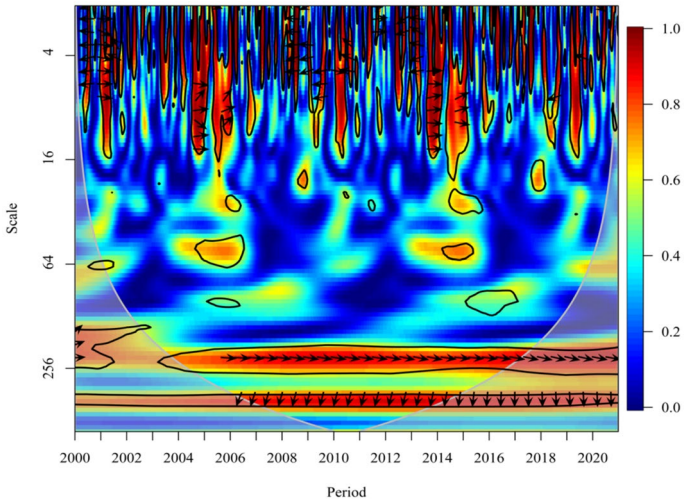

Fig. 3 Wavelet coherence: CO_2 vs R&D for all countries

In developed countries (Fig. 4), short-term results (Scale 0–16) shows causalities at high and medium frequencies. Bidirectional causalities are portrayed in 2002 to 2003, 2007, 2010 to 2014, and 2018 to 2019.

Unidirectional causality appeared in 2001 and 2009, where CO_2caused R&D with a negative correlation at high and medium frequencies. In 2004, R&D positively influenced CO_2 at medium frequency with unidirectional causality. No causality in the medium and long term in developed countries is visible. From the latter part of 2018, applications of technologies like CO_2 capture and storage projects emerged in countries like UK, USA, Canada, and Australia, showing the road map to reduce CO_2 emissions (Wang et al., 2021). A study for G7 countries reveals R&D intensity negatively correlated with carbon emissions across the time range of 1970 to 2017, except for Canada and UK. For Canada in the short term relationships shifted to positive in the medium and long term (Erdogan et al., 2023). The findings suggest R&D investments reduces CO_2 emission through cleaner production, and carbon capture technologies. In short term, testing and manufacturing new technologies temporarily increase emissions in developed countries.

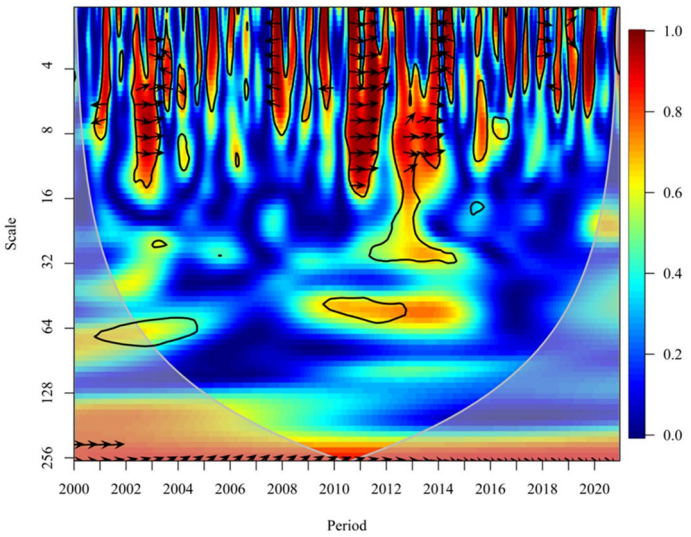

Fig. 4 Wavelet coherence: CO_2 vs R&D for Developed Countries

In contrast, the UK had a short and medium term positive correlation with emisssions, shifting to negative in the long term, taking into consideration the findings show negative unidirectional causality from 2000 to 2018. This shows R&D investments reduces emissions, as seen in G7 countries. Considering globalisation, Japan has a positive correlation for CO_2, suggesting R&D investments in new high technological industries such as clean technology (Y. Huang et al., 2021a, 2021b). A Japanese study on green R&D explains R&D with eco-innovations related to production, processing and operational efficiencies, analysing the relationship with carbon emissions, revealing a negative relationship (Lee & Min, 2015). Above studies support this study's findings, showing unidirectional causality between CO_2 and R&D. Developed countries like USA and Germany have taken steps in reducing CO_2 while supporting the economic and environment sustainability through trading of CO_2 by implementing programs like Carbon Capture Reuse and Carbon Capture Storage (Petrović & Lobanov, 2020).

In developing countries, a mix of bidirectional and unidirectional causalities is visible, as shown in Fig. 5. In 2002 and from 2009 to 2010, bidirectional causalities with high and medium frequencies were portrayed.

The later period from 2011 and 2015 to 2016, unidirectional relationship showed R&D causes CO_2 emissions with a positive correlation, and a similar causality with a negative correlation in 2019 and 2020. A negative unidirectional causality is depicted in 2000 and 2018, in which CO_2 has caused R&D at a high and medium frequency in the short term (Scale 0–8). Medium term (Scale 8–32), shows clear bi-directions in most of the years, 2002, 2009 to 2010, and 2014 to 2016, with high and medium frequencies. Additionally, CO_2 has caused R&D negatively in 2003. In the long term (Scale 32–128) for 7 years, from 2006 to 2012, a bidirectional relationship is depicted, and R&D has positively caused CO_2 at high and medium frequencies.

Further, a positive unidirectional relationship is shown in the countries from 2013 to 2016 among CO_2 and R&D. A study done for G7 countries reveals time-varying relationship between R&D and CO_2, shifting from positive relationship during 1955 to

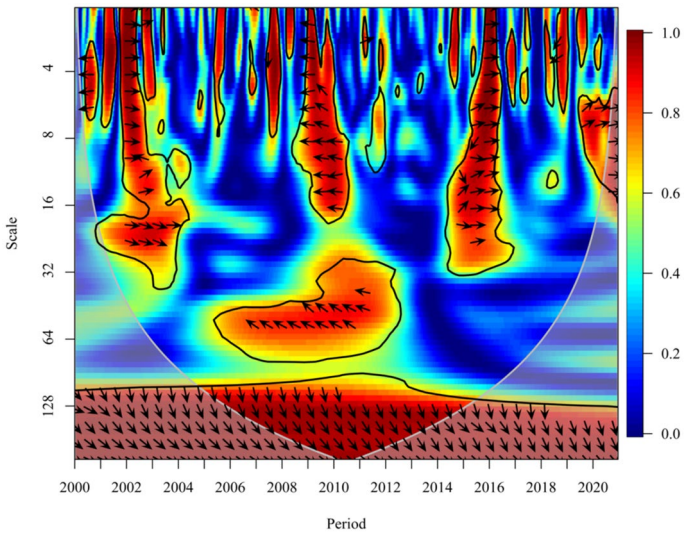

Fig. 5 Wavelet coherence: CO_2 vs R&D for Developing Countries

1990 to a negative relationship in three-quarters of the time from 1990 onwards. During the mid-1950s and mid-1970s, the relationship was largely positive and has started to become negative starting from 1990s. The findings suggest that international organisations like the UN have encouraged technology transfers from developed countries to developing countries, aiding CO_2 mitigation. From developing countries, BRICS nations have increased investment in R&D, creating opportunities for technologiesthat reduce carbon footprint (Awaworyi Churchill et al., 2019). Another study on China reveals that CO_2 emission decreases with research intensity, which directly and indirectly impacts CO_2 reduction through its relationship with the technological gap.

Further, findings suggest that modern R&D growth models will help to understand the issues related to environmental carbon footprint in developing economies (Ang, 2009). Geo-thermal technologies in Turkey and China have reduced 300 million tons and 100 million tons of CO_2, while Iceland utilises 62% of geothermal energy for the productions in the country to achieve the goal of zero-carbon country (Wang et al., 2021).

In economies in transition, as shown in Fig. 6, early 2000s shows no relationship between CO_2 and R&D. In the short-term (Scale 0–8) during 2003 to 2004, a unidirectional causality of R&D leading to CO_2 emissions is positively visible at medium frequency.

Latter half of the period from 2013, 2016 to 2018 shows bidirectional causality between CO_2 and R&D, with high and medium frequencies showing a positive correlation. The years 2010 and 2015 show a unidirectional relationship where CO_2 has led to R&D positively. Medium term (Scale 8–32), shows no causality with low frequency at the beginning of the period. From 2015 to 2019, clear bidirectional causality between CO_2 and R&D is observed at high frequency. In the long-term, from 2014 to 2015, R&D has caused positive CO_2 emissions. From 2016 to 2018, across short, medium, and long-term scales, bidirectional causality emerged between CO_2 and R&D at high frequency, likely due to rapid industrialization leading to increased CO_2 emissions (Mentel et al., 2022). Governments are encouraged to invest in R&D for renewable energy, as such policies can create

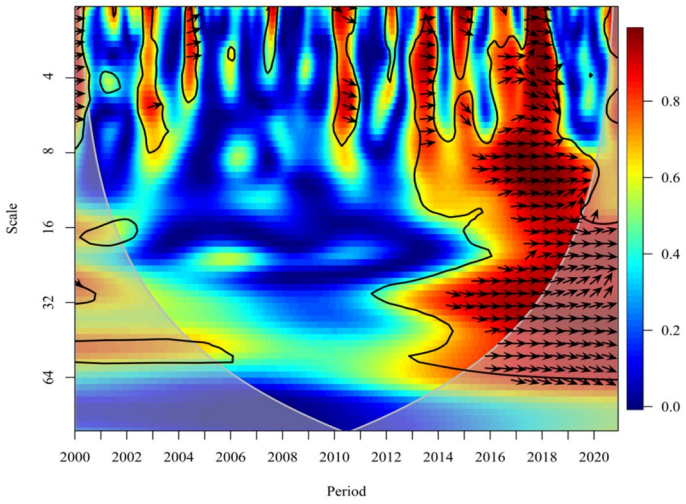

Fig. 6 Wavelet coherence: CO_2 vs R&D for Economies in Transition

a unidirectional impact where increased R&D will reduce CO_2 emissions and advances environmental sustainablilty.

Figure 7 shows no long-term causality for LDCs. Short (Scale 0–2) and medium term (Scale 2–5) results from 2008 to 2011 show both negative and positive unidirectional causality where CO_2 caused R&D at high and medium frequency. From 2000 to 2020, except for 2008 to 2011, no causality is observed. The UN Conference on Trade and Development urges LDCs to adopt "green industrial policies" to transition from carbon-intensive to low-carbon industries. Implementing green technologies and innovation willreduce CO_2

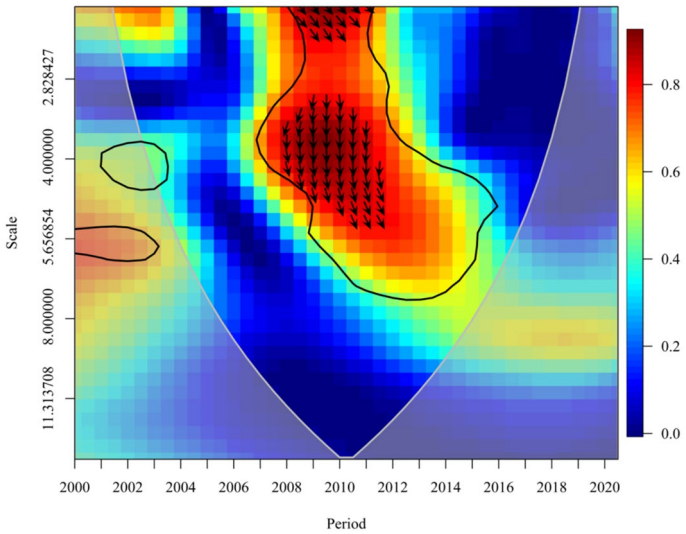

Fig. 7 Wavelet coherence: CO_2 vs R&D for Least Developed Countries

emissions (UNCTAD, 2022). In least-developed economies in transition, renewable energy utilisation projects like wind and solar will help reduce CO_2 emissions.

Short-term (1–3 years) strategies involve projects on promoting renewable energy utilisation and enhancing investments in R&D for clean energy that can accelerate the reduction of CO_2 emissions. Medium-term (3–5 years) strategies supporting R&D projects as funding for technology demonstration, commercialisation efforts, and introducing supportive government policies. Long-term strategies prioritise investments in large-scale emission reductions will help in reduction targets of CO_2 emission for policymakers.

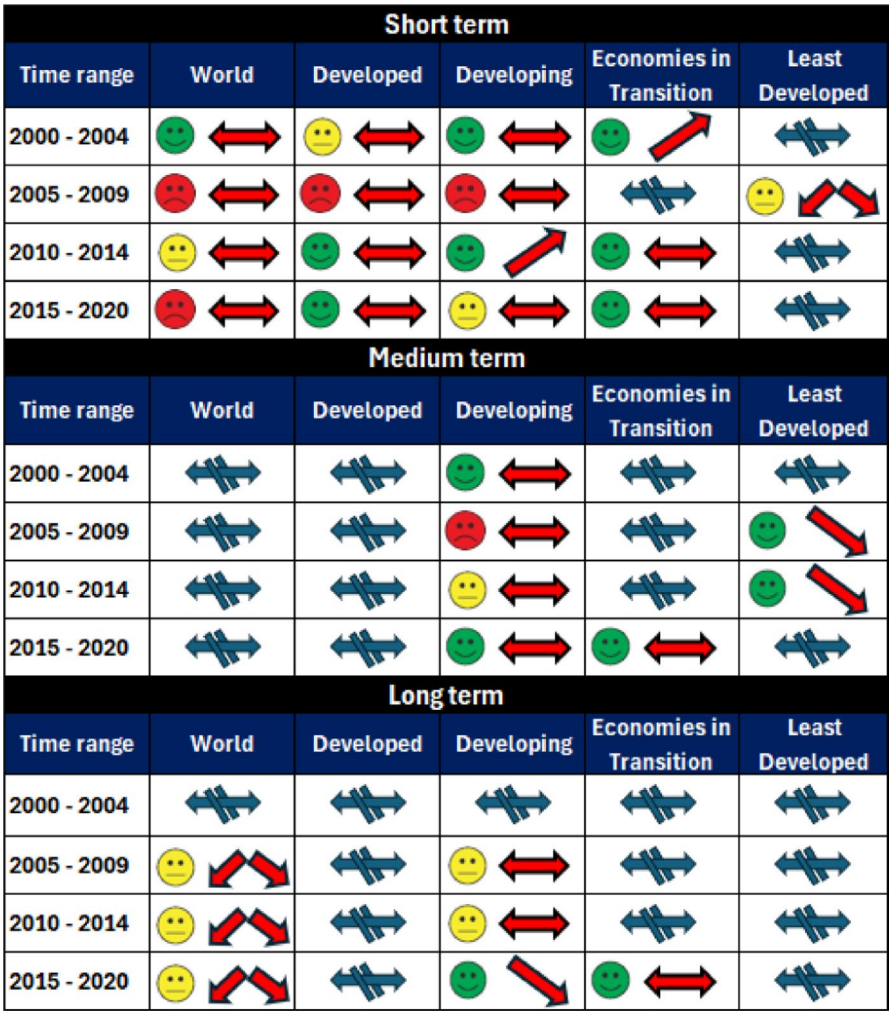

Fig. 8 Summary of Wavelet Coherence Graph. *Note* Second variable causes first variable, First Variable causes second variable. Positive, mixed, negative impacts respectively, Red Yellow colour arrows depicts high, High and medium frequencies respectively, No Causality

Figure 8 summarises the causality and correlation between CO_2 and R&D, as the first and second variables, respectively. This has been classified as developed, developing, economies in transition, and LDC categories based on economic development, including the global context for short, medium, and long-term clustering 5 years each for the time range 2000 to 2020. In the short-term bidirectional causality between CO_2 emission and R&D is observed globally and in all country categories except LDCs. A unidirectional relationship is seen in developing countries from 2010 to 2014; in economies in transition from 2000 to 2004, and in LDCs from 2005 to 2009 showing mixed correlation. No causality is found in economies in transition from 2005 to 2009 or in LDCs for other periods except 2005 to 2009. Considering the medium term, throughout the entire time range, no causality is observed globally or in developed countries, while developing countries show bidirectional relationship for all time ranges.

Economies in transition shows bidirectional relationship in the last five years. Developed countries and LDCs show no causality, while economies in transition exhibit bidirectional causality only in the last five years. Developing countries show no causality in the first five years, unidirectional causality in the last five years, and bidirectional causality from 2005 to 2014. LDCs has a one-way causality from 2005 to 2014 and no causality for the first and last five years. In the long term, in a global context, a unidirectional relationship emphasises a mixed correlation for the years range 2005 to 2020 except for the first five years, showing no causality.

Moreover, the Panel Granger Causality test results show unidirectional causality globally between R&D and CO_2 emission. LDCs show no causality, while Developed, Developing and Economies in transition show unidirectional causality. Appendix 2 contains all the results of the 81 countries and the test results are presented in the Table 3,

Cross-country Granger results display that under developing country category majority of the countries demonstrate unidirectional causality while Iceland, Norway and Poland demonstrate bidirectional causality. Developing Countries such as Argentina, Brazil, China, Egypt, Malaysia along with 6 other countries depict a unidirectional relationship while Colombia, Ecuador, Pakistan, and Singapore display bidirectional causality. Under Economies in transition, only North Macedonia represents bidirectional causality but in LDCs countries only present unidirectional causality.

The integration of Panel Granger Causality analysis provides an additional robustness check, ensuring that observed directional relationships are statistically validated. While the Wavelet Coherence approach has inherent sensitivities to parameter choices and boundary effects, these were mitigated through careful parameter calibration and statistical validation via Monte Carlo simulations.

Table 3 Summary of granger results. *Source*: Author's Compilation

Country catergory	CO_2—RD	RD—CO_2	Causality
All Countries	0.17	3.068*	Unidirection
Developed Countries	0.002	3.628*	Unidirection
Developing countries	1.87	3.255*	Unidirection
Economies In Transition	3.368*	0.008	Unidirection
Least Developed Countries	0.97	0.401	No Causality

The symbols * depicts 10% significance level

5 Conclusion

5.1 Summary of findings

The causality among R&D and CO_2 emission was analysed using the Wavelet coherence method for the period 2000–2020 for different country categories, namely developed, developing, Economics in Transition, and LDCs. Globally, short-term analysis shows both bi-directional and uni-directional causality between the aforementioned variables, while long-term analysis (2006–2016) reveals unidirectional causality, where CO_2 caused R&D with a positive correlation at medium scale with 5% significance level. Developed countries exhibit short-term bidirectional causality with mixed correlations. Developing countries show one-way and two-way causalities with positive and negative correlations in the short and medium-term, with long-term unidirectional causality where R&D positively influenced CO_2 emissions at high and medium frequency. Economies in transitionshow bidirectional causality in the short term and unidirectional causality in medium and long term. LDCs exhibits unidirectional causality in short and long- terms.

5.2 Policy implications

The introduction of multi-faceted approaches involved with technologies tailoring to each country category will support the reduction of CO_2 emissions. For developed countries initiating technologies as Carbon Capture and Storage projects and utilising nuclear energy; for developing countries adapting to off-grid renewable solutions and implementing sustainable production methods using renewable energy; for economies in transition countries conducting and implementing energy efficiency programs in commercial and industrial will help to reduce CO_2 and LDCs can increase usage of renewable energies such as solar and wind to replace fossil fuels.

LDCs often need help with basic needs to emerge from poverty, which makes it impractical LDCs to invest in R&D. However, as an alternative approach wherein LDCs can harness the benefits of technological advancements pioneered by significant economies. Outstanding example is solar panels, the improvements and cost reduction for solar panels, which is a result of R&D conducted mainly by countries such as the USA, have been globalise. These can be used by LDCs rather than bearing an expenditure for R&D. With an emphasis on wave and wind power as well as other advances like solar cooling, solar heating, geothermal energy, and advanced wind power technology; this article investigates ways that the LDCs might make use of a variety of renewable energy technologies. LDCs often face significant economic, technical and political barriers that limit the ability to adopt renewable energy technologies. While the transition to these technologies is critical, overcoming these barriers requires wide support mechanisms. International cooperation, through funds, such as the Green Climate Fund, can provide financing to facilitate renewable energy adoption in these countries. Policymakers must also take the initiative to stabilise regulatory environments that attract foreign investment. These approaches will enable LDCs to overcome their unique challenges and contribute to global climate relief efforts.

This study identifies strategic opportunities for LDCs to adopt these technologies to tackle energy challenges and promote sustainability. Drawing on global assessments, particularly in the Atlantic region (Coasts of South America and Europe from Portugal to Russia). Advocating for policies, collaborating internationally, and implementing

capacity-building programs can help LDCs make the most of innovations from large economies' R&D endeavours, which will hasten their shift to renewable energy. International cooperation can help LDCs to adopt clean energy technologies. Technology transfer programs, such as those supported by the UNFCCC Technology Mechanism, provide access to renewable energy technologies and expertise. Capacity-building initiatives, such as training centres and regional expertise development, help local businesses build, manage and maintain the world's energy systems. Global climate finance mechanisms, such as the Green Climate Fund, provide resources to cover the initial costs of renewable energy projects.

Policymakers can set emission reduction targets to encourage countries to implement technologies suitable for the countries targeting the sectors essential for transportation, industrial, power sector, and energy demand services to support the mitigation of CO_2 emission (Aleluia Reis et al., 2023).

5.3 Limitations and future research directions

It is essential to acknowledge the limitations of this study; even though there are 190 countries globally, the study was based on only 81 countries due to the unavailability of data. The fixed time frame of 21 years insufficient to capture the long-term fluctuations between the variables with the data access has been limited to 2020. Future researchers could incorporate more recent data with additional variables such as solar power, technological variables and eco-innovations, which will provide a comprehensive understanding of novel concepts to mitigate emissions to make the world better. The study employs Panel Granger Causality analysis as a complementary robustness check to validate causal relationships observed through Wavelet Coherence analysis. Statistical significance was tested using Monte Carlo simulations, ensuring reliability of the identified causal patterns. While formal sensitivity testing (e.g., varying wavelet types, smoothing factors) was not explicitly conducted, the methodological choices were carefully calibrated following established literature. Potential boundary effects identified within the Cone of Influence were interpreted with caution to minimize uncertainties.

6 Appendix 1: Data File

Country Name	Year	Country Category	CO2	R&D
Argentina	2013	Developing Countries	4.34225013	0.618489981
Argentina	2015	Developing Countries	4.301913806	0.622619987
Argentina	2011	Developing Countries	4.281028145	0.565970004
Argentina	2012	Developing Countries	4.264111002	0.634909987
Argentina	2014	Developing Countries	4.209111895	0.593959987
Argentina	2016	Developing Countries	4.201815869	0.558149993
Argentina	2008	Developing Countries	4.15237521	0.470550001
Argentina	2010	Developing Countries	4.09984414	0.561039984
Argentina	2007	Developing Countries	4.083151439	0.460070014

Country Name	Year	Country Category	CO2	R&D
Argentina	2017	Developing Countries	4.070111687	0.556309998
Argentina	2018	Developing Countries	3.975650744	0.494349986
Argentina	2006	Developing Countries	3.924261841	0.452160001
Argentina	2009	Developing Countries	3.848348227	0.583980024
Argentina	2019	Developing Countries	3.742029812	0.478130013
Argentina	2005	Developing Countries	3.736716865	0.420740008
Argentina	2004	Developing Countries	3.65608487	0.403759986
Argentina	2000	Developing Countries	3.56791849	0.438840002
Argentina	2020	Developing Countries	3.40561754	0.541540027
Argentina	2001	Developing Countries	3.341877067	0.424609989
Argentina	2003	Developing Countries	3.334890879	0.410129994
Argentina	2002	Developing Countries	3.100488668	0.388859987
Armenia	2020	Economies in Transition	2.404683762	0.209199995
Armenia	2019	Economies in Transition	2.196552367	0.178540006
Armenia	2018	Economies in Transition	2.013779381	0.188759997
Armenia	2012	Economies in Transition	1.961453064	0.238529995
Armenia	2008	Economies in Transition	1.90569819	0.224380001
Armenia	2013	Economies in Transition	1.896163384	0.222159997
Armenia	2014	Economies in Transition	1.895893672	0.241510004
Armenia	2017	Economies in Transition	1.88339587	0.227880001
Armenia	2015	Economies in Transition	1.85625279	0.250019997
Armenia	2016	Economies in Transition	1.767966404	0.233050004
Armenia	2007	Economies in Transition	1.732263389	0.211070001
Armenia	2011	Economies in Transition	1.685606164	0.270139992
Armenia	2009	Economies in Transition	1.521710382	0.290930003
Armenia	2006	Economies in Transition	1.4833044	0.240569994
Armenia	2010	Economies in Transition	1.471883482	0.241390005
Armenia	2005	Economies in Transition	1.463912004	0.257609993
Armenia	2004	Economies in Transition	1.227695063	0.256590009
Armenia	2001	Economies in Transition	1.149647972	0.279870003
Armenia	2003	Economies in Transition	1.133360699	0.321090013
Armenia	2000	Economies in Transition	1.123867493	0.191060007
Armenia	2002	Economies in Transition	1.00440027	0.252550006
Australia	2007	Developed Countries	18.45473766	2.290030003
Australia	2004	Developed Countries	18.36887105	1.849020004
Australia	2006	Developed Countries	18.29274959	2.180109978
Australia	2005	Developed Countries	18.27847309	2.014564991
Australia	2008	Developed Countries	18.23928987	2.399950027
Australia	2009	Developed Countries	18.15720084	2.385349989
Australia	2002	Developed Countries	18.12321078	1.747490048
Australia	2010	Developed Countries	17.97375152	2.37074995
Australia	2001	Developed Countries	17.93072692	1.660345018
Australia	2003	Developed Countries	17.89453913	1.798255026
Australia	2000	Developed Countries	17.8373184	1.573199987
Australia	2011	Developed Countries	17.65605534	2.234839916
Australia	2012	Developed Countries	17.40561767	2.206634998

Country Name	Year	Country Category	CO2	R&D
Australia	2013	Developed Countries	16.7945881	2.17843008
Australia	2016	Developed Countries	16.32033061	1.900240004
Australia	2015	Developed Countries	16.19845822	1.920709968
Australia	2014	Developed Countries	16.15574514	2.049570024
Australia	2017	Developed Countries	16.1491503	1.879770041
Australia	2018	Developed Countries	15.86571352	1.854345024
Australia	2019	Developed Countries	15.59904536	1.828920007
Australia	2020	Developed Countries	14.77613691	1.854345024
Austria	2004	Developed Countries	9.275870702	2.166120052
Austria	2005	Developed Countries	9.266405512	2.373239994
Austria	2003	Developed Countries	9.169316756	2.17456007
Austria	2006	Developed Countries	8.962101511	2.359230042
Austria	2007	Developed Countries	8.588766398	2.41843009
Austria	2002	Developed Countries	8.583836811	2.065979958
Austria	2008	Developed Countries	8.500238419	2.569449902
Austria	2001	Developed Countries	8.444656269	1.9921
Austria	2010	Developed Countries	8.36562481	2.726099968
Austria	2011	Developed Countries	8.136189778	2.668679953
Austria	2000	Developed Countries	7.930858961	1.886019945
Austria	2013	Developed Countries	7.754017979	2.954920053
Austria	2012	Developed Countries	7.723851662	2.914720058
Austria	2009	Developed Countries	7.721228101	2.596740007
Austria	2017	Developed Countries	7.487036755	3.05656004
Austria	2015	Developed Countries	7.318859537	3.049690008
Austria	2016	Developed Countries	7.290777216	3.116549969
Austria	2019	Developed Countries	7.263331201	3.132469893
Austria	2014	Developed Countries	7.260930858	3.084290028
Austria	2018	Developed Countries	7.141140211	3.091820002
Austria	2020	Developed Countries	6.632645737	3.201489925
Azerbaijan	2006	Economies in Transition	3.593402125	0.171650007
Azerbaijan	2005	Economies in Transition	3.580068757	0.219940007
Azerbaijan	2019	Economies in Transition	3.54349533	0.200130001
Azerbaijan	2008	Economies in Transition	3.474404911	0.165539995
Azerbaijan	2003	Economies in Transition	3.469644527	0.324959993
Azerbaijan	2000	Economies in Transition	3.440001988	0.335999995
Azerbaijan	2004	Economies in Transition	3.408403058	0.298310012
Azerbaijan	2020	Economies in Transition	3.398849573	0.223900005
Azerbaijan	2014	Economies in Transition	3.381555622	0.209779993
Azerbaijan	2016	Economies in Transition	3.303957895	0.206369996
Azerbaijan	2015	Economies in Transition	3.292794814	0.222320005
Azerbaijan	2018	Economies in Transition	3.292641249	0.184159994
Azerbaijan	2013	Economies in Transition	3.285574369	0.209690005
Azerbaijan	2001	Economies in Transition	3.25441365	0.340009987
Azerbaijan	2017	Economies in Transition	3.243037648	0.18468
Azerbaijan	2012	Economies in Transition	3.239167347	0.214269996
Azerbaijan	2007	Economies in Transition	3.219523848	0.170059994

Country Name	Year	Country Category	CO2	R&D
Azerbaijan	2002	Economies in Transition	3.203348038	0.301550001
Azerbaijan	2011	Economies in Transition	2.97414762	0.210840002
Azerbaijan	2009	Economies in Transition	2.849570533	0.249760002
Azerbaijan	2010	Economies in Transition	2.685112496	0.218480006
Belarus	2010	Economies in Transition	6.478781371	0.669130027
Belarus	2013	Economies in Transition	6.342249474	0.651910007
Belarus	2012	Economies in Transition	6.323630473	0.646030009
Belarus	2008	Economies in Transition	6.321556971	0.741469979
Belarus	2014	Economies in Transition	6.290067804	0.505479991
Belarus	2018	Economies in Transition	6.279579416	0.60443002
Belarus	2011	Economies in Transition	6.164447338	0.677600026
Belarus	2019	Economies in Transition	6.12342695	0.577329993
Belarus	2006	Economies in Transition	6.121245728	0.660650015
Belarus	2009	Economies in Transition	6.015761028	0.621670008
Belarus	2007	Economies in Transition	5.995939944	0.962029994
Belarus	2017	Economies in Transition	5.946407169	0.584110022
Belarus	2005	Economies in Transition	5.842828709	0.678520024
Belarus	2020	Economies in Transition	5.842407296	0.539009988
Belarus	2016	Economies in Transition	5.829463579	0.500630021
Belarus	2015	Economies in Transition	5.799689169	0.499989986
Belarus	2004	Economies in Transition	5.729965409	0.627590001
Belarus	2003	Economies in Transition	5.361564331	0.611469984
Belarus	2000	Economies in Transition	5.30757214	0.722100019
Belarus	2002	Economies in Transition	5.245821114	0.620899975
Belarus	2001	Economies in Transition	5.209240545	0.708760023
Belgium	2001	Developed Countries	11.50430124	2.032789946
Belgium	2000	Developed Countries	11.44002926	1.936190009
Belgium	2003	Developed Countries	11.13151691	1.841189981
Belgium	2004	Developed Countries	10.87700891	1.820500016
Belgium	2002	Developed Countries	10.72800799	1.903249979
Belgium	2005	Developed Countries	10.58920275	1.790609956
Belgium	2006	Developed Countries	10.24667523	1.82269001
Belgium	2008	Developed Countries	9.964114755	1.936840057
Belgium	2010	Developed Countries	9.808816157	2.061880112
Belgium	2007	Developed Countries	9.778725166	1.84999001
Belgium	2009	Developed Countries	9.253412196	1.998600006
Belgium	2011	Developed Countries	8.741247718	2.173320055
Belgium	2013	Developed Countries	8.651947187	2.330729961
Belgium	2012	Developed Countries	8.578030369	2.281140089
Belgium	2015	Developed Countries	8.434836506	2.428169966
Belgium	2016	Developed Countries	8.310660392	2.523380041
Belgium	2018	Developed Countries	8.184366679	2.860179901
Belgium	2017	Developed Countries	8.139438591	2.66666007
Belgium	2019	Developed Countries	8.093790746	3.156599998
Belgium	2014	Developed Countries	8.061552368	2.370019913
Belgium	2020	Developed Countries	7.398130658	3.396970034

Country Name	Year	Country Category	CO2	R&D
Brazil	2014	Developing Countries	2.51459196	1.269709945
Brazil	2013	Developing Countries	2.413446537	1.195670009
Brazil	2015	Developing Countries	2.365360621	1.370929956
Brazil	2012	Developing Countries	2.271417684	1.126839995
Brazil	2017	Developing Countries	2.185486619	1.117499948
Brazil	2016	Developing Countries	2.161259847	1.286370039
Brazil	2011	Developing Countries	2.11062776	1.139660001
Brazil	2018	Developing Countries	2.064261479	1.167690039
Brazil	2019	Developing Countries	2.050770129	1.210960031
Brazil	2010	Developing Countries	2.026605669	1.159919977
Brazil	2020	Developing Countries	1.942523356	1.145259976
Brazil	2008	Developing Countries	1.939215274	1.129040003
Brazil	2007	Developing Countries	1.847975736	1.08138001
Brazil	2009	Developing Countries	1.799328142	1.118659973
Brazil	2001	Developing Countries	1.792112278	1.061980009
Brazil	2000	Developing Countries	1.783500116	1.047510028
Brazil	2004	Developing Countries	1.778441244	0.963429987
Brazil	2006	Developing Countries	1.777477957	0.988070011
Brazil	2005	Developing Countries	1.775662922	1.002460003
Brazil	2002	Developing Countries	1.760651244	1.009680033
Brazil	2003	Developing Countries	1.701852536	0.999390006
Bulgaria	2007	Developed Countries	6.971019721	0.430029988
Bulgaria	2011	Developed Countries	6.754951603	0.529510021
Bulgaria	2008	Developed Countries	6.678530879	0.447310001
Bulgaria	2006	Developed Countries	6.440554967	0.44216001
Bulgaria	2005	Developed Countries	6.265279466	0.442690015
Bulgaria	2015	Developed Countries	6.207377524	0.949169993
Bulgaria	2017	Developed Countries	6.20201084	0.739950001
Bulgaria	2003	Developed Countries	6.164795384	0.472220004
Bulgaria	2012	Developed Countries	6.162577362	0.600359976
Bulgaria	2004	Developed Countries	6.124991253	0.470860004
Bulgaria	2010	Developed Countries	6.049624919	0.563069999
Bulgaria	2016	Developed Countries	5.834418985	0.769760013
Bulgaria	2018	Developed Countries	5.821777166	0.753790021
Bulgaria	2014	Developed Countries	5.821533906	0.79005003
Bulgaria	2001	Developed Countries	5.766610206	0.44709
Bulgaria	2009	Developed Countries	5.763735447	0.49338001
Bulgaria	2019	Developed Countries	5.613710103	0.832360029
Bulgaria	2002	Developed Countries	5.563226275	0.464729995
Bulgaria	2013	Developed Countries	5.45906018	0.634329975
Bulgaria	2000	Developed Countries	5.314588236	0.495169997
Bulgaria	2020	Developed Countries	4.923280379	0.849240005
Burkina Faso	2019	Least Developed Countries	0.269501589	0.172780007
Burkina Faso	2020	Least Developed Countries	0.253533189	0.248239994
Burkina Faso	2018	Least Developed Countries	0.25242828	0.393195018
Burkina Faso	2017	Least Developed Countries	0.23317368	0.613610029

Country Name	Year	Country Category	CO2	R&D
Burkina Faso	2016	Least Developed Countries	0.207403202	0.2774
Burkina Faso	2015	Least Developed Countries	0.2031091	0.2602
Burkina Faso	2013	Least Developed Countries	0.167097518	0.2312
Burkina Faso	2014	Least Developed Countries	0.164943647	0.197190002
Burkina Faso	2012	Least Developed Countries	0.157359014	0.2194
Burkina Faso	2011	Least Developed Countries	0.132533051	0.2094
Burkina Faso	2010	Least Developed Countries	0.129944788	0.2012
Burkina Faso	2008	Least Developed Countries	0.125648814	0.165680006
Burkina Faso	2009	Least Developed Countries	0.1233289	0.177870005
Burkina Faso	2007	Least Developed Countries	0.114034801	0.098360002
Burkina Faso	2006	Least Developed Countries	0.097824555	0.125009999
Burkina Faso	2000	Least Developed Countries	0.088272312	0.1422
Burkina Faso	2003	Least Developed Countries	0.08460706	0.241119996
Burkina Faso	2004	Least Developed Countries	0.084325594	0.21514
Burkina Faso	2001	Least Developed Countries	0.083612223	0.168160006
Burkina Faso	2005	Least Developed Countries	0.082969117	0.151659995
Burkina Faso	2002	Least Developed Countries	0.081317933	0.301109999
Canada	2007	Developed Countries	17.38063077	1.90357995
Canada	2003	Developed Countries	17.20835919	1.967810035
Canada	2005	Developed Countries	17.0275681	1.971269965
Canada	2004	Developed Countries	16.79418597	1.997339964
Canada	2000	Developed Countries	16.75746674	1.858479977
Canada	2002	Developed Countries	16.72041069	1.971709967
Canada	2006	Developed Countries	16.59521392	1.943040013
Canada	2008	Developed Countries	16.55942629	1.855780005
Canada	2001	Developed Countries	16.33143678	2.021169901
Canada	2011	Developed Countries	15.99827172	1.787140012
Canada	2014	Developed Countries	15.85217722	1.714169979
Canada	2013	Developed Countries	15.84080976	1.70539999
Canada	2010	Developed Countries	15.79453766	1.825279951
Canada	2012	Developed Countries	15.73682394	1.772320032
Canada	2015	Developed Countries	15.64990728	1.693240047
Canada	2018	Developed Countries	15.63665416	1.737200022
Canada	2017	Developed Countries	15.54719472	1.687019944
Canada	2009	Developed Countries	15.50450587	1.91742003
Canada	2016	Developed Countries	15.42182253	1.729030013
Canada	2019	Developed Countries	15.05274694	1.755730033
Canada	2020	Developed Countries	13.59937492	1.894840002
Chile	2019	Developing Countries	4.827620075	0.342049986
Chile	2016	Developing Countries	4.783525703	0.371030003
Chile	2017	Developing Countries	4.743802419	0.356790006
Chile	2013	Developing Countries	4.740083124	0.390300006
Chile	2018	Developing Countries	4.629657059	0.369159997
Chile	2015	Developing Countries	4.603236105	0.382959992
Chile	2012	Developing Countries	4.521602782	0.362129986
Chile	2011	Developing Countries	4.452800824	0.352880001

Country Name	Year	Country Category	CO2	R&D
Chile	2020	Developing Countries	4.395151064	0.334960014
Chile	2014	Developing Countries	4.328593459	0.376679987
Chile	2010	Developing Countries	4.101883998	0.331649989
Chile	2008	Developing Countries	4.080770343	0.374920011
Chile	2007	Developing Countries	3.91463437	0.311430007
Chile	2009	Developing Countries	3.888128201	0.354030013
Chile	2006	Developing Countries	3.498597301	0.2936
Chile	2005	Developing Countries	3.460143672	0.2745
Chile	2004	Developing Countries	3.431902652	0.2534
Chile	2000	Developing Countries	3.284598763	0.149
Chile	2003	Developing Countries	3.165410522	0.2303
Chile	2002	Developing Countries	3.129989633	0.2052
Chile	2001	Developing Countries	3.119374428	0.1781
China	2020	Developing Countries	7.756137907	2.40666008
China	2019	Developing Countries	7.645435786	2.244630098
China	2018	Developing Countries	7.533193134	2.140579939
China	2013	Developing Countries	7.320154925	1.997859955
China	2014	Developing Countries	7.304712872	2.022429943
China	2017	Developing Countries	7.226160154	2.116029978
China	2015	Developing Countries	7.145131535	2.057009935
China	2016	Developing Countries	7.105479936	2.100330114
China	2012	Developing Countries	7.04520023	1.912140012
China	2011	Developing Countries	6.901347326	1.780339956
China	2010	Developing Countries	6.335419767	1.713719964
China	2009	Developing Countries	5.798319938	1.664800048
China	2008	Developing Countries	5.435079096	1.445919991
China	2007	Developing Countries	5.306368006	1.373690009
China	2006	Developing Countries	4.910276197	1.368540049
China	2005	Developing Countries	4.467696361	1.307919979
China	2004	Developing Countries	3.945154871	1.214980006
China	2003	Developing Countries	3.434036479	1.12037003
China	2002	Developing Countries	2.964821228	1.057860017
China	2001	Developing Countries	2.774762197	0.940330029
China	2000	Developing Countries	2.650409102	0.893159986
Colombia	2016	Developing Countries	1.753795803	0.270509988
Colombia	2015	Developing Countries	1.719390231	0.365420014
Colombia	2014	Developing Countries	1.715820964	0.303169996
Colombia	2013	Developing Countries	1.680987882	0.257609993
Colombia	2018	Developing Countries	1.610391517	0.312330008
Colombia	2019	Developing Countries	1.577820141	0.32201001
Colombia	2017	Developing Countries	1.565075176	0.26109001
Colombia	2020	Developing Countries	1.552259423	0.289609998
Colombia	2011	Developing Countries	1.539898376	0.198420003
Colombia	2012	Developing Countries	1.533846498	0.221159995
Colombia	2000	Developing Countries	1.504406398	0.131060004
Colombia	2001	Developing Countries	1.495770043	0.1329

Country Name	Year	Country Category	CO2	R&D
Colombia	2010	Developing Countries	1.431317954	0.193580002
Colombia	2002	Developing Countries	1.418226358	0.155589998
Colombia	2009	Developing Countries	1.414241941	0.193509996
Colombia	2003	Developing Countries	1.381373481	0.173979998
Colombia	2007	Developing Countries	1.378771938	0.183070004
Colombia	2005	Developing Countries	1.37815501	0.165570006
Colombia	2008	Developing Countries	1.376187818	0.195409998
Colombia	2006	Developing Countries	1.36051066	0.164269999
Colombia	2004	Developing Countries	1.359213785	0.169640005
Costa Rica	2007	Developing Countries	1.712267448	0.356550008
Costa Rica	2008	Developing Countries	1.669354038	0.385930002
Costa Rica	2017	Developing Countries	1.636715779	0.425870001
Costa Rica	2013	Developing Countries	1.623425478	0.54253
Costa Rica	2018	Developing Countries	1.620121197	0.371439993
Costa Rica	2016	Developing Countries	1.619528412	0.443349987
Costa Rica	2014	Developing Countries	1.616811387	0.556270003
Costa Rica	2011	Developing Countries	1.587802884	0.462350011
Costa Rica	2009	Developing Countries	1.577536632	0.517180026
Costa Rica	2012	Developing Countries	1.572163789	0.547129989
Costa Rica	2019	Developing Countries	1.564824452	0.350730002
Costa Rica	2015	Developing Countries	1.539842157	0.436650008
Costa Rica	2010	Developing Countries	1.537237693	0.479900002
Costa Rica	2006	Developing Countries	1.497657013	0.42693001
Costa Rica	2005	Developing Countries	1.453675687	0.399905011
Costa Rica	2004	Developing Countries	1.397573363	0.372880012
Costa Rica	2003	Developing Countries	1.384444959	0.361900002
Costa Rica	2020	Developing Countries	1.35999555	0.33002001
Costa Rica	2002	Developing Countries	1.339729585	0.3681
Costa Rica	2001	Developing Countries	1.337873919	0.3426
Costa Rica	2000	Developing Countries	1.243166642	0.411350012
Croatia	2007	Developed Countries	5.306461368	0.784929991
Croatia	2008	Developed Countries	5.041249923	0.878009975
Croatia	2003	Developed Countries	5.021124	0.940689981
Croatia	2006	Developed Countries	5.009859298	0.733129978
Croatia	2005	Developed Countries	4.975470663	0.847760022
Croatia	2004	Developed Countries	4.90003717	1.020020008
Croatia	2009	Developed Countries	4.716619348	0.835070014
Croatia	2002	Developed Countries	4.713128758	0.940869987
Croatia	2010	Developed Countries	4.529770847	0.732339978
Croatia	2001	Developed Countries	4.464557747	0.917620003
Croatia	2011	Developed Countries	4.445054948	0.738470018
Croatia	2017	Developed Countries	4.220576836	0.847270012
Croatia	2012	Developed Countries	4.07797621	0.739560008
Croatia	2019	Developed Countries	4.064519478	1.079630017
Croatia	2016	Developed Countries	4.042977719	0.849950016
Croatia	2000	Developed Countries	4.036074554	1.042500019

Country Name	Year	Country Category	CO2	R&D
Croatia	2018	Developed Countries	4.020066328	0.951250017
Croatia	2013	Developed Countries	3.997143588	0.798169971
Croatia	2015	Developed Countries	3.94953949	0.828159988
Croatia	2020	Developed Countries	3.860705392	1.242609978
Croatia	2014	Developed Countries	3.830795144	0.772589982
Cuba	2015	Developing Countries	2.575844183	0.428539991
Cuba	2000	Developing Countries	2.553001403	0.478650004
Cuba	2013	Developing Countries	2.549971166	0.474669993
Cuba	2012	Developing Countries	2.536932027	0.407160014
Cuba	2010	Developing Countries	2.489722036	0.607670009
Cuba	2001	Developing Countries	2.465642056	0.565299988
Cuba	2007	Developing Countries	2.45588088	0.436150014
Cuba	2011	Developing Countries	2.441544212	0.271919996
Cuba	2016	Developing Countries	2.396082811	0.342229992
Cuba	2009	Developing Countries	2.391133355	0.614849985
Cuba	2006	Developing Countries	2.378215073	0.441390008
Cuba	2008	Developing Countries	2.371909853	0.500609994
Cuba	2002	Developing Countries	2.365566639	0.564450026
Cuba	2018	Developing Countries	2.354698575	0.536909997
Cuba	2014	Developing Countries	2.354133321	0.415960014
Cuba	2005	Developing Countries	2.340177238	0.549199998
Cuba	2017	Developing Countries	2.31478145	0.430660009
Cuba	2003	Developing Countries	2.288427843	0.582430005
Cuba	2004	Developing Countries	2.259611196	0.602310002
Cuba	2019	Developing Countries	2.157740903	0.553080022
Cuba	2020	Developing Countries	2.152769678	0.518379986
Cyprus	2003	Developed Countries	7.831359024	0.318340003
Cyprus	2008	Developed Countries	7.772590375	0.385939986
Cyprus	2007	Developed Countries	7.735644718	0.400070012
Cyprus	2004	Developed Countries	7.63612661	0.335640013
Cyprus	2005	Developed Countries	7.618445185	0.367269993
Cyprus	2006	Developed Countries	7.579223033	0.383459985
Cyprus	2000	Developed Countries	7.516791688	0.226899996
Cyprus	2009	Developed Countries	7.449409257	0.444370002
Cyprus	2002	Developed Countries	7.298456313	0.27967
Cyprus	2001	Developed Countries	7.246976151	0.236939996
Cyprus	2010	Developed Countries	6.991677333	0.442919999
Cyprus	2011	Developed Countries	6.667272152	0.452630013
Cyprus	2012	Developed Countries	6.137878321	0.437649995
Cyprus	2017	Developed Countries	6.091071498	0.542590022
Cyprus	2016	Developed Countries	6.026642045	0.519699991
Cyprus	2018	Developed Countries	5.906151058	0.614049971
Cyprus	2019	Developed Countries	5.851879339	0.709500015
Cyprus	2014	Developed Countries	5.787450244	0.512049973
Cyprus	2015	Developed Countries	5.771090223	0.47529
Cyprus	2013	Developed Countries	5.508034496	0.484849989

Country Name	Year	Country Category	CO2	R&D
Cyprus	2020	Developed Countries	5.471998009	0.843869984
Czechia	2001	Developed Countries	12.17051065	1.098709941
Czechia	2000	Developed Countries	12.16147575	1.109969974
Czechia	2004	Developed Countries	12.13933254	1.139350057
Czechia	2003	Developed Countries	12.10250385	1.142099977
Czechia	2007	Developed Countries	12.08222916	1.295719981
Czechia	2006	Developed Countries	11.96940493	1.225419998
Czechia	2005	Developed Countries	11.93722667	1.161000013
Czechia	2002	Developed Countries	11.78884871	1.09818995
Czechia	2008	Developed Countries	11.43214623	1.233579993
Czechia	2010	Developed Countries	10.89966881	1.326699972
Czechia	2009	Developed Countries	10.84323956	1.286560059
Czechia	2011	Developed Countries	10.59633837	1.544770002
Czechia	2012	Developed Countries	10.2104838	1.76967001
Czechia	2013	Developed Countries	9.787677169	1.879240036
Czechia	2017	Developed Countries	9.773987068	1.768550038
Czechia	2016	Developed Countries	9.747753525	1.670029998
Czechia	2018	Developed Countries	9.66462802	1.899060011
Czechia	2015	Developed Countries	9.592919971	1.916890025
Czechia	2014	Developed Countries	9.497131068	1.958330035
Czechia	2019	Developed Countries	9.156117906	1.927340031
Czechia	2020	Developed Countries	8.304017496	1.985990047
Denmark	2003	Developed Countries	10.98844019	2.510849953
Denmark	2006	Developed Countries	10.69175866	2.403000116
Denmark	2001	Developed Countries	10.12270883	2.324660063
Denmark	2002	Developed Countries	10.01495369	2.441450119
Denmark	2004	Developed Countries	9.941228856	2.419159889
Denmark	2000	Developed Countries	9.851270204	2.186199903
Denmark	2007	Developed Countries	9.779732005	2.515409946
Denmark	2005	Developed Countries	9.263313941	2.393369913
Denmark	2008	Developed Countries	9.124710278	2.773459911
Denmark	2009	Developed Countries	8.67875711	3.055140018
Denmark	2010	Developed Countries	8.674756651	2.917069912
Denmark	2011	Developed Countries	7.736727934	2.944649935
Denmark	2013	Developed Countries	7.11686268	2.970479965
Denmark	2012	Developed Countries	6.834607513	2.981250048
Denmark	2014	Developed Countries	6.347153128	2.914089918
Denmark	2016	Developed Countries	6.169734341	3.092829943
Denmark	2015	Developed Countries	5.930324767	3.054970026
Denmark	2017	Developed Countries	5.756134453	2.931240082
Denmark	2018	Developed Countries	5.718912959	2.966029882
Denmark	2019	Developed Countries	5.107386426	2.896850109
Denmark	2020	Developed Countries	4.691237308	2.968729973
Ecuador	2014	Developing Countries	2.619452044	0.442660004
Ecuador	2015	Developing Countries	2.555603263	0.2022
Ecuador	2013	Developing Countries	2.525035157	0.379900008

Country Name	Year	Country Category	CO2	R&D
Ecuador	2010	Developing Countries	2.485325644	0.402969986
Ecuador	2011	Developing Countries	2.434523047	0.339910001
Ecuador	2016	Developing Countries	2.420480809	0.1619
Ecuador	2012	Developing Countries	2.395077514	0.332359999
Ecuador	2018	Developing Countries	2.366829826	0.0573
Ecuador	2009	Developing Countries	2.340029001	0.394630015
Ecuador	2017	Developing Countries	2.308763807	0.1136
Ecuador	2019	Developing Countries	2.285055011	0.059
Ecuador	2008	Developing Countries	2.18586216	0.227789998
Ecuador	2006	Developing Countries	2.150486746	0.128629997
Ecuador	2007	Developing Countries	2.14961091	0.131940007
Ecuador	2005	Developing Countries	2.049402717	0.1652
Ecuador	2020	Developing Countries	1.957575349	0
Ecuador	2004	Developing Countries	1.934132781	0.1175
Ecuador	2001	Developing Countries	1.887934324	0.0515
Ecuador	2003	Developing Countries	1.853654532	0.057349999
Ecuador	2002	Developing Countries	1.849362949	0.055339999
Ecuador	2000	Developing Countries	1.746444999	0.0485
Egypt, Arab Rep	2017	Developing Countries	2.402416496	0.644860029
Egypt, Arab Rep	2016	Developing Countries	2.359353496	0.70848
Egypt, Arab Rep	2012	Developing Countries	2.356422775	0.50898999
Egypt, Arab Rep	2015	Developing Countries	2.315542399	0.718580008
Egypt, Arab Rep	2009	Developing Countries	2.311789945	0.433120012
Egypt, Arab Rep	2011	Developing Countries	2.306806899	0.531539977
Egypt, Arab Rep	2010	Developing Countries	2.295790948	0.433450013
Egypt, Arab Rep	2018	Developing Countries	2.294016243	0.688390017
Egypt, Arab Rep	2014	Developing Countries	2.292245767	0.636489987
Egypt, Arab Rep	2013	Developing Countries	2.290225234	0.63894999
Egypt, Arab Rep	2008	Developing Countries	2.265319239	0.270240009
Egypt, Arab Rep	2007	Developing Countries	2.230582304	0.255100012
Egypt, Arab Rep	2006	Developing Countries	2.117644783	0.259030014
Egypt, Arab Rep	2019	Developing Countries	2.063160783	0.796169996
Egypt, Arab Rep	2005	Developing Countries	2.051425407	0.241410002
Egypt, Arab Rep	2020	Developing Countries	1.961122572	0.915639997
Egypt, Arab Rep	2004	Developing Countries	1.864027038	0.269939989
Egypt, Arab Rep	2003	Developing Countries	1.751113518	0.2155
Egypt, Arab Rep	2002	Developing Countries	1.73994703	0.1904
Egypt, Arab Rep	2001	Developing Countries	1.739148792	0.1667
Egypt, Arab Rep	2000	Developing Countries	1.605887604	0.192469999
Estonia	2007	Developed Countries	14.74311543	1.05874002
Estonia	2013	Developed Countries	14.2993497	1.724120021
Estonia	2011	Developed Countries	13.93856893	2.305219889
Estonia	2010	Developed Countries	13.89466569	1.578989983
Estonia	2014	Developed Countries	13.38478333	1.430230021
Estonia	2008	Developed Countries	13.07428819	1.25188005
Estonia	2012	Developed Countries	12.8442212	2.12480998

Country Name	Year	Country Category	CO2	R&D
Estonia	2017	Developed Countries	12.73243033	1.276849985
Estonia	2005	Developed Countries	12.40626672	0.917050004
Estonia	2004	Developed Countries	12.29679645	0.845839977
Estonia	2003	Developed Countries	12.17024629	0.764649987
Estonia	2016	Developed Countries	12.08946716	1.243059993
Estonia	2006	Developed Countries	11.94674824	1.112769961
Estonia	2018	Developed Countries	11.88893604	1.409989953
Estonia	2001	Developed Countries	10.97293812	0.698390007
Estonia	2015	Developed Countries	10.92977307	1.46776998
Estonia	2002	Developed Countries	10.72613912	0.712029994
Estonia	2000	Developed Countries	10.68909115	0.600000024
Estonia	2009	Developed Countries	10.5265958	1.396790028
Estonia	2019	Developed Countries	7.582120103	1.631459951
Estonia	2020	Developed Countries	5.338399816	1.750920057
Finland	2003	Developed Countries	13.75559321	3.298219919
Finland	2004	Developed Countries	12.94580591	3.30907011
Finland	2006	Developed Countries	12.72721024	3.332149982
Finland	2007	Developed Countries	12.30972712	3.337039948
Finland	2002	Developed Countries	12.19853948	3.253079891
Finland	2001	Developed Countries	11.77486619	3.193720102
Finland	2010	Developed Countries	11.65808248	3.705319881
Finland	2008	Developed Countries	10.66362605	3.5369699
Finland	2000	Developed Countries	10.64437313	3.241379976
Finland	2005	Developed Countries	10.57170894	3.323699951
Finland	2011	Developed Countries	10.23025564	3.618060112
Finland	2009	Developed Countries	10.14838156	3.734019995
Finland	2013	Developed Countries	9.228085749	3.271369934
Finland	2012	Developed Countries	9.126037062	3.39831996
Finland	2014	Developed Countries	8.452183205	3.147510052
Finland	2016	Developed Countries	8.31624753	2.724420071
Finland	2018	Developed Countries	8.049188427	2.75748992
Finland	2015	Developed Countries	7.813697924	2.871959925
Finland	2017	Developed Countries	7.809318955	2.727869987
Finland	2019	Developed Countries	7.423039601	2.7996099
Finland	2020	Developed Countries	6.570145128	2.912430048
France	2001	Developed Countries	6.141051661	2.138040066
France	2000	Developed Countries	6.126515445	2.093460083
France	2003	Developed Countries	6.052955998	2.119940042
France	2005	Developed Countries	6.026677842	2.051510096
France	2004	Developed Countries	6.026319535	2.094609976
France	2002	Developed Countries	6.004364485	2.174489975
France	2006	Developed Countries	5.84238818	2.050940037
France	2007	Developed Countries	5.670764603	2.024509907
France	2008	Developed Countries	5.564039942	2.061170101
France	2010	Developed Countries	5.350407866	2.178570032
France	2009	Developed Countries	5.314137365	2.212069988

Country Name	Year	Country Category	CO2	R&D
France	2012	Developed Countries	5.152358494	2.227070093
France	2013	Developed Countries	5.127899428	2.237030029
France	2011	Developed Countries	5.127105446	2.191610098
France	2017	Developed Countries	4.747916929	2.198879957
France	2016	Developed Countries	4.703475673	2.222379923
France	2015	Developed Countries	4.675935087	2.227020025
France	2014	Developed Countries	4.614807136	2.275919914
France	2018	Developed Countries	4.570517428	2.196660042
France	2019	Developed Countries	4.460164948	2.191790104
France	2020	Developed Countries	3.953682452	2.281889915
Georgia	2019	Economies in Transition	2.835791247	0.284680009
Georgia	2020	Economies in Transition	2.754709196	0.300799996
Georgia	2017	Economies in Transition	2.657481054	0.270229995
Georgia	2016	Economies in Transition	2.632753008	0.285860002
Georgia	2018	Economies in Transition	2.609706729	0.280519992
Georgia	2015	Economies in Transition	2.523141909	0.299279988
Georgia	2014	Economies in Transition	2.326710605	0.173179999
Georgia	2013	Economies in Transition	2.158342273	0.078560002
Georgia	2012	Economies in Transition	1.929000551	0.1907
Georgia	2011	Economies in Transition	1.73616463	0.1829
Georgia	2009	Economies in Transition	1.474484056	0.1739
Georgia	2007	Economies in Transition	1.45760873	0.1737
Georgia	2010	Economies in Transition	1.405473639	0.1773
Georgia	2008	Economies in Transition	1.257337696	0.1727
Georgia	2006	Economies in Transition	1.211566904	0.1769
Georgia	2000	Economies in Transition	1.17062709	0.215299994
Georgia	2005	Economies in Transition	1.087286023	0.176579997
Georgia	2001	Economies in Transition	0.875902663	0.238480002
Georgia	2004	Economies in Transition	0.858876491	0.244200006
Georgia	2003	Economies in Transition	0.79894001	0.217600003
Georgia	2002	Economies in Transition	0.743594029	0.185739994
Germany	2001	Developed Countries	10.29361229	2.40437007
Germany	2003	Developed Countries	10.13876361	2.47461009
Germany	2002	Developed Countries	10.10301134	2.436219931
Germany	2000	Developed Countries	10.09936589	2.40982008
Germany	2004	Developed Countries	9.95044613	2.435189962
Germany	2006	Developed Countries	9.886479572	2.47232008
Germany	2005	Developed Countries	9.729463121	2.441930056
Germany	2013	Developed Countries	9.624229367	2.835989952
Germany	2008	Developed Countries	9.617457887	2.615129948
Germany	2007	Developed Countries	9.527623267	2.460479975
Germany	2010	Developed Countries	9.453388627	2.730240107
Germany	2012	Developed Countries	9.451289047	2.881659985
Germany	2011	Developed Countries	9.299002904	2.805550098
Germany	2014	Developed Countries	9.088527768	2.877840042
Germany	2015	Developed Countries	9.087344804	2.933789968

Country Name	Year	Country Category	CO2	R&D
Germany	2016	Developed Countries	9.072972388	2.94039011
Germany	2009	Developed Countries	8.971731407	2.742660046
Germany	2017	Developed Countries	8.858344511	3.047100067
Germany	2018	Developed Countries	8.537042688	3.110110044
Germany	2019	Developed Countries	7.927187624	3.167789936
Germany	2020	Developed Countries	7.255221028	3.129790068
Greece	2007	Developed Countries	9.441114623	0.576550007
Greece	2005	Developed Countries	9.278637163	0.578960001
Greece	2003	Developed Countries	9.170567172	0.546540022
Greece	2006	Developed Countries	9.137884944	0.561179996
Greece	2004	Developed Countries	9.113949332	0.5273
Greece	2008	Developed Countries	9.063643358	0.661830008
Greece	2001	Developed Countries	8.893999815	0.559480011
Greece	2002	Developed Countries	8.860393054	0.553010017
Greece	2000	Developed Countries	8.741650786	0.5913
Greece	2009	Developed Countries	8.529760961	0.625569999
Greece	2010	Developed Countries	7.874814737	0.603470027
Greece	2011	Developed Countries	7.613504634	0.684260011
Greece	2012	Developed Countries	7.250812154	0.710049987
Greece	2013	Developed Countries	6.610378952	0.814779997
Greece	2014	Developed Countries	6.385059031	0.839980006
Greece	2015	Developed Countries	6.285087825	0.966050029
Greece	2017	Developed Countries	6.210831583	1.152279973
Greece	2016	Developed Countries	6.20348737	1.005290031
Greece	2018	Developed Countries	6.058130519	1.21370995
Greece	2019	Developed Countries	5.595284353	1.274960041
Greece	2020	Developed Countries	4.767184937	1.50793004
Hungary	2003	Developed Countries	5.74427181	0.918829978
Hungary	2004	Developed Countries	5.575243496	0.859899998
Hungary	2005	Developed Countries	5.543852449	0.919510007
Hungary	2001	Developed Countries	5.524415229	0.913100004
Hungary	2006	Developed Countries	5.506450463	0.977400005
Hungary	2002	Developed Countries	5.473180971	0.983550012
Hungary	2007	Developed Countries	5.355168868	0.954450011
Hungary	2000	Developed Countries	5.350451	0.790960014
Hungary	2008	Developed Countries	5.281251955	0.977569997
Hungary	2017	Developed Countries	5.052101734	1.317020059
Hungary	2018	Developed Countries	5.033254347	1.507750034
Hungary	2019	Developed Countries	4.836876267	1.472910047
Hungary	2010	Developed Countries	4.788038988	1.12864995
Hungary	2009	Developed Countries	4.773098931	1.128020048
Hungary	2011	Developed Countries	4.704029703	1.179250002
Hungary	2020	Developed Countries	4.591652907	1.59315002
Hungary	2016	Developed Countries	4.508691288	1.179870009
Hungary	2015	Developed Countries	4.407596931	1.339589953
Hungary	2012	Developed Countries	4.377582189	1.254230022

Country Name	Year	Country Category	CO2	R&D
Hungary	2013	Developed Countries	4.120313569	1.38409996
Hungary	2014	Developed Countries	4.117501825	1.344599962
Iceland	2000	Developed Countries	7.913941786	2.57201004
Iceland	2004	Developed Countries	7.908920342	2.692594886
Iceland	2002	Developed Countries	7.803793088	2.821199894
Iceland	2003	Developed Countries	7.689977584	2.705499887
Iceland	2007	Developed Countries	7.648363429	2.532939911
Iceland	2005	Developed Countries	7.620461423	2.679689884
Iceland	2006	Developed Countries	7.610227071	2.852659941
Iceland	2001	Developed Countries	7.591343589	2.839890003
Iceland	2008	Developed Countries	6.87628775	2.464139938
Iceland	2009	Developed Countries	6.618545113	2.59713006
Iceland	2013	Developed Countries	6.27555874	1.692379951
Iceland	2014	Developed Countries	6.254085392	1.936159968
Iceland	2015	Developed Countries	6.219488234	2.181319952
Iceland	2010	Developed Countries	6.159973085	2.500400066
Iceland	2011	Developed Countries	5.919332694	2.403670073
Iceland	2012	Developed Countries	5.799211764	2.048025012
Iceland	2016	Developed Countries	4.868247282	2.110110044
Iceland	2017	Developed Countries	4.866045428	2.084130049
Iceland	2018	Developed Countries	4.817688768	2.000809908
Iceland	2019	Developed Countries	4.543450104	2.341650009
Iceland	2020	Developed Countries	3.947465365	2.490689993
India	2018	Developing Countries	1.795595299	0.66000998
India	2019	Developing Countries	1.752534366	0.659420013
India	2017	Developing Countries	1.704926721	0.66602999
India	2014	Developing Countries	1.642465277	0.701590002
India	2016	Developing Countries	1.639914019	0.669839978
India	2015	Developing Countries	1.631323487	0.693099976
India	2020	Developing Countries	1.576093232	0.64635998
India	2013	Developing Countries	1.5276744	0.706420004
India	2012	Developing Countries	1.498204123	0.743990004
India	2011	Developing Countries	1.396878498	0.755020022
India	2010	Developing Countries	1.338033835	0.788489997
India	2009	Developing Countries	1.278873603	0.833140016
India	2008	Developing Countries	1.180361247	0.858759999
India	2007	Developing Countries	1.123599482	0.805069983
India	2006	Developing Countries	1.036533922	0.804729998
India	2005	Developing Countries	0.984261473	0.824109972
India	2004	Developing Countries	0.955470157	0.756900012
India	2003	Developing Countries	0.905456602	0.719290018
India	2002	Developing Countries	0.897242649	0.72566998
India	2000	Developing Countries	0.885077949	0.756990016
India	2001	Developing Countries	0.883746998	0.735909998
Iran, Islamic Rep	2014	Developing Countries	7.570578314	0.314920001
Iran, Islamic Rep	2018	Developing Countries	7.445127905	0.774060011

Country Name	Year	Country Category	CO2	R&D
Iran, Islamic Rep	2013	Developing Countries	7.439600755	0.23601
Iran, Islamic Rep	2017	Developing Countries	7.412902628	0.759829998
Iran, Islamic Rep	2015	Developing Countries	7.325792139	0.393830001
Iran, Islamic Rep	2009	Developing Countries	7.296521917	0.272579998
Iran, Islamic Rep	2016	Developing Countries	7.288966176	0.57683
Iran, Islamic Rep	2011	Developing Countries	7.231194867	0.279385
Iran, Islamic Rep	2012	Developing Countries	7.230857675	0.294349998
Iran, Islamic Rep	2019	Developing Countries	7.222980003	0.788290024
Iran, Islamic Rep	2010	Developing Countries	7.179825153	0.264420003
Iran, Islamic Rep	2008	Developing Countries	7.133930129	0.64647001
Iran, Islamic Rep	2007	Developing Countries	7.109332655	0.602840006
Iran, Islamic Rep	2020	Developing Countries	7.063351321	1.2507
Iran, Islamic Rep	2006	Developing Countries	6.793040158	0.559210002
Iran, Islamic Rep	2005	Developing Countries	6.423183788	0.622839987
Iran, Islamic Rep	2004	Developing Countries	6.047643734	0.504530013
Iran, Islamic Rep	2003	Developing Countries	5.735837341	0.59483999
Iran, Islamic Rep	2002	Developing Countries	5.49371214	0.495579988
Iran, Islamic Rep	2001	Developing Countries	5.310374072	0.50217998
Iran, Islamic Rep	2000	Developing Countries	5.194284917	0.50917998
Ireland	2001	Developed Countries	11.59143385	1.051939964
Ireland	2005	Developed Countries	11.21429433	1.191969991
Ireland	2000	Developed Countries	11.17780685	1.083829999
Ireland	2002	Developed Countries	11.17253106	1.055750012
Ireland	2006	Developed Countries	11.05938776	1.198869944
Ireland	2003	Developed Countries	11.03129447	1.124349952
Ireland	2004	Developed Countries	10.97904754	1.177780032
Ireland	2007	Developed Countries	10.59454751	1.234079957
Ireland	2008	Developed Countries	10.22627242	1.391260028
Ireland	2009	Developed Countries	8.948168564	1.613710046
Ireland	2010	Developed Countries	8.847879074	1.594769955
Ireland	2016	Developed Countries	8.203375787	1.175070047
Ireland	2012	Developed Countries	8.046360359	1.556750059
Ireland	2011	Developed Countries	7.966687947	1.552620053
Ireland	2015	Developed Countries	7.887609351	1.182119966
Ireland	2017	Developed Countries	7.848149556	1.251870036
Ireland	2013	Developed Countries	7.718343463	1.567579985
Ireland	2018	Developed Countries	7.699027554	1.167199969
Ireland	2014	Developed Countries	7.633852469	1.52098
Ireland	2019	Developed Countries	7.257748757	1.225270033
Ireland	2020	Developed Countries	6.76822759	1.232519984
Israel	2012	Developing Countries	9.615473105	4.080520153
Israel	2003	Developing Countries	9.406326143	3.764539957
Israel	2002	Developing Countries	9.296894977	4.000639915
Israel	2004	Developing Countries	9.275943604	3.749030113
Israel	2007	Developing Countries	9.275344355	4.299980164
Israel	2010	Developing Countries	9.250262343	3.863290071

Country Name	Year	Country Category	CO2	R&D
Israel	2008	Developing Countries	9.127079685	4.255119801
Israel	2006	Developing Countries	9.120178063	4.019979954
Israel	2000	Developing Countries	9.063014788	3.826519966
Israel	2001	Developing Countries	9.000232955	4.064400196
Israel	2011	Developing Countries	8.99106338	3.93520999
Israel	2005	Developing Countries	8.803971083	3.922820091
Israel	2009	Developing Countries	8.780551993	4.045159817
Israel	2013	Developing Countries	8.313480985	4.025990009
Israel	2015	Developing Countries	7.913354256	4.214630127
Israel	2014	Developing Countries	7.877332425	4.110610008
Israel	2016	Developing Countries	7.633161713	4.471739769
Israel	2017	Developing Countries	7.563873618	4.624149799
Israel	2019	Developing Countries	6.935752154	5.215640068
Israel	2018	Developing Countries	6.91499302	4.776130199
Israel	2020	Developing Countries	6.345216004	5.705550194
Italy	2004	Developed Countries	8.189340766	1.050250053
Italy	2005	Developed Countries	8.173814347	1.044350028
Italy	2003	Developed Countries	8.064421038	1.058940053
Italy	2006	Developed Countries	8.025843914	1.084010005
Italy	2007	Developed Countries	7.860786871	1.128990054
Italy	2002	Developed Countries	7.772183978	1.081240058
Italy	2001	Developed Countries	7.66262916	1.040699959
Italy	2000	Developed Countries	7.662108329	1.003640056
Italy	2008	Developed Countries	7.564324796	1.159719944
Italy	2010	Developed Countries	6.836875163	1.217970014
Italy	2009	Developed Countries	6.718921188	1.217869997
Italy	2011	Developed Countries	6.68055037	1.201550007
Italy	2012	Developed Countries	6.32766192	1.262189984
Italy	2013	Developed Countries	5.751877662	1.301069975
Italy	2015	Developed Countries	5.563294289	1.338500023
Italy	2016	Developed Countries	5.498244377	1.366420031
Italy	2017	Developed Countries	5.437912061	1.370129943
Italy	2014	Developed Countries	5.38744256	1.338400006
Italy	2018	Developed Countries	5.376940361	1.424430013
Italy	2019	Developed Countries	5.311030987	1.461590052
Italy	2020	Developed Countries	4.732372771	1.506800056
Japan	2013	Developed Countries	9.944495272	3.27895999
Japan	2012	Developed Countries	9.827855738	3.173710108
Japan	2007	Developed Countries	9.593603175	3.292570114
Japan	2014	Developed Countries	9.564305918	3.367880106
Japan	2005	Developed Countries	9.512764042	3.130919933
Japan	2003	Developed Countries	9.504764403	2.993200064
Japan	2011	Developed Countries	9.495009896	3.205369949
Japan	2002	Developed Countries	9.468870493	2.965140104
Japan	2004	Developed Countries	9.449563638	2.981250048
Japan	2000	Developed Countries	9.3377238	2.858409882

Country Name	Year	Country Category	CO2	R&D
Japan	2006	Developed Countries	9.331294289	3.227659941
Japan	2015	Developed Countries	9.268049646	3.24071002
Japan	2001	Developed Countries	9.220202282	2.923480034
Japan	2016	Developed Countries	9.166714407	3.106659889
Japan	2017	Developed Countries	9.063691208	3.166359901
Japan	2008	Developed Countries	9.04895325	3.292239904
Japan	2010	Developed Countries	9.036009995	3.104949951
Japan	2018	Developed Countries	8.76197885	3.219199896
Japan	2009	Developed Countries	8.609230985	3.195899963
Japan	2019	Developed Countries	8.478400575	3.218240023
Japan	2020	Developed Countries	8.03149587	3.268970013
Kazakhstan	2008	Economies in Transition	15.34125316	0.216539994
Kazakhstan	2013	Economies in Transition	15.26310479	0.171320006
Kazakhstan	2011	Economies in Transition	14.82468475	0.153490007
Kazakhstan	2012	Economies in Transition	14.5663226	0.165250003
Kazakhstan	2010	Economies in Transition	14.07327542	0.153410003
Kazakhstan	2009	Economies in Transition	13.27406094	0.22924
Kazakhstan	2007	Economies in Transition	12.81257685	0.208839998
Kazakhstan	2006	Economies in Transition	12.10466887	0.242809996
Kazakhstan	2014	Economies in Transition	12.10422549	0.167219996
Kazakhstan	2017	Economies in Transition	11.9137581	0.126670003
Kazakhstan	2018	Economies in Transition	11.86754957	0.116829999
Kazakhstan	2016	Economies in Transition	11.37883973	0.141790003
Kazakhstan	2020	Economies in Transition	11.29774331	0.126019999
Kazakhstan	2005	Economies in Transition	11.17166937	0.283609986
Kazakhstan	2019	Economies in Transition	11.05087035	0.118409999
Kazakhstan	2015	Economies in Transition	10.89105129	0.169510007
Kazakhstan	2004	Economies in Transition	10.52619519	0.248370007
Kazakhstan	2003	Economies in Transition	9.802269351	0.252460003
Kazakhstan	2002	Economies in Transition	8.820775199	0.255089998
Kazakhstan	2000	Economies in Transition	8.072763922	0.181040004
Kazakhstan	2001	Economies in Transition	7.904209994	0.220090002
Korea, Rep	2018	Developing Countries	12.21645617	4.516329765
Korea, Rep	2017	Developing Countries	12.19149342	4.292059898
Korea, Rep	2016	Developing Countries	12.0162046	3.987040043
Korea, Rep	2011	Developing Countries	11.98480362	3.591989994
Korea, Rep	2012	Developing Countries	11.95852705	3.850399971
Korea, Rep	2015	Developing Countries	11.91468649	3.978199959
Korea, Rep	2013	Developing Countries	11.89003693	3.951240063
Korea, Rep	2019	Developing Countries	11.82528359	4.627029896
Korea, Rep	2010	Developing Countries	11.60782984	3.315779924
Korea, Rep	2014	Developing Countries	11.58871562	4.077859879
Korea, Rep	2020	Developing Countries	10.99002958	4.795710087
Korea, Rep	2009	Developing Countries	10.68064538	3.146689892
Korea, Rep	2008	Developing Countries	10.49694353	2.988869905
Korea, Rep	2007	Developing Countries	10.34626459	2.872580051

Country Name	Year	Country Category	CO2	R&D
Korea, Rep	2004	Developing Countries	10.10574342	2.442140102
Korea, Rep	2006	Developing Countries	10.07162061	2.719340086
Korea, Rep	2005	Developing Countries	9.982494185	2.522900105
Korea, Rep	2003	Developing Countries	9.686601174	2.277220011
Korea, Rep	2002	Developing Countries	9.675782441	2.207740068
Korea, Rep	2001	Developing Countries	9.640540826	2.278650045
Korea, Rep	2000	Developing Countries	9.514045353	2.12519002
Kuwait	2005	Developing Countries	31.27431609	0.100830004
Kuwait	2006	Developing Countries	30.64979443	0.084789999
Kuwait	2004	Developing Countries	28.75242456	0.130099997
Kuwait	2008	Developing Countries	28.61150615	0.085510001
Kuwait	2007	Developing Countries	28.16354439	0.08585
Kuwait	2009	Developing Countries	27.7777897	0.112130001
Kuwait	2003	Developing Countries	27.65683277	0.143470004
Kuwait	2010	Developing Countries	27.42637996	0.101400003
Kuwait	2002	Developing Countries	27.15374501	0.180010006
Kuwait	2001	Developing Countries	26.7055251	0.178839996
Kuwait	2011	Developing Countries	26.49355483	0.098959997
Kuwait	2000	Developing Countries	25.75749354	0.125420004
Kuwait	2012	Developing Countries	25.1324211	0.097209997
Kuwait	2013	Developing Countries	23.95814308	0.301530004
Kuwait	2015	Developing Countries	22.77502	0.096600004
Kuwait	2014	Developing Countries	22.74999043	0.427049994
Kuwait	2016	Developing Countries	22.57269795	0.079850003
Kuwait	2017	Developing Countries	21.91040082	0.080399998
Kuwait	2018	Developing Countries	21.46122994	0.063490003
Kuwait	2020	Developing Countries	21.16961025	0.186609998
Kuwait	2019	Developing Countries	21.13521425	0.191459998
Kyrgyz Republic	2012	Economies in Transition	1.809459267	0.166099995
Kyrgyz Republic	2018	Economies in Transition	1.788258367	0.101070002
Kyrgyz Republic	2015	Economies in Transition	1.723480334	0.119029999
Kyrgyz Republic	2014	Economies in Transition	1.68768743	0.125359997
Kyrgyz Republic	2013	Economies in Transition	1.653087629	0.14914
Kyrgyz Republic	2016	Economies in Transition	1.59151246	0.111210003
Kyrgyz Republic	2019	Economies in Transition	1.551593817	0.090159997
Kyrgyz Republic	2017	Economies in Transition	1.522861476	0.107069999
Kyrgyz Republic	2008	Economies in Transition	1.399120086	0.190170005
Kyrgyz Republic	2011	Economies in Transition	1.394552642	0.156330004
Kyrgyz Republic	2020	Economies in Transition	1.37997538	0.088809997
Kyrgyz Republic	2009	Economies in Transition	1.251017034	0.15997
Kyrgyz Republic	2007	Economies in Transition	1.228665249	0.234249994
Kyrgyz Republic	2010	Economies in Transition	1.173736669	0.155469999
Kyrgyz Republic	2003	Economies in Transition	1.106358932	0.222719997
Kyrgyz Republic	2004	Economies in Transition	1.088780927	0.199259996
Kyrgyz Republic	2005	Economies in Transition	1.027970403	0.198609993
Kyrgyz Republic	2006	Economies in Transition	1.027575502	0.230140001

Country Name	Year	Country Category	CO2	R&D
Kyrgyz Republic	2002	Economies in Transition	0.994870459	0.198100001
Kyrgyz Republic	2000	Economies in Transition	0.94792177	0.156369999
Kyrgyz Republic	2001	Economies in Transition	0.801217367	0.171890005
Latvia	2010	Developed Countries	4.06096622	0.60571003
Latvia	2018	Developed Countries	4.039697505	0.638689995
Latvia	2019	Developed Countries	3.954965509	0.636269987
Latvia	2007	Developed Countries	3.877518094	0.551069975
Latvia	2011	Developed Countries	3.834182401	0.715619981
Latvia	2008	Developed Countries	3.722876084	0.577199996
Latvia	2012	Developed Countries	3.721491074	0.663070023
Latvia	2013	Developed Countries	3.702785436	0.613210022
Latvia	2015	Developed Countries	3.699519653	0.619400024
Latvia	2006	Developed Countries	3.696384306	0.646910012
Latvia	2017	Developed Countries	3.664156174	0.511039972
Latvia	2014	Developed Countries	3.65250564	0.68908
Latvia	2016	Developed Countries	3.646422599	0.435140014
Latvia	2020	Developed Countries	3.645612168	0.729910016
Latvia	2005	Developed Countries	3.446044062	0.527069986
Latvia	2009	Developed Countries	3.438486526	0.448579997
Latvia	2004	Developed Countries	3.365483611	0.398400009
Latvia	2003	Developed Countries	3.318771567	0.359299988
Latvia	2002	Developed Countries	3.182532217	0.40843001
Latvia	2001	Developed Countries	3.147909651	0.402630001
Latvia	2000	Developed Countries	2.926894891	0.43483001
Lithuania	2019	Developed Countries	4.200151961	0.993529975
Lithuania	2020	Developed Countries	4.184000415	1.13361001
Lithuania	2018	Developed Countries	4.159315063	0.936619997
Lithuania	2007	Developed Countries	4.088021703	0.801739991
Lithuania	2008	Developed Countries	4.08550852	0.789319992
Lithuania	2010	Developed Countries	4.06905151	0.783299983
Lithuania	2012	Developed Countries	3.991534832	0.893040001
Lithuania	2006	Developed Countries	3.981670438	0.79203999
Lithuania	2017	Developed Countries	3.967680702	0.896260023
Lithuania	2011	Developed Countries	3.911872568	0.902689993
Lithuania	2016	Developed Countries	3.905926684	0.842410028
Lithuania	2005	Developed Countries	3.861276715	0.748210013
Lithuania	2013	Developed Countries	3.831065403	0.948719978
Lithuania	2015	Developed Countries	3.809894282	1.043409944
Lithuania	2014	Developed Countries	3.704481738	1.030110002
Lithuania	2009	Developed Countries	3.69662046	0.830839992
Lithuania	2004	Developed Countries	3.52820118	0.751399994
Lithuania	2003	Developed Countries	3.289018869	0.664129972
Lithuania	2002	Developed Countries	3.259651932	0.657549977
Lithuania	2001	Developed Countries	3.214083827	0.667620003
Lithuania	2000	Developed Countries	3.004941226	0.585529983
Luxembourg	2005	Developed Countries	25.61043774	1.558730006

Country Name	Year	Country Category	CO2	R&D
Luxembourg	2004	Developed Countries	25.45279909	1.58818996
Luxembourg	2006	Developed Countries	24.79111877	1.648859978
Luxembourg	2007	Developed Countries	23.15533768	1.571650028
Luxembourg	2003	Developed Countries	22.67697009	1.62349999
Luxembourg	2008	Developed Countries	22.55704492	1.546630025
Luxembourg	2002	Developed Countries	22.00549112	1.612140016
Luxembourg	2010	Developed Countries	21.75566571	1.423730016
Luxembourg	2011	Developed Countries	21.04150309	1.424530029
Luxembourg	2009	Developed Countries	20.97882009	1.588389993
Luxembourg	2001	Developed Countries	20.6522847	1.589140016
Luxembourg	2012	Developed Countries	20.1489417	1.206640005
Luxembourg	2000	Developed Countries	19.61196424	1.583140016
Luxembourg	2013	Developed Countries	18.72294611	1.233809948
Luxembourg	2014	Developed Countries	17.3339397	1.217000008
Luxembourg	2015	Developed Countries	16.03464863	1.25225997
Luxembourg	2018	Developed Countries	15.33152397	1.171800017
Luxembourg	2019	Developed Countries	15.3230398	1.18287003
Luxembourg	2016	Developed Countries	15.19877529	1.266899943
Luxembourg	2017	Developed Countries	15.1030627	1.238980055
Luxembourg	2020	Developed Countries	12.45695323	1.091500044
Madagascar	2019	Least Developed Countries	0.142653575	0.3151
Madagascar	2017	Least Developed Countries	0.13301723	0.01275
Madagascar	2015	Least Developed Countries	0.132173016	0.012925
Madagascar	2016	Least Developed Countries	0.124763837	0.01264
Madagascar	2014	Least Developed Countries	0.124323711	0.01321
Madagascar	2013	Least Developed Countries	0.124225069	0.0871
Madagascar	2018	Least Developed Countries	0.123102265	0.2391
Madagascar	2012	Least Developed Countries	0.119381318	0.0897
Madagascar	2000	Least Developed Countries	0.101996549	0.100319996
Madagascar	2001	Least Developed Countries	0.099884707	0.18175
Madagascar	2011	Least Developed Countries	0.098168717	0.090669997
Madagascar	2020	Least Developed Countries	0.097269541	0.4105
Madagascar	2005	Least Developed Countries	0.090976184	0.150959998
Madagascar	2004	Least Developed Countries	0.090162751	0.192599997
Madagascar	2003	Least Developed Countries	0.08764234	0.290699989
Madagascar	2008	Least Developed Countries	0.086788281	0.117640004
Madagascar	2007	Least Developed Countries	0.08647948	0.120909996
Madagascar	2010	Least Developed Countries	0.08604277	0.099030003
Madagascar	2006	Least Developed Countries	0.084602827	0.141190007
Madagascar	2009	Least Developed Countries	0.079850957	0.130539998
Madagascar	2002	Least Developed Countries	0.065183262	0.201729998
Malaysia	2014	Developing Countries	7.719435953	1.26275003
Malaysia	2015	Developing Countries	7.603420444	1.279450059
Malaysia	2019	Developing Countries	7.464999716	0.995569974
Malaysia	2018	Developing Countries	7.452371382	1.040259957
Malaysia	2013	Developing Countries	7.402951013	1.17772001

Country Name	Year	Country Category	CO2	R&D
Malaysia	2020	Developing Countries	7.383715412	0.950879991
Malaysia	2016	Developing Countries	7.348421251	1.415169954
Malaysia	2008	Developing Countries	7.318407813	0.78846997
Malaysia	2017	Developing Countries	7.039825673	1.227714956
Malaysia	2007	Developing Countries	6.993229591	0.699764997
Malaysia	2010	Developing Countries	6.959707228	1.036080003
Malaysia	2011	Developing Countries	6.935319956	1.033419967
Malaysia	2012	Developing Countries	6.925634921	1.092689991
Malaysia	2006	Developing Countries	6.549858347	0.611060023
Malaysia	2005	Developing Countries	6.440996321	0.605480015
Malaysia	2009	Developing Countries	6.431278592	1.010010004
Malaysia	2004	Developing Countries	6.230942287	0.599900007
Malaysia	2003	Developing Countries	5.821076338	0.626220018
Malaysia	2002	Developing Countries	5.64888519	0.652540028
Malaysia	2001	Developing Countries	5.498931996	0.560765013
Malaysia	2000	Developing Countries	5.419703075	0.468989998
Malta	2007	Developed Countries	6.676763604	0.54539001
Malta	2008	Developed Countries	6.654713603	0.526669979
Malta	2003	Developed Countries	6.543195629	0.235660002
Malta	2006	Developed Countries	6.539717943	0.578440011
Malta	2005	Developed Countries	6.503662396	0.528930008
Malta	2004	Developed Countries	6.474475911	0.48822999
Malta	2012	Developed Countries	6.465283267	0.804319978
Malta	2001	Developed Countries	6.33313657	0.235660002
Malta	2010	Developed Countries	6.240169068	0.587409973
Malta	2011	Developed Countries	6.18135432	0.665059984
Malta	2009	Developed Countries	6.084945342	0.507399976
Malta	2002	Developed Countries	5.855003801	0.238309994
Malta	2013	Developed Countries	5.567332681	0.743359983
Malta	2000	Developed Countries	5.458269566	0.233010009
Malta	2014	Developed Countries	5.422291156	0.691789985
Malta	2015	Developed Countries	3.723376766	0.715149999
Malta	2019	Developed Countries	3.290468236	0.56427002
Malta	2017	Developed Countries	3.250434296	0.55211997
Malta	2018	Developed Countries	3.203474816	0.576089978
Malta	2020	Developed Countries	3.125557893	0.654410005
Malta	2016	Developed Countries	2.969764316	0.556890011
Mauritius	2017	Developing Countries	3.30021575	0.354229987
Mauritius	2019	Developing Countries	3.296800515	0.35699001
Mauritius	2018	Developing Countries	3.26641524	0.333869994
Mauritius	2016	Developing Countries	3.193281567	0.214
Mauritius	2015	Developing Countries	3.136404992	0.2054
Mauritius	2014	Developing Countries	3.131442236	0.2044
Mauritius	2013	Developing Countries	3.032741374	0.2098
Mauritius	2012	Developing Countries	2.966042988	0.177729994
Mauritius	2020	Developing Countries	2.938514108	0.403239995

Country Name	Year	Country Category	CO2	R&D
Mauritius	2010	Developing Countries	2.928502879	0.2524
Mauritius	2011	Developing Countries	2.905611927	0.235
Mauritius	2008	Developing Countries	2.786545682	0.2908
Mauritius	2009	Developing Countries	2.744284444	0.2714
Mauritius	2007	Developing Countries	2.738881763	0.3094
Mauritius	2006	Developing Countries	2.677642391	0.326
Mauritius	2005	Developing Countries	2.411390478	0.360529989
Mauritius	2004	Developing Countries	2.268872394	0.368180007
Mauritius	2003	Developing Countries	2.265261215	0.32604
Mauritius	2002	Developing Countries	2.168814922	0.368050009
Mauritius	2001	Developing Countries	2.144635861	0.362569988
Mauritius	2000	Developing Countries	2.04899766	0.284020007
Mexico	2007	Developing Countries	4.220761327	0.398330003
Mexico	2012	Developing Countries	4.202413546	0.420960009
Mexico	2006	Developing Countries	4.194183397	0.369219989
Mexico	2011	Developing Countries	4.190989787	0.471289992
Mexico	2008	Developing Countries	4.189727319	0.443870008
Mexico	2010	Developing Countries	4.113210914	0.49485001
Mexico	2005	Developing Countries	4.098800784	0.398440003
Mexico	2013	Developing Countries	4.056055227	0.425029993
Mexico	2009	Developing Countries	4.037593962	0.47953999
Mexico	2004	Developing Countries	3.983825688	0.38815999
Mexico	2003	Developing Countries	3.95094019	0.393139988
Mexico	2015	Developing Countries	3.925368326	0.429430008
Mexico	2016	Developing Countries	3.920323024	0.387780011
Mexico	2014	Developing Countries	3.892355248	0.435299993
Mexico	2000	Developing Countries	3.874145961	0.306129992
Mexico	2017	Developing Countries	3.862759412	0.328319997
Mexico	2002	Developing Countries	3.824967946	0.354299992
Mexico	2001	Developing Countries	3.811392059	0.324180007
Mexico	2019	Developing Countries	3.612165141	0.283939987
Mexico	2018	Developing Countries	3.587489305	0.307110012
Mexico	2020	Developing Countries	3.040766375	0.296380013
Moldova	2019	Economies in Transition	3.348667379	0.241449997
Moldova	2020	Economies in Transition	3.267846368	0.23511
Moldova	2018	Economies in Transition	3.160420552	0.256260008
Moldova	2017	Economies in Transition	2.926840954	0.257889986
Moldova	2011	Economies in Transition	2.916944425	0.337639987
Moldova	2016	Economies in Transition	2.904908914	0.280039996
Moldova	2010	Economies in Transition	2.897999339	0.36649999
Moldova	2012	Economies in Transition	2.844887502	0.349070013
Moldova	2008	Economies in Transition	2.840876412	0.534630001
Moldova	2007	Economies in Transition	2.831716533	0.545570016
Moldova	2005	Economies in Transition	2.829921235	0.398649991
Moldova	2015	Economies in Transition	2.828160162	0.30735001
Moldova	2006	Economies in Transition	2.768202482	0.406219989

Country Name	Year	Country Category	CO2	R&D
Moldova	2014	Economies in Transition	2.698635146	0.314630002
Moldova	2004	Economies in Transition	2.685027018	0.349029988
Moldova	2003	Economies in Transition	2.674774507	0.324050009
Moldova	2009	Economies in Transition	2.6658053	0.525569975
Moldova	2013	Economies in Transition	2.511402112	0.297829986
Moldova	2002	Economies in Transition	2.467004536	0.2038
Moldova	2001	Economies in Transition	2.404892166	0.146
Moldova	2000	Economies in Transition	2.294140737	0.0816
Mongolia	2019	Developing Countries	7.160835656	0.092699997
Mongolia	2018	Developing Countries	6.809659067	0.101609997
Mongolia	2013	Developing Countries	6.461561118	0.232460007
Mongolia	2020	Developing Countries	6.430645335	0.13301
Mongolia	2017	Developing Countries	6.32277465	0.134200007
Mongolia	2014	Developing Countries	6.242888388	0.223399997
Mongolia	2012	Developing Countries	6.138738388	0.239130005
Mongolia	2016	Developing Countries	5.998504731	0.183449998
Mongolia	2015	Developing Countries	5.835434973	0.156399995
Mongolia	2011	Developing Countries	5.732418152	0.230540007
Mongolia	2010	Developing Countries	5.295464973	0.244379997
Mongolia	2009	Developing Countries	5.114344888	0.304780006
Mongolia	2007	Developing Countries	4.997422901	0.23827
Mongolia	2008	Developing Countries	4.925951645	0.336670011
Mongolia	2006	Developing Countries	4.81132726	0.191210002
Mongolia	2005	Developing Countries	4.320847278	0.237760007
Mongolia	2002	Developing Countries	3.850073979	0.251729995
Mongolia	2004	Developing Countries	3.767325506	0.267769992
Mongolia	2003	Developing Countries	3.700508732	0.251800001
Mongolia	2000	Developing Countries	3.670643445	0.187570006
Mongolia	2001	Developing Countries	3.627920558	0.26749
Montenegro	2008	Economies in Transition	4.365373301	0.9822
Montenegro	2019	Economies in Transition	4.181644556	0.363279998
Montenegro	2010	Economies in Transition	4.171913443	0.8074
Montenegro	2011	Economies in Transition	4.089640191	0.314850003
Montenegro	2020	Economies in Transition	4.067560912	0.5896
Montenegro	2018	Economies in Transition	4.018308431	0.503740013
Montenegro	2015	Economies in Transition	3.791795988	0.374000013
Montenegro	2012	Economies in Transition	3.757003292	0.344579995
Montenegro	2013	Economies in Transition	3.649830089	0.374309987
Montenegro	2017	Economies in Transition	3.642510199	0.34898001
Montenegro	2014	Economies in Transition	3.567649282	0.363200009
Montenegro	2006	Economies in Transition	3.543433194	1.229910016
Montenegro	2016	Economies in Transition	3.456033476	0.324539989
Montenegro	2007	Economies in Transition	3.4071849	1.145210028
Montenegro	2004	Economies in Transition	3.328063427	1.018740058
Montenegro	2005	Economies in Transition	3.263759216	0.924430013
Montenegro	2003	Economies in Transition	3.085571079	0.797720015

Country Name	Year	Country Category	CO2	R&D
Montenegro	2002	Economies in Transition	2.896307608	0.4794
Montenegro	2009	Economies in Transition	2.82632534	0.9064
Montenegro	2001	Economies in Transition	2.744975987	0.585349998
Montenegro	2000	Economies in Transition	2.513998501	0.691299996
Netherlands	2004	Developed Countries	10.57111142	1.789010048
Netherlands	2003	Developed Countries	10.49982305	1.783900023
Netherlands	2001	Developed Countries	10.41469683	1.796090007
Netherlands	2002	Developed Countries	10.36783306	1.745429993
Netherlands	2010	Developed Countries	10.29831131	1.704040051
Netherlands	2005	Developed Countries	10.28966656	1.773880005
Netherlands	2000	Developed Countries	10.17842879	1.789800048
Netherlands	2008	Developed Countries	10.046576	1.622689962
Netherlands	2007	Developed Countries	10.04478413	1.670300007
Netherlands	2006	Developed Countries	10.01478579	1.740669966
Netherlands	2009	Developed Countries	9.708683184	1.665699959
Netherlands	2011	Developed Countries	9.511010375	1.881309986
Netherlands	2012	Developed Countries	9.398612781	1.916270018
Netherlands	2013	Developed Countries	9.348141014	2.15605998
Netherlands	2016	Developed Countries	9.306892404	2.150810003
Netherlands	2015	Developed Countries	9.290242937	2.14605999
Netherlands	2017	Developed Countries	9.089265634	2.178570032
Netherlands	2014	Developed Countries	8.881905066	2.173300028
Netherlands	2018	Developed Countries	8.785144105	2.138799906
Netherlands	2019	Developed Countries	8.41396928	2.184350014
Netherlands	2020	Developed Countries	7.471553479	2.321820021
New Zealand	2003	Developed Countries	8.293007549	1.148910046
New Zealand	2005	Developed Countries	8.280848593	1.120429993
New Zealand	2006	Developed Countries	8.188572384	1.139034986
New Zealand	2001	Developed Countries	8.148125242	1.100289941
New Zealand	2004	Developed Countries	8.033296636	1.134670019
New Zealand	2008	Developed Countries	8.020423494	1.204890013
New Zealand	2002	Developed Countries	7.988628593	1.124599993
New Zealand	2007	Developed Countries	7.876911786	1.15763998
New Zealand	2000	Developed Countries	7.635378593	1.075
New Zealand	2012	Developed Countries	7.283727683	1.192820013
New Zealand	2009	Developed Countries	7.244387115	1.252140045
New Zealand	2013	Developed Countries	7.178023908	1.15339005
New Zealand	2010	Developed Countries	7.136621693	1.24219501
New Zealand	2014	Developed Countries	7.078644968	1.190780044
New Zealand	2015	Developed Countries	7.003340999	1.228170037
New Zealand	2011	Developed Countries	6.90935219	1.232249975
New Zealand	2017	Developed Countries	6.840493601	1.349120021
New Zealand	2019	Developed Countries	6.830053021	1.406409979
New Zealand	2016	Developed Countries	6.615409092	1.288645029
New Zealand	2018	Developed Countries	6.613271844	1.377765
New Zealand	2020	Developed Countries	6.160799183	1.435054958

Country Name	Year	Country Category	CO2	R&D
North Macedonia	2007	Economies in Transition	4.564634542	0.170929998
North Macedonia	2008	Economies in Transition	4.455522454	0.223580003
North Macedonia	2011	Economies in Transition	4.448349048	0.222760007
North Macedonia	2005	Economies in Transition	4.360546038	0.228249997
North Macedonia	2003	Economies in Transition	4.356235257	0.210639998
North Macedonia	2006	Economies in Transition	4.339171896	0.193729997
North Macedonia	2012	Economies in Transition	4.269147092	0.326759994
North Macedonia	2001	Economies in Transition	4.260984175	0.293099999
North Macedonia	2000	Economies in Transition	4.205640684	0.418879986
North Macedonia	2004	Economies in Transition	4.202910245	0.232370004
North Macedonia	2009	Economies in Transition	4.150982776	0.196789995
North Macedonia	2010	Economies in Transition	4.053325444	0.216340005
North Macedonia	2002	Economies in Transition	4.023697168	0.244609997
North Macedonia	2019	Economies in Transition	3.831137375	0.367830008
North Macedonia	2013	Economies in Transition	3.80914637	0.438939989
North Macedonia	2014	Economies in Transition	3.600002128	0.516460001
North Macedonia	2017	Economies in Transition	3.58457114	0.354389995
North Macedonia	2015	Economies in Transition	3.449913198	0.44411999
North Macedonia	2016	Economies in Transition	3.359581952	0.435849994
North Macedonia	2018	Economies in Transition	3.347723287	0.363669991
North Macedonia	2020	Economies in Transition	3.279420187	0.372640014
Norway	2010	Developed Countries	8.205017864	1.641199946
Norway	2003	Developed Countries	8.146326663	1.675719976
Norway	2004	Developed Countries	8.134915536	1.53974998
Norway	2007	Developed Countries	8.018448328	1.557940006
Norway	2006	Developed Countries	7.983947396	1.449720025
Norway	2011	Developed Countries	7.888270913	1.617140055
Norway	2005	Developed Countries	7.865911966	1.477149963
Norway	2013	Developed Countries	7.801169496	1.642160058
Norway	2015	Developed Countries	7.764858661	1.923499942
Norway	2009	Developed Countries	7.753452981	1.716779947
Norway	2008	Developed Countries	7.733045427	1.545560002
Norway	2012	Developed Countries	7.725323513	1.610530019
Norway	2014	Developed Countries	7.716801577	1.703690052
Norway	2001	Developed Countries	7.695417846	1.560199976
Norway	2000	Developed Countries	7.633790228	1.6955
Norway	2002	Developed Countries	7.575979599	1.626449943
Norway	2016	Developed Countries	7.56103856	2.032870054
Norway	2017	Developed Countries	7.42375167	2.081670046
Norway	2018	Developed Countries	7.261315879	2.03482008
Norway	2019	Developed Countries	7.042320943	2.135999918
Norway	2020	Developed Countries	6.72508005	2.24435997
Pakistan	2017	Developing Countries	0.918472672	0.212139994
Pakistan	2018	Developing Countries	0.85042708	0.193444997
Pakistan	2016	Developing Countries	0.848207169	0.229094997
Pakistan	2019	Developing Countries	0.824459652	0.17475

Country Name	Year	Country Category	CO2	R&D
Pakistan	2020	Developing Countries	0.810360216	0.0835
Pakistan	2007	Developing Countries	0.801504378	0.632499993
Pakistan	2015	Developing Countries	0.778086203	0.24605
Pakistan	2009	Developing Countries	0.764440548	0.448060006
Pakistan	2008	Developing Countries	0.756912388	0.540279999
Pakistan	2006	Developing Countries	0.742989902	0.515495002
Pakistan	2014	Developing Countries	0.74061942	0.269449994
Pakistan	2010	Developing Countries	0.72190976	0.388614997
Pakistan	2011	Developing Countries	0.713434273	0.329169989
Pakistan	2012	Developing Countries	0.711250897	0.311009988
Pakistan	2013	Developing Countries	0.710993637	0.292849988
Pakistan	2005	Developing Countries	0.697409169	0.398490012
Pakistan	2004	Developing Countries	0.693317063	0.4269
Pakistan	2000	Developing Countries	0.637262087	0.115659997
Pakistan	2003	Developing Countries	0.633183139	0.3704
Pakistan	2001	Developing Countries	0.627048268	0.151649997
Pakistan	2002	Developing Countries	0.626753894	0.198870003
Panama	2019	Developing Countries	3.095050433	0.119039997
Panama	2012	Developing Countries	2.786147667	0.075340003
Panama	2014	Developing Countries	2.766436784	0.140520006
Panama	2011	Developing Countries	2.709401807	0.173040003
Panama	2013	Developing Countries	2.682755401	0.062059999
Panama	2015	Developing Countries	2.681231882	0.120329998
Panama	2016	Developing Countries	2.645680837	0.144940004
Panama	2010	Developing Countries	2.536305575	0.144529998
Panama	2017	Developing Countries	2.474668969	0.147180006
Panama	2009	Developing Countries	2.44384989	0.132100001
Panama	2018	Developing Countries	2.381318791	0.117200002
Panama	2020	Developing Countries	2.231443025	0.210329995
Panama	2006	Developing Countries	2.223582508	0.235369995
Panama	2007	Developing Countries	2.180985391	0.181720003
Panama	2005	Developing Countries	2.152657033	0.231830001
Panama	2008	Developing Countries	2.087817958	0.190650001
Panama	2001	Developing Countries	2.030856341	0.360740006
Panama	2000	Developing Countries	1.759884547	0.362639993
Panama	2003	Developing Countries	1.736637574	0.321090013
Panama	2002	Developing Countries	1.73342433	0.342200011
Panama	2004	Developing Countries	1.7295597	0.226459995
Paraguay	2018	Developing Countries	1.297481674	0.146840006
Paraguay	2017	Developing Countries	1.246325175	0.148880005
Paraguay	2019	Developing Countries	1.240668873	0.137510002
Paraguay	2016	Developing Countries	1.147764782	0.116760001
Paraguay	2020	Developing Countries	1.144591192	0.156969994
Paraguay	2015	Developing Countries	1.030681699	0.09674
Paraguay	2014	Developing Countries	0.924028535	0.079010002
Paraguay	2011	Developing Countries	0.892890908	0.042160001

Country Name	Year	Country Category	CO2	R&D
Paraguay	2013	Developing Countries	0.882701828	0.071630001
Paraguay	2010	Developing Countries	0.874265616	0.0531
Paraguay	2012	Developing Countries	0.874070327	0.065169998
Paraguay	2009	Developing Countries	0.801024239	0.05
Paraguay	2008	Developing Countries	0.765825803	0.041129999
Paraguay	2003	Developing Countries	0.735552619	0.061349999
Paraguay	2004	Developing Countries	0.733652566	0.060660001
Paraguay	2006	Developing Countries	0.714513499	0.0491
Paraguay	2002	Developing Countries	0.714157085	0.074929997
Paraguay	2001	Developing Countries	0.693614422	0.066990003
Paraguay	2000	Developing Countries	0.687826795	0.096
Paraguay	2005	Developing Countries	0.675293479	0.060910001
Paraguay	2007	Developing Countries	0.665546243	0.048
Peru	2016	Developing Countries	1.826380485	0.120080002
Peru	2015	Developing Countries	1.776300578	0.117020003
Peru	2014	Developing Countries	1.751594051	0.108050004
Peru	2019	Developing Countries	1.735641775	0.156959996
Peru	2017	Developing Countries	1.717243013	0.120849997
Peru	2018	Developing Countries	1.695130882	0.126829997
Peru	2013	Developing Countries	1.656254081	0.081739999
Peru	2011	Developing Countries	1.642847492	0.082819998
Peru	2012	Developing Countries	1.617521506	0.055300001
Peru	2010	Developing Countries	1.539485423	0.079
Peru	2009	Developing Countries	1.419219461	0.0789
Peru	2020	Developing Countries	1.398566019	0.171719998
Peru	2008	Developing Countries	1.329318686	0.08
Peru	2007	Developing Countries	1.182095893	0.0823
Peru	2004	Developing Countries	1.11985372	0.155780002
Peru	2005	Developing Countries	1.11171717	0.0905
Peru	2006	Developing Countries	1.086769854	0.0858
Peru	2000	Developing Countries	1.074275095	0.112659998
Peru	2002	Developing Countries	1.014505367	0.106140003
Peru	2003	Developing Countries	0.983143205	0.108130001
Peru	2001	Developing Countries	0.982316838	0.110959999
Philippines	2019	Developing Countries	1.32152779	0.3239
Philippines	2018	Developing Countries	1.28139073	0.322219998
Philippines	2017	Developing Countries	1.250314542	0.2493
Philippines	2020	Developing Countries	1.189679452	0.3459
Philippines	2016	Developing Countries	1.152751307	0.2174
Philippines	2015	Developing Countries	1.077253514	0.156829998
Philippines	2014	Developing Countries	1.00490795	0.144450001
Philippines	2013	Developing Countries	0.957913716	0.132070005
Philippines	2000	Developing Countries	0.922837864	0.2259
Philippines	2005	Developing Countries	0.883249431	0.106919996
Philippines	2004	Developing Countries	0.883116735	0.116094995
Philippines	2001	Developing Countries	0.882362848	0.1966

Country Name	Year	Country Category	CO2	R&D
Philippines	2003	Developing Countries	0.88183504	0.125269994
Philippines	2012	Developing Countries	0.878944848	0.122145001
Philippines	2002	Developing Countries	0.876627897	0.132630005
Philippines	2010	Developing Countries	0.865602879	0.110615
Philippines	2011	Developing Countries	0.856822589	0.112219997
Philippines	2008	Developing Countries	0.822328628	0.106995001
Philippines	2009	Developing Countries	0.821133982	0.109010004
Philippines	2007	Developing Countries	0.817880458	0.104979999
Philippines	2006	Developing Countries	0.788442016	0.105949998
Poland	2010	Developed Countries	8.247004676	0.726189971
Poland	2017	Developed Countries	8.236243136	1.037850022
Poland	2006	Developed Countries	8.23499125	0.551020026
Poland	2007	Developed Countries	8.220639991	0.561930001
Poland	2018	Developed Countries	8.209531333	1.206099987
Poland	2011	Developed Countries	8.159932723	0.752210021
Poland	2008	Developed Countries	8.087059985	0.599439979
Poland	2012	Developed Countries	7.969684286	0.889970005
Poland	2004	Developed Countries	7.905616389	0.55250001
Poland	2005	Developed Countries	7.89596453	0.562780023
Poland	2016	Developed Countries	7.895752254	0.968209982
Poland	2013	Developed Countries	7.841820794	0.884829998
Poland	2003	Developed Countries	7.793067688	0.538060009
Poland	2009	Developed Countries	7.791554656	0.661059976
Poland	2019	Developed Countries	7.768855783	1.323349953
Poland	2000	Developed Countries	7.730919997	0.640779972
Poland	2001	Developed Countries	7.676919487	0.621590018
Poland	2015	Developed Countries	7.610021183	1.004230022
Poland	2014	Developed Countries	7.516889192	0.950760007
Poland	2002	Developed Countries	7.515499983	0.55675
Poland	2020	Developed Countries	7.367563373	1.386080027
Portugal	2002	Developed Countries	6.29627863	0.72183001
Portugal	2005	Developed Countries	6.233623051	0.757550001
Portugal	2000	Developed Countries	5.99240148	0.721560001
Portugal	2004	Developed Countries	5.926137327	0.729300022
Portugal	2001	Developed Countries	5.923501566	0.76481998
Portugal	2003	Developed Countries	5.786847294	0.698019981
Portugal	2006	Developed Countries	5.744758174	0.954479992
Portugal	2007	Developed Countries	5.576951605	1.124169946
Portugal	2008	Developed Countries	5.383921865	1.443349957
Portugal	2009	Developed Countries	5.327241121	1.580010056
Portugal	2017	Developed Countries	5.171956157	1.319280028
Portugal	2010	Developed Countries	4.817631537	1.535290003
Portugal	2015	Developed Countries	4.812853275	1.243299961
Portugal	2018	Developed Countries	4.809612613	1.349550009
Portugal	2011	Developed Countries	4.723430414	1.457409978
Portugal	2016	Developed Countries	4.716035676	1.280750036

Country Name	Year	Country Category	CO2	R&D
Portugal	2012	Developed Countries	4.585926334	1.378610015
Portugal	2013	Developed Countries	4.451935228	1.324679971
Portugal	2014	Developed Countries	4.416000981	1.289919972
Portugal	2019	Developed Countries	4.332448043	1.395619988
Portugal	2020	Developed Countries	3.784907587	1.613919973
Romania	2006	Developed Countries	4.683185051	0.456820011
Romania	2008	Developed Countries	4.645519558	0.552150011
Romania	2007	Developed Countries	4.631934271	0.511479974
Romania	2003	Developed Countries	4.548841989	0.397080004
Romania	2004	Developed Countries	4.444220583	0.389420003
Romania	2005	Developed Countries	4.441102202	0.412620008
Romania	2002	Developed Countries	4.313431226	0.377209991
Romania	2001	Developed Countries	4.302409591	0.391290009
Romania	2011	Developed Countries	4.171702851	0.474590003
Romania	2012	Developed Countries	4.080349845	0.462399989
Romania	2000	Developed Countries	3.965744999	0.366259992
Romania	2009	Developed Countries	3.962157924	0.443949997
Romania	2018	Developed Countries	3.861061715	0.497289985
Romania	2010	Developed Countries	3.832784829	0.446660012
Romania	2019	Developed Countries	3.817062957	0.47615999
Romania	2017	Developed Countries	3.788308728	0.506929994
Romania	2015	Developed Countries	3.699829468	0.487960011
Romania	2016	Developed Countries	3.633348386	0.48864001
Romania	2013	Developed Countries	3.607471352	0.390240014
Romania	2014	Developed Countries	3.593303303	0.382079989
Romania	2020	Developed Countries	3.564137501	0.465380013
Russian Federation	2011	Economies in Transition	11.8849497	1.015450001
Russian Federation	2019	Economies in Transition	11.79719417	1.03531003
Russian Federation	2012	Economies in Transition	11.70206537	1.027660012
Russian Federation	2007	Economies in Transition	11.61126905	1.116109967
Russian Federation	2008	Economies in Transition	11.59565409	1.044350028
Russian Federation	2006	Economies in Transition	11.5683691	1.072939992
Russian Federation	2018	Economies in Transition	11.49657125	0.990019977
Russian Federation	2013	Economies in Transition	11.37700431	1.027320027
Russian Federation	2010	Economies in Transition	11.32540095	1.130200028
Russian Federation	2020	Economies in Transition	11.23228807	1.090989947
Russian Federation	2005	Economies in Transition	11.23185215	1.067970037
Russian Federation	2014	Economies in Transition	11.20820771	1.072409987
Russian Federation	2003	Economies in Transition	11.13039808	1.286030054
Russian Federation	2004	Economies in Transition	11.11271137	1.151329994
Russian Federation	2015	Economies in Transition	11.0520055	1.100849986
Russian Federation	2017	Economies in Transition	11.03519921	1.109670043
Russian Federation	2016	Economies in Transition	10.88742693	1.102380037
Russian Federation	2009	Economies in Transition	10.83210855	1.251919985
Russian Federation	2002	Economies in Transition	10.77263875	1.246520042
Russian Federation	2001	Economies in Transition	10.73578414	1.176939964

Country Name	Year	Country Category	CO2	R&D
Russian Federation	2000	Economies in Transition	10.6676603	1.04982996
Serbia	2004	Economies in Transition	7.704822503	0.289530009
Serbia	2006	Economies in Transition	7.152196789	0.439850003
Serbia	2003	Economies in Transition	7.112272279	0.491380006
Serbia	2011	Economies in Transition	7.081766506	0.683340013
Serbia	2007	Economies in Transition	6.97189585	0.578769982
Serbia	2005	Economies in Transition	6.811809371	0.395300001
Serbia	2008	Economies in Transition	6.778829265	0.669659972
Serbia	2017	Economies in Transition	6.743135953	0.872380018
Serbia	2020	Economies in Transition	6.714517172	0.905579984
Serbia	2002	Economies in Transition	6.642040135	0.639680028
Serbia	2019	Economies in Transition	6.627579916	0.886669993
Serbia	2018	Economies in Transition	6.615354386	0.918910027
Serbia	2016	Economies in Transition	6.607094434	0.83822
Serbia	2013	Economies in Transition	6.486829109	0.683669984
Serbia	2010	Economies in Transition	6.460167791	0.702279985
Serbia	2009	Economies in Transition	6.402955303	0.817300022
Serbia	2015	Economies in Transition	6.399950503	0.810899973
Serbia	2012	Economies in Transition	6.360565389	0.853160024
Serbia	2001	Economies in Transition	6.158754266	0.304010004
Serbia	2000	Economies in Transition	5.851965836	0.85424
Serbia	2014	Economies in Transition	5.466697221	0.723089993
Singapore	2000	Developing Countries	10.45647507	1.816990018
Singapore	2001	Developing Countries	10.15736542	2.009299994
Singapore	2002	Developing Countries	9.887762066	2.032819986
Singapore	2004	Developing Countries	9.508518085	2.078589916
Singapore	2003	Developing Countries	9.273223218	1.996790051
Singapore	2005	Developing Countries	8.650599822	2.148060083
Singapore	2011	Developing Countries	8.636110044	2.069550037
Singapore	2006	Developing Countries	8.445470894	2.116559982
Singapore	2017	Developing Countries	8.432299827	1.899049997
Singapore	2010	Developing Countries	8.354508373	1.929180026
Singapore	2007	Developing Countries	8.343723215	2.319859982
Singapore	2012	Developing Countries	8.224530474	1.918329954
Singapore	2015	Developing Countries	8.208109049	2.174449921
Singapore	2013	Developing Countries	8.133169555	1.921040058
Singapore	2014	Developing Countries	8.117137172	2.082279921
Singapore	2016	Developing Countries	8.019891274	2.07291007
Singapore	2018	Developing Countries	8.018212077	1.809579968
Singapore	2008	Developing Countries	7.939751159	2.596740007
Singapore	2019	Developing Countries	7.918410385	1.885059953
Singapore	2009	Developing Countries	7.785710605	2.127899885
Singapore	2020	Developing Countries	7.686683702	2.163049936
Slovak Republic	2001	Developed Countries	7.171956473	0.624650002
Slovak Republic	2005	Developed Countries	7.16912035	0.493319988
Slovak Republic	2003	Developed Countries	7.133544027	0.561460018

Country Name	Year	Country Category	CO2	R&D
Slovak Republic	2002	Developed Countries	7.079416587	0.563139975
Slovak Republic	2000	Developed Countries	7.065165754	0.638059974
Slovak Republic	2006	Developed Countries	7.048747323	0.47488001
Slovak Republic	2004	Developed Countries	6.967339751	0.500689983
Slovak Republic	2007	Developed Countries	6.919612207	0.447459996
Slovak Republic	2008	Developed Countries	6.896373516	0.461369991
Slovak Republic	2010	Developed Countries	6.571950882	0.605499983
Slovak Republic	2011	Developed Countries	6.319835714	0.652549982
Slovak Republic	2009	Developed Countries	6.295273695	0.472719997
Slovak Republic	2017	Developed Countries	6.173022221	0.884559989
Slovak Republic	2013	Developed Countries	6.081287651	0.820050001
Slovak Republic	2018	Developed Countries	6.059571809	0.83555001
Slovak Republic	2012	Developed Countries	5.981808125	0.794610023
Slovak Republic	2016	Developed Countries	5.799847463	0.788569987
Slovak Republic	2019	Developed Countries	5.6897073	0.822409987
Slovak Republic	2015	Developed Countries	5.670137972	1.157269955
Slovak Republic	2014	Developed Countries	5.617285785	0.876999974
Slovak Republic	2020	Developed Countries	5.319054808	0.897809982
Slovenia	2008	Developed Countries	8.588513622	1.626729965
Slovenia	2006	Developed Countries	8.118969459	1.537050009
Slovenia	2007	Developed Countries	8.068590501	1.427029967
Slovenia	2005	Developed Countries	7.956364342	1.417780042
Slovenia	2004	Developed Countries	7.861545148	1.37026
Slovenia	2002	Developed Countries	7.783588113	1.443249941
Slovenia	2003	Developed Countries	7.722976971	1.247910023
Slovenia	2001	Developed Countries	7.720701184	1.467669964
Slovenia	2010	Developed Countries	7.701518562	2.05133009
Slovenia	2011	Developed Countries	7.648319915	2.412970066
Slovenia	2009	Developed Countries	7.603782771	1.811840057
Slovenia	2012	Developed Countries	7.35169231	2.560610056
Slovenia	2000	Developed Countries	7.311336526	1.359820008
Slovenia	2013	Developed Countries	7.062345597	2.564870119
Slovenia	2017	Developed Countries	6.834970006	1.865300059
Slovenia	2018	Developed Countries	6.785737362	1.945940018
Slovenia	2016	Developed Countries	6.732550718	2.007639885
Slovenia	2019	Developed Countries	6.543333724	2.041280031
Slovenia	2015	Developed Countries	6.367580618	2.195650101
Slovenia	2014	Developed Countries	6.359276036	2.365479946
Slovenia	2020	Developed Countries	5.934735179	2.142659903
South Africa	2008	Developing Countries	8.446649685	0.805670023
South Africa	2010	Developing Countries	8.217612227	0.662840009
South Africa	2014	Developing Countries	8.191152527	0.709869981
South Africa	2013	Developing Countries	8.116434954	0.663299978
South Africa	2012	Developing Countries	8.034649259	0.669340014
South Africa	2007	Developing Countries	7.943858574	0.793640018
South Africa	2009	Developing Countries	7.902048941	0.749930024

Country Name	Year	Country Category	CO2	R&D
South Africa	2004	Developing Countries	7.824764075	0.726809978
South Africa	2011	Developing Countries	7.808053742	0.66753
South Africa	2005	Developing Countries	7.704297845	0.770240009
South Africa	2019	Developing Countries	7.688907623	0.614300013
South Africa	2017	Developing Countries	7.683707811	0.762570024
South Africa	2006	Developing Countries	7.672712199	0.80290997
South Africa	2018	Developing Countries	7.667377025	0.687730014
South Africa	2015	Developing Countries	7.607188524	0.731469989
South Africa	2016	Developing Countries	7.544589571	0.749920011
South Africa	2003	Developing Countries	7.338956173	0.676500022
South Africa	2002	Developing Countries	6.950513574	0.659370005
South Africa	2001	Developing Countries	6.78372306	0.642239988
South Africa	2020	Developing Countries	6.687563147	0.603600025
South Africa	2000	Developing Countries	6.076553172	0.625239988
Spain	2005	Developed Countries	8.029197431	1.099560022
Spain	2007	Developed Countries	7.842320847	1.240530014
Spain	2004	Developed Countries	7.817928356	1.040889978
Spain	2006	Developed Countries	7.69812925	1.177019954
Spain	2003	Developed Countries	7.553341743	1.02373004
Spain	2002	Developed Countries	7.548673405	0.959710002
Spain	2000	Developed Countries	7.230213057	0.882759988
Spain	2001	Developed Countries	7.216250353	0.888329983
Spain	2008	Developed Countries	7.056479349	1.325000048
Spain	2009	Developed Countries	6.214687048	1.363639951
Spain	2011	Developed Countries	5.893329176	1.333410025
Spain	2010	Developed Countries	5.885763493	1.35995996
Spain	2012	Developed Countries	5.77854921	1.298760056
Spain	2017	Developed Countries	5.681590779	1.209769964
Spain	2015	Developed Countries	5.538855216	1.221789956
Spain	2018	Developed Countries	5.521059835	1.241510034
Spain	2016	Developed Countries	5.340585339	1.189859986
Spain	2013	Developed Countries	5.229400787	1.27481997
Spain	2014	Developed Countries	5.206009215	1.241590023
Spain	2019	Developed Countries	5.131798801	1.250249982
Spain	2020	Developed Countries	4.279594571	1.410390019
Sweden	2003	Developed Countries	6.162233629	3.579479933
Sweden	2002	Developed Countries	6.053104115	3.726639986
Sweden	2000	Developed Countries	6.005054717	4.3066
Sweden	2004	Developed Countries	5.959094376	3.361289978
Sweden	2001	Developed Countries	5.901251804	3.873800039
Sweden	2005	Developed Countries	5.546508738	3.35958004
Sweden	2006	Developed Countries	5.366981242	3.474999905
Sweden	2007	Developed Countries	5.143619019	3.233829975
Sweden	2010	Developed Countries	5.116747205	3.167890072
Sweden	2008	Developed Countries	4.991877663	3.469990015
Sweden	2011	Developed Countries	4.704307121	3.187020063

Country Name	Year	Country Category	CO2	R&D
Sweden	2009	Developed Countries	4.598659033	3.395279884
Sweden	2012	Developed Countries	4.41169766	3.230249882
Sweden	2013	Developed Countries	4.206927664	3.260420084
Sweden	2014	Developed Countries	4.021509657	3.101840019
Sweden	2015	Developed Countries	3.992178534	3.219029903
Sweden	2016	Developed Countries	3.899110005	3.247359991
Sweden	2017	Developed Countries	3.794924047	3.362790108
Sweden	2018	Developed Countries	3.529743944	3.321059942
Sweden	2019	Developed Countries	3.401593966	3.387579918
Sweden	2020	Developed Countries	3.242989143	3.489599943
Tajikistan	2020	Economies in Transition	0.977533024	0.08969
Tajikistan	2019	Economies in Transition	0.960233171	0.093670003
Tajikistan	2018	Economies in Transition	0.887070871	0.094010003
Tajikistan	2017	Economies in Transition	0.75712073	0.109569997
Tajikistan	2016	Economies in Transition	0.629971309	0.106219999
Tajikistan	2015	Economies in Transition	0.575406353	0.103399999
Tajikistan	2014	Economies in Transition	0.550493446	0.116240002
Tajikistan	2007	Economies in Transition	0.454594081	0.067780003
Tajikistan	2008	Economies in Transition	0.415182916	0.06983
Tajikistan	2013	Economies in Transition	0.392681965	0.11851
Tajikistan	2004	Economies in Transition	0.381847096	0.066969998
Tajikistan	2006	Economies in Transition	0.38066335	0.107320003
Tajikistan	2012	Economies in Transition	0.378966219	0.114320002
Tajikistan	2005	Economies in Transition	0.356638517	0.095700003
Tajikistan	2000	Economies in Transition	0.350864132	0.0676
Tajikistan	2001	Economies in Transition	0.335483498	0.089529999
Tajikistan	2011	Economies in Transition	0.329384665	0.121480003
Tajikistan	2002	Economies in Transition	0.326183111	0.07068
Tajikistan	2003	Economies in Transition	0.325980159	0.068850003
Tajikistan	2009	Economies in Transition	0.322035092	0.085770003
Tajikistan	2010	Economies in Transition	0.321040534	0.089139998
Thailand	2019	Developing Countries	3.849043757	1.143169999
Thailand	2015	Developing Countries	3.824676098	0.61609
Thailand	2013	Developing Countries	3.80405746	0.44163999
Thailand	2016	Developing Countries	3.794470231	0.778289974
Thailand	2017	Developing Countries	3.767896681	1.001659989
Thailand	2014	Developing Countries	3.736041694	0.479880005
Thailand	2018	Developing Countries	3.718427852	1.113739967
Thailand	2020	Developing Countries	3.714255806	1.328189969
Thailand	2012	Developing Countries	3.705856454	0.401549995
Thailand	2010	Developing Countries	3.526681931	0.298005
Thailand	2011	Developing Countries	3.477784925	0.36146
Thailand	2008	Developing Countries	3.473931644	0.203309998
Thailand	2007	Developing Countries	3.470192492	0.200800002
Thailand	2006	Developing Countries	3.388047487	0.232710004
Thailand	2005	Developing Countries	3.374235962	0.218889996

Country Name	Year	Country Category	CO2	R&D
Thailand	2009	Developing Countries	3.315705418	0.234549999
Thailand	2004	Developing Countries	3.26804608	0.238279998
Thailand	2003	Developing Countries	3.020757876	0.245340005
Thailand	2002	Developing Countries	2.967397137	0.230550006
Thailand	2001	Developing Countries	2.808749463	0.252310008
Thailand	2000	Developing Countries	2.678777546	0.244709998
Trinidad and Tobago	2011	Developing Countries	15.66386389	0.040240001
Trinidad and Tobago	2013	Developing Countries	15.39935685	0.054110002
Trinidad and Tobago	2010	Developing Countries	15.20460953	0.047710001
Trinidad and Tobago	2014	Developing Countries	15.17528906	0.076530002
Trinidad and Tobago	2012	Developing Countries	15.02904479	0.041590001
Trinidad and Tobago	2007	Developing Countries	14.79267594	0.059220001
Trinidad and Tobago	2015	Developing Countries	14.59453203	0.080480002
Trinidad and Tobago	2006	Developing Countries	14.56483642	0.072329998
Trinidad and Tobago	2008	Developing Countries	14.36822006	0.030719999
Trinidad and Tobago	2009	Developing Countries	13.58144607	0.056650002
Trinidad and Tobago	2005	Developing Countries	12.84078666	0.114309996
Trinidad and Tobago	2016	Developing Countries	12.44893931	0.087090001
Trinidad and Tobago	2017	Developing Countries	12.32558753	0.086060002
Trinidad and Tobago	2004	Developing Countries	11.82510366	0.114409998
Trinidad and Tobago	2018	Developing Countries	11.80540556	0.082220003
Trinidad and Tobago	2003	Developing Countries	11.41215531	0.115010001
Trinidad and Tobago	2019	Developing Countries	11.31303229	0.059409998
Trinidad and Tobago	2020	Developing Countries	10.15711917	0.064340003
Trinidad and Tobago	2002	Developing Countries	9.416819469	0.131779999
Trinidad and Tobago	2001	Developing Countries	8.680626371	0.104170002
Trinidad and Tobago	2000	Developing Countries	7.659868654	0.108000003
Tunisia	2015	Developing Countries	2.736460007	0.59412998
Tunisia	2014	Developing Countries	2.710310695	0.619880021
Tunisia	2012	Developing Countries	2.604725469	0.649370015
Tunisia	2017	Developing Countries	2.602781049	0.699540019
Tunisia	2018	Developing Countries	2.599764804	0.716449976
Tunisia	2010	Developing Countries	2.59948015	0.658060014
Tunisia	2016	Developing Countries	2.594443261	0.565389991
Tunisia	2019	Developing Countries	2.576495226	0.746580005
Tunisia	2013	Developing Countries	2.53107798	0.637000024
Tunisia	2008	Developing Countries	2.430690668	0.639330029
Tunisia	2011	Developing Countries	2.421693378	0.674579978
Tunisia	2009	Developing Countries	2.409401489	0.706439972
Tunisia	2020	Developing Countries	2.408622528	0.6948
Tunisia	2007	Developing Countries	2.397519185	0.665400028
Tunisia	2006	Developing Countries	2.334331531	0.677290022
Tunisia	2005	Developing Countries	2.265866436	0.711950004
Tunisia	2004	Developing Countries	2.236659226	0.730949998
Tunisia	2001	Developing Countries	2.198172049	0.6594
Tunisia	2002	Developing Countries	2.19396366	0.54302001

Country Name	Year	Country Category	CO2	R&D
Tunisia	2003	Developing Countries	2.154417814	0.650439978
Tunisia	2000	Developing Countries	2.129599418	0.6588
Turkiye	2017	Developing Countries	5.20587915	1.176319957
Turkiye	2018	Developing Countries	5.08691958	1.27173996
Turkiye	2020	Developing Countries	4.885863926	1.367570043
Turkiye	2019	Developing Countries	4.828961059	1.321460009
Turkiye	2016	Developing Countries	4.747839002	1.119789958
Turkiye	2015	Developing Countries	4.518290365	0.876890004
Turkiye	2014	Developing Countries	4.426835448	0.856400013
Turkiye	2012	Developing Countries	4.387019248	0.825950027
Turkiye	2011	Developing Countries	4.292988692	0.793929994
Turkiye	2013	Developing Countries	4.1903947	0.812059999
Turkiye	2007	Developing Countries	4.1188081	0.686160028
Turkiye	2010	Developing Countries	4.071715146	0.793690026
Turkiye	2008	Developing Countries	4.042198694	0.687409997
Turkiye	2009	Developing Countries	4.002087419	0.803619981
Turkiye	2006	Developing Countries	3.751129307	0.552919984
Turkiye	2005	Developing Countries	3.420478493	0.563809991
Turkiye	2000	Developing Countries	3.375207115	0.465579987
Turkiye	2004	Developing Countries	3.31343146	0.497130007
Turkiye	2003	Developing Countries	3.277513994	0.465319991
Turkiye	2002	Developing Countries	3.153687172	0.509039998
Turkiye	2001	Developing Countries	3.039264896	0.522469997
Ukraine	2003	Economies in Transition	6.90667501	1.071660042
Ukraine	2007	Economies in Transition	6.711370218	0.818690002
Ukraine	2008	Economies in Transition	6.511177945	0.809909999
Ukraine	2006	Economies in Transition	6.497195657	0.914030015
Ukraine	2004	Economies in Transition	6.472604332	1.04392004
Ukraine	2002	Economies in Transition	6.305502602	0.962689996
Ukraine	2005	Economies in Transition	6.271184113	0.995180011
Ukraine	2011	Economies in Transition	6.199226948	0.710900009
Ukraine	2001	Economies in Transition	6.176286003	0.989440024
Ukraine	2012	Economies in Transition	6.077865492	0.723630011
Ukraine	2000	Economies in Transition	6.047132268	0.929040015
Ukraine	2013	Economies in Transition	5.941323178	0.73299998
Ukraine	2010	Economies in Transition	5.862660906	0.802789986
Ukraine	2009	Economies in Transition	5.463591765	0.82595998
Ukraine	2014	Economies in Transition	5.251101919	0.650340021
Ukraine	2016	Economies in Transition	4.480765808	0.483390003
Ukraine	2015	Economies in Transition	4.231466707	0.614769995
Ukraine	2018	Economies in Transition	4.159868343	0.471130013
Ukraine	2019	Economies in Transition	3.933652536	0.433840007
Ukraine	2017	Economies in Transition	3.902160853	0.448790014
Ukraine	2020	Economies in Transition	3.753816189	0.403180003
United Kingdom	2001	Developed Countries	9.223024627	1.596580029
United Kingdom	2003	Developed Countries	9.104093197	1.579620004

Country Name	Year	Country Category	CO2	R&D
United Kingdom	2004	Developed Countries	9.053089952	1.529979944
United Kingdom	2000	Developed Countries	9.014527721	1.609060049
United Kingdom	2005	Developed Countries	8.955400659	1.549049973
United Kingdom	2002	Developed Countries	8.940232738	1.613729954
United Kingdom	2006	Developed Countries	8.908613466	1.575399995
United Kingdom	2007	Developed Countries	8.651030537	1.617089987
United Kingdom	2008	Developed Countries	8.337820015	1.607859969
United Kingdom	2010	Developed Countries	7.689567494	1.63496995
United Kingdom	2009	Developed Countries	7.490694289	1.666599989
United Kingdom	2012	Developed Countries	7.344260926	1.576310039
United Kingdom	2013	Developed Countries	7.076100428	1.620110035
United Kingdom	2011	Developed Countries	7.04484324	1.645210028
United Kingdom	2014	Developed Countries	6.433347	2.264499903
United Kingdom	2015	Developed Countries	6.159376361	2.270270109
United Kingdom	2016	Developed Countries	5.824502691	2.311450005
United Kingdom	2017	Developed Countries	5.553291497	2.323199987
United Kingdom	2018	Developed Countries	5.425128404	2.704819918
United Kingdom	2019	Developed Countries	5.175842473	2.665519953
United Kingdom	2020	Developed Countries	4.601142251	2.931440115
United States	2000	Developed Countries	20.46979674	2.619839907
United States	2001	Developed Countries	20.17153693	2.637150049
United States	2004	Developed Countries	19.59761671	2.486860037
United States	2003	Developed Countries	19.50650553	2.550149918
United States	2005	Developed Countries	19.46927252	2.501929998
United States	2002	Developed Countries	19.44553028	2.547450066
United States	2007	Developed Countries	19.04291178	2.615159988
United States	2006	Developed Countries	18.94591684	2.545449972
United States	2008	Developed Countries	18.27849126	2.744810104
United States	2010	Developed Countries	17.43173699	2.714449883
United States	2009	Developed Countries	16.80868142	2.791820049
United States	2011	Developed Countries	16.60418962	2.738029957
United States	2013	Developed Countries	16.11117526	2.702150106
United States	2014	Developed Countries	16.04091676	2.717859983
United States	2012	Developed Countries	15.78976015	2.672840118
United States	2015	Developed Countries	15.56001544	2.786999941
United States	2018	Developed Countries	15.2225181	3.010099888
United States	2016	Developed Countries	15.14988272	2.853499889
United States	2017	Developed Countries	14.82324544	2.904320002
United States	2019	Developed Countries	14.67338071	3.170490026
United States	2020	Developed Countries	13.03282795	3.4677701
Uruguay	2012	Developing Countries	2.526657951	0.308079988
Uruguay	2008	Developing Countries	2.32308372	0.374410003
Uruguay	2009	Developing Countries	2.292327272	0.402390003
Uruguay	2011	Developing Countries	2.26255839	0.329620004
Uruguay	2013	Developing Countries	2.176045049	0.291180015
Uruguay	2019	Developing Countries	1.985381557	0.426670015

Country Name	Year	Country Category	CO2	R&D
Uruguay	2015	Developing Countries	1.956378507	0.351090014
Uruguay	2014	Developing Countries	1.91658249	0.317070007
Uruguay	2016	Developing Countries	1.911408105	0.37391001
Uruguay	2018	Developing Countries	1.910014526	0.50594002
Uruguay	2006	Developing Countries	1.905948983	0.363849998
Uruguay	2020	Developing Countries	1.89971905	0.446619987
Uruguay	2010	Developing Countries	1.874277997	0.32881999
Uruguay	2017	Developing Countries	1.783589504	0.440519989
Uruguay	2007	Developing Countries	1.7588807	0.42159
Uruguay	2000	Developing Countries	1.657997755	0.209250003
Uruguay	2004	Developing Countries	1.647624586	0.3488
Uruguay	2005	Developing Countries	1.632413158	0.460310012
Uruguay	2001	Developing Countries	1.49845241	0.223715
Uruguay	2002	Developing Countries	1.370234642	0.238179997
Uruguay	2003	Developing Countries	1.355234514	0.2948
Uzbekistan	2002	Economies in Transition	5.139631645	0.293559998
Uzbekistan	2001	Economies in Transition	5.034975735	0.34544
Uzbekistan	2000	Economies in Transition	5.022413429	0.360630006
Uzbekistan	2004	Economies in Transition	4.826724816	0.270410001
Uzbekistan	2006	Economies in Transition	4.808052627	0.223949999
Uzbekistan	2003	Economies in Transition	4.767966551	0.268249989
Uzbekistan	2008	Economies in Transition	4.720545146	0.193540007
Uzbekistan	2007	Economies in Transition	4.562326932	0.217209995
Uzbekistan	2005	Economies in Transition	4.554977644	0.237409994
Uzbekistan	2010	Economies in Transition	4.419814161	0.154300004
Uzbekistan	2011	Economies in Transition	4.384333013	0.148770005
Uzbekistan	2009	Economies in Transition	4.196737901	0.203150004
Uzbekistan	2012	Economies in Transition	3.799902601	0.15512
Uzbekistan	2013	Economies in Transition	3.698566951	0.155000001
Uzbekistan	2019	Economies in Transition	3.504662697	0.113059998
Uzbekistan	2018	Economies in Transition	3.420322793	0.123939998
Uzbekistan	2014	Economies in Transition	3.40963401	0.153349996
Uzbekistan	2017	Economies in Transition	3.387256627	0.148340002
Uzbekistan	2020	Economies in Transition	3.376303785	0.138500005
Uzbekistan	2016	Economies in Transition	3.307404884	0.17238
Uzbekistan	2015	Economies in Transition	3.17449495	0.164969996

7 Appendix 2: Cross-country analysis between CO_2 and RD for all income categories using Granger Causality

Developed Countries					
Country	CO_2→dRD	dRD—CO2	Country	dCO2—dRD	dRD—dCO2
Latvia	0.22291	0.16755	Netherlands	3.122	5.098
	dCO2→RD	**RD—dCO2**	Norway	5.199*	5.224*
Sweden	3.5489	3.5489	Poland	9.271***	11.040***
	dCO2—dRD	**dRD -dCO2**	Romania	0.658	0.193
Austria	0.065	1.612	Slovak Republic	0.004	0.572
Bulgaria	1.939	6.175**	United Kingdom	1.357	1.566
Canada	0.140	9.425***		**dCO2—ddRD**	**ddRD—dCO2**
Croatia	3.713	2.623	Belgium	1.862	0.676
Czechia	6.312*	1.118	Cyprus	0.722	7.166**
Denmark	0.110	2.959	Finland	3.493	0.589
Estonia	1.702	8.492**	New Zealand	0.080	0.279*
France	0.413	2.957	Portugal	4.466	0.043
Germany	0.331	0.905	Slovenia	2.358	1.339
Hungary	2.235	0.669	Spain	1.478	1.558
Iceland	8.306**	4.965*	United States	0.940	0.244
Ireland	4.759*	0.024		**ddCO2—dRD**	**dRD—ddCO2**
Italy	0.156	2.164	Greece	0.490	0.403
Japan	2.548	6.791***	Luxembourg	3.164	0.684
Lithuania	1.844	0.798		**ddCO2—ddRD**	**ddRD—ddCO2**
Malta	0.903	0.117	Australia	1.993	9.191

Developing Countries					
	CO2—dRD	dRD—CO2		dCO2—ddRD	ddRD—dCO2
Iran	0.477	0.257	Israel	2.339	0.631
	CO2—ddRD	**ddRD—CO2**	Pakistan	3.169*	7.034***
South Africa	5.346*	0.083		**ddCO2—dRD**	**dRD—ddCO2**
Thailand	3.081*	0.230	China	1.780	5.275*
	dCO2—RD	**RD—dCO2**	Ecuador	4.357**	4.357**
Chile	0.360	2.480	Egypt	0.053	4.140**
Cuba	0.570	0.182	India	0.421	1.024
Kuwait	0.947	1.963	Korea	1.082	0.225
Singapore	5.771**	5.020**	Mongolia	0.567	4.507
Tunisia	0.540	1.816	Paraguay	0.334	0.477
	dCO2—dRD	**dRD—dCO2**	Peru	2.542	1.149
Argentina	0.649	3.028*		**ddCO2—ddRD**	**ddRD—ddCO2**
Brazil	2.023	12.440***	Mexico	0.000	0.007
Colombia	20.234***	6.916**	Philippines	2.529	0.322
Costa Rica	1.922	1.248			

Developing Countries				
	CO2—dRD	dRD—CO2	dCO2—ddRD	ddRD—dCO2
Malaysia	0.219	10.806***		
Mauritius	0.607	4.624*		
Panama	2.929	1.872		
Trinidad and Tobago	13.680***	3.420		
Turkey	0.580	4.815*		
Uruguay	4.422**	2.382		

Economies in Transition Countries					
Country	CO2—RD	RD—CO2	Country	dCO2—dRD	dRD—dCO2
Russia	0.849	0.515	Georgia	0.773	0.479
	CO2—dRD	**dRD—CO2**	Kazakhstan	1.126	2.182
Serbia	0.863	0.367	Kyrgyz Republic	0.789	3.702*
	dCO2—RD	**RD—dCO2**	Moldova	0.050	1.103
Armenia	3.409	0.818	Montenegro	0.397	4.328**
Uzbekistan	0.221**	0.030	North Macedonia	6.990***	3.167*
	dCO2—dRD	**dRD—dCO2**	Tajikistan	0.564	0.594
Azerbaijan	1.438	0.040	Ukraine	0.147	9.423***
Belarus	5.688*	2.431			

Least Developed Countries					
Country	dCO2—RD	RD—dCO2	Country	dCO2—dRD	dRD—dCO2
Burkina Faso	1.655	10.756***	Madagascar	3.911**	0.076

The symbols *, **, *** depicts 10%, 5%, 1% significance level respectively.

Source: Author's Compilation.

Data availability The authors confirm that all data generated or analysed during this study are included as electronic supplementary file.

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