STUDY OF THE POSSIBLE LINKS BETWEEN CO_2 EMISSIONS AND EMPLOYMENT STATUS

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Abstract

While humanity confronts the results of past policies in economic, social and environmental terms, attempting to mitigate the evident impacts on the environment and human life, this study attempts to explore the possible relationship between unemployment rates and their affect on climate change through carbon dioxide (CO_2) emissions from human economic activity. It is certain that issues of this magnitude are deeply interdisciplinary and their profound understanding requires complex and multi layered approach, in conjunction with the ensuing impacts in all different aspects. In this study, the formulation of a correlation between those two variables is attempted, through statistical processing of international data. Results are indicating towards a moderate correlation to an extent sufficient enough to allow research on the causes. The objections attribution is based on sample survey, using predefined assumptions. The aggregated results of the survey, acknowledging the delimitations set for the scope of this study, did not provide an unequivocal correlation on cause basis, but revealed all the parameters needed to be included in a future statistical analysis and survey in order for robust conclusions to be reached.

Key Words: *Climate Change, CO_2 Emissions, Environmental Footprint, Unemployment*

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Introduction

What is ultimately more important for a modern society, Climate Change or unemployment (ILO, 1982)? This is an important dilemma created as a result of the proposed shutdown of a large steel plant. Such industries release large amounts of CO_2, but are also the main foundation for several modern economies (Worldsteel, 2014). A similar situation applies to coal. Burning coal releases large amount of CO_2 (Pacyna et al., 2016), but for the extraction hundreds of thousands people are employed (Chung, 2016). Whereas coal is not extinct, but instead inactive in the ground, formed millions of years ago (Taylor et al., 2009), it would be

theoretically possible for the coal-mining industry to employ hundreds of thousands of workers again sometime in the near future. Thus, those advocating against unemployment will naturally want to open the mines again, but those supporting awareness against climate change and global warming will seek to keep carbon in the ground forever.

Both the major issues of Climate Change (Zhang et al., 2011; IPCC, 2014) and unemployment (Rontos et al., 2016) cause global concern (IPCC, 2014) under the modern, fragile, socio-economic regime of completely free market (Bockman, 2011). The correlation between the two under the current, globally evolving, social and political conditions may constitute keynote knowledge for understanding and mitigating both. However, the theoretical mechanism that connects those two social and economic variables, for the scope of this research, lies within the context of Cato's diagram indicating the relationship between the three pillars of sustainability (Scott-Cato, 2008).

Figure 1: ***The 3 pillars of sustainability (image from UTSC Sustainability Office)***

In this context, this research approaches Climate Change through the probable causes of human economic activity, which increases greenhouse gas concentrations in the atmosphere (Janssens-Maenhout et al., 2011), in relation to unemployment rates and ultimately, the extent on which the latter affects or not CO_2 emissions. While the relation between economy and climate change has been thoroughly studied (Pie et al 2013, 2014) and the effect of unemployment and inflation in an economic system have been also analytically investigated (Alogoskoufis, 2016) (see Okun's Law, Philips Curve, Kuznets Curve Keynesian economics), the possible correlation between unemployment and Climate Change (through CO_2 emissions) remains unidentified.

Within the context of efforts in finding a joint solution, if Climate Change and unemployment proved to be mutually exclusive then how should these two issues be addressed? If employment is found to increase CO_2 emissions per capita, then would it make sense to promote, as a measure of mitigating Climate Change, to deliberate exclusion -under welfare state insurance benefits- of a percentage (say 30%) of the individuals currently in the labour force; *i.e. be paid not to produce*? Or, if this question is posed differently, is it possible that the extent of the retirement age has a specific environmental impact and, thus, may have an indirect cost that has not been taken under account yet?

Accordingly, parallel to the current market ethics (Weber and Parsons, 2013) on which most modern western societies are built on, should there be incentives for job creation even if it leads to increased CO_2 emissions?

The so-called green economy and/or green job, is for many researchers a myth, or better an illusion, for many and different reasons, but mainly because it employs a small number of people whose wages are overwhelmingly subsidized by government funds. Thus, most green industries are simply unprofitable or not economically viable without those funds. Funds, though, resulting from the state revenues, ie. taxes. (indicatively Morriss et al., 2009; Musu, 2010; Mulvaney, 2014). The current European policy and strategy in support of the so called green jobs and renewably energy sources, dates back at least a decade and has become at some point a primary proposal from the USA. However, considering the case in Europe revealed that these policies are terribly damaging and economically unproductive (Green, 2011). Hence, following these studies, one can conclude that the green job agenda actually contributes in losing jobs, regarding the jobs lost per green job created and the environmental impact occurred with each MW of renewable energy installed. Therefore, is there in the current economic situation in Europe, an ally for employment besides green jobs?

Methodology

The selected methodological approach for this research had two major steps. A quantitative comparative statistical analysis was applied to CO_2 emissions data[1] and unemployment rates data[2] of 38 countries around globe, for a time period between 1980 and 2014. Countries selection was made upon listing the top 20 countries in the world in CO_2 emissions, the top 20 countries in the world in unemployment rates as appeared from data[1-2] extracted during this research, and the countries which were included in the survey research. Statistical data analysis included the calculation of the average, mode, media, mean and standard deviation, as well as the calculation of the correlation coefficient between the variables of each country throughout the whole time period, and the development of scatter-grams and trend-lines for the data-sets. The aforementioned correlation was used to develop the initial hypothesis, which has given the delimitations set for the scope of the current research, that CO_2 emissions correlate with unemployment.

In order to investigate further if there is a causal relationship between unemployment and CO2 emissions, and hence with climate change, an online survey was designed and conducted in March 2016 with a single month duration. In accordance with the guidelines of this research, duration was subject of the response rates and the sufficiently large data acquired for analysis.

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1 Global per capita CO2 emissions from human economic activity, 1980-2014. Emissions: 2015 update with 2014 emissions of fossil fuel use and industrial process emissions (cement production, carbonate use of limestone and dolomite, non-energy use of fuels and other combustion). Substance: CO2 country totals excluding short-cycle biomass burning and excluding large-scale biomass burning. Unit: ton (Mg) CO2 per capita and per year. Date: 25/11/2015. Sources: EDGARv4.3, EC, JRC, Netherlands Environmental Assessment Agency. The EDGARv4.3FT2014 emissions are calculated based on the energy balance statistics of IEA (2014), BP (2013-2014) data of BP Statistical Review of World Energy, June 2015, Chinese coal consumption data of the China Statistical Abstract, October 2015, UNDR (2013) World Population Prospects, the 2012 Revision Report United Nations, Department of Economic and Social Affairs, Population Division. Reference: Olivier, J.G.J., Janssens-Maenhout, G., Muntean, M. and Peters, J.A.H.W. (2015) Trends in global CO2 emissions: 2015 Report. PBL Netherlands Environmental Assessment Agency, The Hague; European Commission, Joint Research Centre (JRC), Institute for Environment and Sustainability (IES). JRC98184, PBL1803, Internet: http://edgar.jrc.ec.europa.eu/news_docs/jrc-2015-trends-in-global-co2-emissions-2015-report-98184.pdf, November 2015

2 Global Unemployment Rates, 1980-2014. Units: Percent of total labor force. Source International Monetary Fund, World Economic Outlook Database, April 2015, CIA World Factbook.

The questionnaire was drawn up to record the environmental footprint of those who are working/employed in relation to those unemployed. As certain aspects were beyond the scope of the current research, the latter were not separated in respect to types of unemployment (Skenderi and Uka, 2015). Delimitations were also set in regard to geographic, economic and social data. For example, there was no distinction between those leaving in a city centre and those leaving in suburbs regarding their needs for public transportation use, or between those leaving in different geographic latitudes regarding their needs for electricity (i.e. heating/cooling).

The developed survey was mainly based on closed-ended questions, with the exception of some questions regarding demographics. The main type of questions included in the survey were factual ones, i.e. respondents were invited to answer how they think, feel and express an opinion or intention regarding specific things that concern them, that are familiar with or that can easily estimate, eliciting knowledge and attitudes in relation to climate change, environmental values, behaviours and demographics.

The survey consisted of two essential parts: a) one focused in questions through which to determine the environmental footprint and b) one to identify the demographic profile of the survey responders. The environmental footprint determination questions were developed in accordance with the *Global Footprint Network* measuring the supply of and demand on nature (Global Footprint Network, 2016). The order in which questions became available, took under account the levels of comfort of the responder, as well as attraction factors. The first part introduces the respondent directly to the scope of the research with questions both general and specific content, *i.e. Do you believe global warming is caused by humans?; Do you consider "thinking green" an economic luxury?; What is the level of carbon dioxide increased by?; What is the unemployment rate today?; Are you currently employed?;* The second part basically separates the respondents to employed and unemployed. For the employed respondents, clarification questions regarding their working environment follow, while for the unemployed respondents, the questions try to determine their type of unemployment. Although, as previously mentioned, the type of unemployment variable was beyond the scope of the current research, it was deemed necessary to be recorded for statistical accuracy and probable future use. The third section is focusing on examining the environmental footprint of each respondent, *i.e. How often do you eat meat, fish, diary?; How much do you spend on clothing and household equipment?; What is the size of your house?; Do you recycle and use energy saving lighting?; How far do you travel by car, public transportation, boat and airplane?;* The last part was dedicated to examine certain demographic characteristics of the sample, *i.e. the gender, the age, the education status, the income, the political affiliations* (McCright, 2010), *the relevance to environmental science.*

The questionnaire was send via e-mail to a random sample of people all around the globe in about 4,500 e-mail addresses from OUC's e-mail data base for surveys and was shared in social media networks with estimated engagement of about 5,250 users (N=510; response rate=5,23%). In some participating countries the response rate is moderate to low.

The questionnaire was developed in a neutral manner, without leading and influencing the respondents, hence demographic questions were placed in the last section, aiming in excluding any possible emotional responses (Watson and Greer, 1983). Upon completion of the survey, processing and statistical analysis of the data followed. A first analysis separated the complete questionnaires and excluded those who did not meet certain criteria[3]. Thus from the total 510 initial questionnaire replies, 110 were excluded meaning that 78.4% of the sample answered was utilise for this research.

[3] Criteria included the exclusion of those aged less than 16 years old, of those not stating their age, of those not stating their country of residence, and of those that did not answered in all the questions of the survey.

For this study and further to the initial analysis, a separation of the responders was applied regarding their country of residence in order to deeper investigate and analyze the demographic profile characteristics in relation to some specific country characteristics and the environmental footprint in an attempt to additionally recognize potential patterns with regard to the initial hypothesis. The two countries that were selected for additional study were the second and third by rate of responds, thus Cyprus and United Kingdom. Greece, the first country by rate of responds, was not selected due to the presence of certain characteristics in the under research time of period of the political and financial state of the country that could affect the final outcome (ex. supernumery elections, extreme variations of the unemployment rates, prolonged economic crisis with effects in society, etc.). Moreover, it is an attempt to recognize if the high respond rates from Greece have or not misleadingly shaped the final outcome.

Results

The comparative statistical analysis from the data regarding the CO_2 emissions and unemployment rates are presented in Table1. Furthermore, a scatter-gram with the trend-line of all the above mentioned values of the data is presented in Figure1.

The analysis between the variables, prove correlation. In the future, a more empirical evaluation, based on regression analysis, can be implemented in order to derive more confident conclusions. The correlation consists of a general tendency, but there are also different indications on particular countries. Those findings come to link directly CO_2 emissions and unemployment, in fact, relate each one's economic activity to climate change through his environmental footprint. However, despite the significance of those results, which help to identify potential causes, it is not possible to determine a causal relationship between the two variables; correlation does not imply causality. Therefore the survey research was necessary.

Table 1: ***Correlation coefficient in absolute terms of per capita CO_2 emissions values[1] and of unemployment rates[2] per country. Statistical indicators.***

Country	R	Country	R	Average
Australia	0.689	Japan	0.659	0.392
Austria	0.627	Mexico	0.152	**Mode**
Bahrain	0.843	Netherlands	0.368	0.610
Belgium	0.174	New Zealand	0.060	**Median**
Brazil	0.276	Norway	0.005	0.366
Bulgaria	0.378	Pakistan	0.607	**Mean Deviation**
Canada	0.512	Poland	0.303	0.227
China	0.679	Portugal	0.253	**St. Deviation**
Cyprus	0.105	Russian Federation	0.057	0.269
Czech Republic	0.234	Slovakia	0.001	
Denmark	0.011	South Africa	0.316	
France	0.607	Spain	0.741	
Germany	0.260	Sweden	0.412	
Greece	0.038	Switzerland	0.383	
Hungary	0.904	Taiwan	0.793	
Iceland	0.598	Turkey	0.518	
Indonesia	0.827	Ukraine	0.264	
Iran	0.019	United Kingdom	0.364	
Italy	0.281	United States	0.570	

In order to develop a reliable measure of the environmental footprint of the two social groups under study, the statistical analysis of the survey responds, discussed below, focuses on three sets of variables, i.e. quantitative demographics; qualitative demographics and lifestyle measures including education, knowledge and political orientation; quantitative environmental behaviour of the sample.

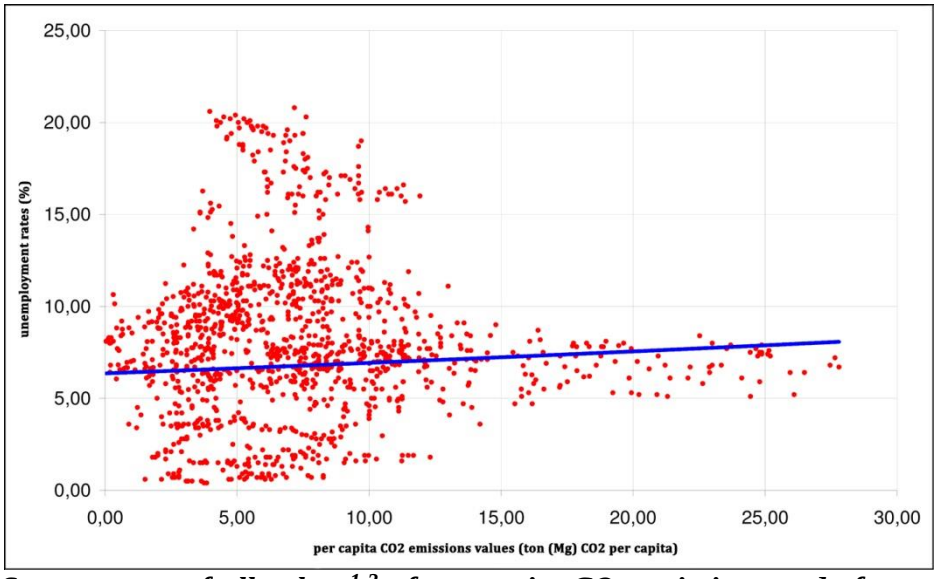

Figure 2: ***Scatter gram of all values[1-2] of per capita CO_2 emissions and of unemployment rates of all countries included in this research of a time period of 1980-2014.***

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Table 2: ***Demographic profile of survey respondents for the total sample and for Cypriot and UK respondents.***

	Total	Cyprus	UK
Gender			
Female	60.8%	63%	76%
Male	39.2%	38%	24%
Age			
18-30	33%	28%	57%
30-45	52%	64%	33%
45-60	13%	6%	10%
>60	2%	3%	0%
Education			
Basic Education	0.6%	0%	0%
Secondary Education	4.3%	4%	0%
Higher Education	39.3%	29%	19%
Master of PhD Education	55.8%	67%	81%
Relation to Environmental Science			
No	77.8%	75%	86%

Yes	22.3%	25%	14%
Political Affiliation			
Centre	27.5%	25%	24%
Left	26%	13%	33%
Extreme Left	2.3%	0%	0%
Right	12.8%	11%	0%
Extreme Right	0.2%	0%	0%
Don't know/No opinion	31.2%	51%	43%
Monthly Income			
0-500€	22.8%	13%	24%
501-1000€	26.1%	22%	0%
1001-1500€	23.3%	26%	14%
1501-2000€	11%	22%	10%
2001-2500€	6%	8%	14%
2501-3000€	3.2%	6%	14%
3001-3500€	2.8%	3%	10%
3501-4000€	1.4%	0%	5%
4001-4500€	0.4%	0%	0%
4501-5000€	0.4%	0%	0%
>5000€	2,6€	0%	10%
Currently Employed			
Yes	77%	81%	76%
No	23%	19%	24%

Survey's included demographic measures are presented in Table2 (qualitative and quantitative). Table3 presents a synthesis of the environmental footprint of those responders unemployed and those that are currently working in terms of the highest percent of the given responds.

Table 3: Environmental footprint comparison table of those currently employed and those currently unemployed, as recorded from the survey's highest percent responds for each one of the two groups of people for the total sample along with Cypriot and UK respondents.

		Total		Cyprus		UK	
Currently employed?		No	Yes	No	Yes	No	Yes
How often do you eat meat?	Occasionally	48%	57%	57%	57%	80%	56%
How often do you eat fish?	Infrequently	61%	68%	64%	64%	100%	44%
How often do you eat eggs, milk and dairy?	Often	43%	43%	29%	41%	40%	50%
What clothing and footwear goods do you buy each month?	Not at all, unless it is an absolute necessity	48%	50%	50%	41%	80%	38%
How much do you spend per year on household furnishings and appliances?	Very little (around 200€)	74%	0%	71%	41%	60%	69%
	Not very much (around 600€)	17%	63%				
How much of your paper, cardboard and plastic waste do you recycle?	All possible	30%	38%	21%	33%	80%	44%
	Most			43%	26%		

How many people live in your household?	Two	26%	29%	7%	24%	20%	56%
	Three			36%	10%	40%	6%
	Four			36%	41%		
What is the size of your house?	Small (around 100m2)	43%	38%			60%	31%
	Medium (around 150m2)			43%	34%		
Do you use energy saving lighting?	All the lights in my house are energy efficient	30%	45%	43%	48%		
	Half of the lights in my house are energy efficient					40%	44%
	I do not know					60%	6%
What do you typically spend per month on electricity for your home?	Around 60€	43%	54%	36%	52%	80%	56%
	Around 120€			43%	40%		
How far do you travel by car each week (as a driver of passenger)?	Around 80km	39%	41%	57%	40%		
	I never ride a car					100%	63%
What is the fuel consumption of the car you travel in most often?	Medium (8L/100km)	57%	55%	79%	67%	60%	31%
	Very Low (4L/100km)					40%	63%
How often do you drive in a car with someone else?	Occasionally	30%	36%	36%	29%	40%	50%
	Often			21%	34%		
How far do you travel by public transit each week (bus, rail, subway, etc)?	1 to 10 km	26%	21%				
	0 km	22%	43%	79%	97%		
	11 to 40 km					80%	31%
How many hours do you fly each year?	3 hours trip(s)	26%	20%	21%	29%		
	I do not	22%	22%	36%	19%		
	30 hours trips					40%	19%
	15 hours trips					20%	38%
How many hours do you travel by boat each year?	I do not	43%	43%	71%	88%	100%	38%

Discussion

Given that Climate Change does not concern in an equal, horizontal manner all parties (Parry et al, 2007), vulnerable points of societies and economies must be studied among countries through the anthropogenic social, psychological, economic and cultural background, with its resulting biophysical alterations and dynamics, regardless of their geography location.

How do economic losses from unemployment affect greenhouse gas emissions in relation to losing jobs in core labour industries, accumulating non-productive population mainly in the city centres and how does this reflect in attitudes, perceptions and behaviours? This article offers a view on the insufficient opportunities to work (unemployment) -as a major issue and

challenge facing both developed and developing countries (Ashford et al., 2012)- and the probable caused environmental effects, in order to arrive to an informed judgment concerning whether, or more appropriately under what conditions, a deliberate boost in job opportunities makes sense for a region in crisis. Our stating point is not a focus on reducing consumption, but on emphasizing that social and environmental sustainability require sustainable earning capacity for poor and middle-class people.

Global Warming affects both local and regional market's risks and opportunities worldwide (Dell et al., 2009, 2012, 2014). The main impact occurs, as expected, in industries depending on climate (eg. agriculture, fisheries, forestry, tourism, insurance, health care, etc.). Climate Change affects global employment and economic instability, extending far beyond the industries' most sensitive to climate (Field, 2014). Climate Change is absolute and every aspect of human life is affected to some extent by the patterns and the changes (Baldwin, 2014). Therefore, as the effects of Climate Change accumulate, people will be obliged in changes to their lifestyle. In specific parts of the world, the changes to occur will be essential and extensive (Clark et al., 2016) opening up new investment values (Webster et al., 2003) and realignments in employment. In other parts of the world, those changes may be of less importance, but even then, if the will occur within a short time of period (Clark et al., 2016) may become an aggregating force for rearrangement in business opportunities.

The optimum interpretation of unemployment, as expressed, is an environmental tool to break the constantly accelerating GDP growth as to maintain the sustainability levels in the context of resource consumption and environmental impacts (McVittie et al, 2008). Full employment condition, aiming at developing more environmentally efficient production and consumption patterns, could potentially provide an important and constantly cumulative environmental benefit, combined with reduced consumption of resources (Friedman, 2008). Maybe so, the future of the economy and manpower will benefit from the resultant structural increases in living standards and GDP growth.

In this study, the survey was not targeted to a sample of the total population and was conducted as previously mentioned via e-mail written in English. Hence, the high representation of Greek and Cypriot responders (i.e. 77%) along with the high percentage (i.e. 95%) in high educational qualifications –(see foreign language speakers) aligned with the wider literature findings stating that educated people are more likely to complete a questionnaire (Curtin et al., 2000; Singer et al., 2000)- are partly justified. Although the study is limited, it is important to note that is one of the first studies on the subject. From that perspective and in parallel with the scope of this research the level of representativeness was considered enough. Indeed though, for conclusive results perhaps the survey should have been left available longer time of period and should be addressed in one or two more language options.

Consistent with the wider literature (indicatively Lorenzoni and Pidgeon, 2006; McCright and Dunlap, 2011; Nisbet, 2009; Weber and Stern, 2011), findings from this study suggest widespread knowledge and concern about climate change. However, this, does not translate into personal engagement namely in terms of cognition, affect and behaviour (Lorenzoni, Nicholson-Cole and Whitmarsh, 2007).

Indeed, many of the participants/responders do not consider "thinking green" an economic luxury (61.5%), believe global warming is caused by humans (89.5%), see a relationship between unemployment rates and climate change (46.5%), even though their field of studies or occupation is not related to environmental science (77.8%), recycle (90.8%), use energy saving lighting (86.5%), use cars with fuel consumption below 10L/100Km (84.3%), and consider as a top priority growing a sustainable economy (52.5%).

Accordingly, for Cyprus, it is clear for those currently unemployed that are not prevailing a raising awareness, but rather are confused.16% of the responders consider "thinking green"

an economic luxury, just 22% believe that global warming is caused by humans, they are not aware of the level of carbon dioxide increase (since the industrial revolution), but do consider environmental protection (global warming mitigation) and growing a sustainably economy top priorities, compared to decreasing unemployment rates. According to the same sample responders are not aware of the current unemployment rates, while they don't identify a relation between employment status and climate change.

In parallel UK citizens responders that are currently unemployed do consider "thinking green" an economic luxury by 60% and they strongly believe that global warming is cause by humans (100%). Similarly to the Cypriot responders they are unaware of the level of carbon dioxide increase (80%) but they consider decreasing unemployment rates (60%) as a top priority even if they are not aware of the range of these rates, in conjunction with those currently working, who consider top priority growing a sustainable economy (75%). UK responders also do not identify a relationship between employment status rates and climate change (40%), unlike the currently employed (50%).

As the goal of this article is not to conduct a cross-country comparison of the effect of unemployment in climate change, but to examine this relation independently from country characteristics, to further indicate the absence or presence of some categorical effects that may be expected to shift the outcome (ex. country characteristics, occurrence of wars, major strikes, financial crisis, etc) the use of dummy variables should be an appropriate approach for further analysis.

Observations of the aforementioned findings indicates that the environmental footprint of the two community groups under study is common. Furthermore, the examination of the two separate countries showed none significant alternations in consumer habits and life style choices, hence in the total environmental footprint. This research's result though, can be challenged taking into account the delimitations set for the scope of this research. The fact that from this research do not arise a clear causal relationship to the initial hypothesis, does not imply it does not exist, especially if in the future the research emphasises in the comparison of developing countries as well. Besides, the most optimistic interpretation of Kuznets environmental curve states, growth in income is itself the solution to environmental problems (Andreoni and Levinson, 1998).

In the current literature and the scientific field of environmental science, appears to be none research on the questions raised in the current study.

The political, economic, social and even biological correlation and interpretation of all indicators that arise, such as per capita GDP, per capita CO_2 emissions, unemployment rate, long-term unemployment index, education index, geographical features, political conditions, are subject to further investigation, evaluation and correlation. Given the combination of all parameters from a new methodological approach and statistical analysis, it will become possible to address conclusively this multidimensional theorem. Further research on this subject should include, besides the obvious gradual removing of the delimitations set for the scope of the current paper, a cross-country comparison, the use of an econometric technique based on probabilistic models and a more mathematical approach (empirical curve equation).

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