THE CAUSAL RELATIONSHIP AMONG SUSTAINABLE DEVELOPMENT INDICATORS AND ECONOMIC GROWTH – THE CASE OF EU28 COUNTRIES

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Abstract. The concept of sustainable development can be compared to issues like democracy and globalization, because it has become a widespread contest and very important in this present time. It has compelled many authors and researchers to delve into its pillars such as social, economic and environmental likewise its indicators. The main aim of authors and researchers is characterized by finding the direction and strengths of impact among the pillars and indicators and probably come up with distinct ideas to support decision making of policy makers. Specifically, the relationship between economic growth and environmental pollution, as well as economic growth and energy consumption, has been extensively studied over the past two decades. Our study is focused on the causal relationship among the sustainable development indicators (GDP, transportation, energy consumption, and carbon emission) and their impact on economics growth in the 27 EU countries during 2005-2014. Carbon emission is regarded responsible for the majority of greenhouse gases. We use Grey models to find the relationship among the indicators. The analyses of causal relation point up the strengths and weaknesses of the sustainable development indicators (S. D. I.) on the GDP and economic growth. Based on the results the appropriate recommendation will be made.

Keywords: CO2 emissions, energy consumption, transportation, GDP

JEL Classification: Q01, Q43, C23

1. Introduction

Every single nation on the globe had the aim to attain lofty and higher economic growth from the beginning of industrial revolution with the mission of achieving this through the use of both renewable and non-renewable resources. Though this idea seemed very wise and laudable but not much concern was given to its impact on the environmental quality (Hajek & Olej, 2010). By the turn of some decades, the adverse impact of economic growth on environmental quality began to resurface as the the emission of carbon dioxide increased couple with global warming and climate change. This raise concern among world institutions (United Nations Framework Convention on Climate Change (UNFCCC); Global Environmental Facility (GEF); European Environmental Agency (EEA), etc.), as well as many scholars to find nexus between economic growth and macroeconomic variables such CO_2 emission, energy consumption, income, population, FDI, etc. using different econometric methodologies. Kraft & Kraft (1978) pioneered the topic by determining the causal relation between energy and gross national product (GNP). Their conclusion portrayed a unidirectional relationship, which implied the relation runs from GNP to energy consumption but there was no relation between energy to GNP. Ozturk & Acaravcci (2010) also investigated the long-run and casual relationship between economic growth energy consumption, carbon emission, employment in Turkey using data from 1968-2005 by using autoregressive distribution lag bounds testing method of cointegration. The result showed that neither energy consumption per capita nor carbon emission causes real GDP growth. Yet employment ratio has a causal relation to real GDP per capita. Yuan et al. (2010) examined the relation between China's economic growth and energy consumption using grey incidence analyses and data from 1980-2007. The results in the different period were not the same, although there was some positive effect on GDP. Simply put, reducing carbon emission and share energy consumption do not necessary have an adverse effect on the output in Turkey. Arouri et al. (2012) used panel unit root test and cointegration technique to determine the relationship between energy consumption and real GDP for twelve North Africa and Middle East countries (MENA) from 1981-2005. The result indicated that there is a significant impact of energy consumption and carbon dioxide emission. Similarly, the result indicated that there is a quadratic relation between real GDP and carbon dioxide emission in the whole region. Put differently, reduction in carbon emission per capita might have the same effect on GDP per capita in future for the region as the region keeps on growing.

As a result, it can now be deduced from the few empirical studies that there have been contradictory views. This can be traced from the outcome on some the macroeconomic variable and economic growth. Hence the topic (assertion) is creating more curiosity for further research since many regions of the globe have not been explored to assess the current trend of the topic. For instance, EU has been one of world leading institutions who have shown much concern about economic growth and environmental quality by minimizing the adverse effect of carbon dioxid/greenhouse gases and energy consumption on economic growth. Explicit evidence can be traced from climatic initiative put in from 1991 to reduce emission and improve energy efficiency.

Similarly, greenhouse gas emission in Europe, according to Micquel Arias Conte (EU climate head), has also declined to the lowest level from 1990-2014 which is about 23% more than the estimated 1/5 projected for the year 2020. At the same time, the EU economy grew by 46% and she declared this before the Paris Conference in last year December. The institution still has set a goal to reduce their emission to minimize global warming by 2 degrees by mid of this century whiles ensuring economic growth. Consequently, other researchers challenge the possibility of achieving this goal. In a like manner, they have believed that EU can achieve this if its member countries can reduce their emission 3 times from now.

Hence this paper investigates the relationship between economic growth and environmental pollution, energy consumption, transportation in the 28 EU countries. Taking into consideration the recent year data, we will use regression analyses and Univariate Grey Prediction (GP) modelling to predict the future trend. This tool is used because it provides high accuracy forecasts compared with other technique and also offers a reliable forecast for variables like energy consumption, and CO_2/greenhouse gas emission.

The remainder of this paper is organized as follows. Section 2 describes the data used and illustrates the model and econometric methodology and the GP approach. Section 3 discusses the empirical findings, and the last section summarizes findings and policy implications.

2. Research Methodology

2.1 Data

Annual time series data from Eurostat and it covers 1995 to 2014 for the purpose of this study. With the exception of countries like Estonia, and Latvia which had insufficient transportation data for some of the years, all the countries have full data. The variables used are the GDP (measured in millions of Euro), energy consumption (measured in million tons of oil equivalent), CO_2 emission (greenhouse gas emissions in CO_2 equivalent indexed to 1990), and Transportation (measured in passenger-kilometers travelled relative to GDP at 2000 change rate). The specific objective of this study is to find the direction of causal relationship between economic growth and environmental pollution, energy consumption along with transportation. The summary statistics (mean value) of GDP, Energy consumption, CO_2 emission and Transportation are presented in Table 1.

Table 1: Mean values of variables

Country	GDP	Energy consumption	CO_2	Transportation
BELGIUM	306797.2	50.51	96.48	39336
BULGARIA	69498.3	18.55	60.59	5330
CZECH REPUBLIC	108092.4	40.78	73.51	19305
DENMARK	205732.4	19.43	99.43	22651
GERMANY	2350019.0	313.90	81.63	152425
ESTONIA	11025.5	5.57	47.77	2044
IRELAND	141311.7	13.80	117.47	20895
GREECE	177885.7	27.54	116.77	37311
SPAIN	844024.2	118.49	132.64	110488
FRANCE	1721451.4	246.00	98.38	91423
CROATIA	33910.8	8.39	80.89	4383
ITALY	1398532.2	165.08	102.44	168268
CYPRUS	14156.4	2.40	148.73	2855
LATVIA	14059.5	4.37	44.70	2224
LITHUANIA	20750.5	7.38	44.66	1764
LUXEMBURG	30458.8	4.09	92.24	3406
HUNGARY	76616.0	23.89	75.94	17096
MALTA	320811.1	0.88	144.49	997
NETHERLAND	526896.0	67.48	99.23	15926
AUSTRIA	252059.9	30.01	107.82	27061
POLLAND	257554.4	91.06	85.88	49134
PORTUGAL	147484.7	22.27	127.57	13497
ROMANIA	83263.9	37.07	56.48	11403
SLOVENIA	28460.8	6.70	105.42	3630
SLOVAKIA	42932.9	16.78	66.42	9260
FINLAND	159756.0	33.45	102.63	17021
SWEDEN	315771.5	48.18	93.52	24318
UK	1788210.3	210.60	86.20	106708

Source: own processing

2.2 Econometric Model

Based on the previous literature and findings in energy economics, it is prudent to form a long-run relationship between energy consumption, CO_2, transportation and GDP in a linear quadratic form, with an aim of testing the validity between the dependent variables (GDP) and independent variables (energy consumption, CO_2 and transportation):

$$GDP = \alpha + \beta_1 EC_{it} + \beta_2 CO2_{it} + \beta_3 TRANS_{it} + u_{it}, \quad (1)$$

where $i=1,2,\dots,N$, N is the number of countries, t denotes time, α is intercept, β_1, β_2 and β_3 are regression parameters, and u_{it} is assumed to be serial uncorrelated error term.

Pooled, fixed and random effects were used to deduce three models correspondingly. The hypothesized signs of the regression parameters were as follows: transportation (+), energy consumption (+) as they stimulate economic growth and CO_2 (-). These assumptions were based on the results of previous studies (but for different regions of the world) (Yuan et al., 2010; Arouri et al., 2012).

3. Results

3.1 Pooled Effect Model

This model assumes that all 28 EU countries have the same values of variables. The result of pool effect model in Table 2 suggests that energy consumption and transportation were the variables that can explain GDP ($P<0.01$). On the other hand, CO_2 emissions were not significant. Also, GDP had positive significant effect on the independent variables. Therefore, 1% increase in GDP increases both energy consumption and transportation by 5846.17 and 3.54, respectively. Similarly, 1% increase in GDP decreases CO_2 emissions by 115.36.

Table 2: Results of pooled effect model

Input variables	Coef.	Std. Err	*t*	*P*>|*t*|	95% conf. interval	
Energy consumption	5846.17	165.61	35.30	0.000	5520.871	6171.458
CO_2	-115.36	226.92	-0.51	0.611	-561.083	330.355
Transportation	3.54	.28	12.57	0.000	2.982	4.088
Constant term	-58391.46	22055.53	-2.65	0.008	-101713.8	-15069.1

Source: own processing

3.2 Fixed Effect Model

The model allows for heterogeneity among individual variables. In addition, it assumes that all the countries have different intercept values but it does not vary over time (it is time invariant). This model shows that energy consumption and transportation are the variables that can explain GDP (Table 3). On the other hand, CO_2 emissions were again not significant to explain GDP. Besides, 1% increases in GDP increases transportation by 9.16. Conversely, 1% increase in GDP decreases energy consumption and CO_2 by 2711.95 and 628.36, respectively.

Table 3: Results of fixed effect model

Input variables	Coef.	Std. Err	*t*	*P*>|*t*|	95% conf. interval	
Energy consumption	-2711.95	762.32	-3.56	0.000	-4209.500	-1214.407
CO_2	-628.36	461.82	-1.36	0.174	-1535.578	278.860
Transportation	9.16	.31	29.77	0.000	8.552	9.760
Constant term	291924.40	43384.99	6.73	0.000	206696.3	377152.4

Source: own processing

3.3 Random Effect Model

The model works under assumption that there is a common mean for the intercept. The results in Table 4 illustrate that all the three independent variables can explain GDP. Moreover, 1% increase in GDP increases both energy consumption and transportation by 2639.02 and 8.48, respectively. Similarly, 1% increase in GDP decreases CO_2 by 2018.54.

Table 4: Results of random effect model

Input variables	Coef.	Std. Err	*t*	*P*>|*t*|	95% conf. interval	
Energy consumption	2639.02	317.87	8.30	0.000	2016.009	3262.026
CO_2	-2018.54	388.16	-5.20	0.000	-2779.314	-1257.762
Transportation	8.48	.31	27.11	0.000	7.868	9.095
Constant term	131731.50	43336.45	3.04	0.002	46793.6	216669.4

Source: own processing

4. Conclusion

The causes of the rise and fall in the two variables CO_2 emissions and energy consumption may be attributed to cold winter condition which gives rise to fuel consumption in both residence and commercial sector. The unstable rate of expansion in the industrial sectors in previous years is another cause since it turns out to increase or decrease the CO_2 emissions as well as energy consumption depending on magnitude of the development or expansion.

Our results show that energy consumption, CO_2 emission and transportation have positive impact on GDP. In like manner, the same results have been confirmed by Kasman & Duman (2015), Shahbaz et al. (2014), Pao & Tsai (2011), Belloumi (2009), Shalbaz & Lean (2012), Bowden & Payne (2009) Odhaimbo (2008), Halicioglu (2009), Say & Yucel (2006) and Sheinbaum-Pardo et al. (2012) although their studies were carried out in different countries and regions as well as different time periods. For example, as GDP increases, CO_2 emission decreases and other two variable increases can be evidenced by the pooled and random effect models. This result is explained by three supporting arguments. Firstly, most of the countries in EU have made a very strong effort to control environmental problems specifically air pollution etc. Also all the EU countries have special institutions established to curb the environmental challenges. Countries are abiding by the environmental policies and laws put in place by EU and their ministers of environment, especially in the areas of air, water and land pollution. Therefore, this leads to the reduction of CO_2 emissions and increase in GDP (because less much resource is used to offset the negative effect CO_2 emissions).

In addition, citizen's aware of dangers CO_2 emission on climate has also driven politicians to adopt more effective sustainable energy consumption. These have positive effect on the region. As people are using effective energy consumption products than more energy consuming products, less amount of resource will be sacrifice to combat its negative externality. In effect, consumers want to minimize cost likewise its negative environmental impact. Hence, increase in transportation with less pollution.

Several important policy implications can be proposed based on the results of this study. EU and member countries should continue to monitor baseline for emissions especially the use of technological growth development automobile machines and fluorinated GHG. There should be a clean energy development initiative where people will be willing to voluntary might help to promote green building standards. They should also be supported both materially and finally by greenhouse fund by EU. The EU as well as individual countries should keep on revising their policies to meet their emission reduction target to match the current trend of economic growth. EU should also institute transparency, accountability and compliance scheme which actually will be not used as a punitive measure but must be used as to figure out member countries which off-tract and put them back on track. There should cost effective regulations for all entities especially industries to minimize air pollution.

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