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Economic Growth-CO₂ Emission Relationship in OECD and Non-OECD Countries: A Panel Data Analysis for the Period between 1990-2011

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Abstract:

Economic growth brings about environmental pollution. As from the second half of the 20th century, analyses on the environmental negative externality arising from the economic growth have been accelerated. Certain steps have been taken in order to protect the environment by international organizations having emerged upon the recognition of environment as a variable of economic growth. Environmental sensitivity has come into prominence in the economic growth and economic development process particularly through United Nations Millennium Declaration, Kyoto Protocol, International Environmental Action Plans and national practices of countries. In scope of this study, the relationship between national income and CO₂ emission is tested in consideration of the data between the years 1990-2011 in 44 countries, out of which 22 are OECD countries and 22 are Non-OECD countries. It is determined in consequence of panel data analysis that there is a strong relationship between the national income and CO₂ emission and Environmental Kuznets Curve in the shape of inverted-U for 44 countries.

Key words: Economic Growth, CO₂ Emissions, Environmental Kuznets Curve

Jel Code: O44, Q53

1. Introduction

The relationship between economic growth and environment is mainly based in three main lines. These are win-win, win-lose, and lose-lose. In terms of sustainable development, all kinds of natural resources used in the process of economic growth should be used more carefully in the long run. Thus, a country with the target of development will handle such resources more attentively, produce protective policies and making an effort to enhance renewability. Secondly, one of the parties (economy-environment) will gain a ground and the other will lose in consequence of the economic activity. In this case, economic growth will be provided despite the environment; however, in the long term, one of the parties will be the absolute loser due to the environmental negative externality that will arise. Finally, adoption of an ineffective environmental policy and unsustainable management of natural resources in the process of economic growth will hinder the realization of the desired economic growth. Moreover, inefficient use of available resources will lead to an economic policy aiming growth and development with a high alternative cost.

The United Nations tried to entrench the concept of humanitarian sustainable development, which came to the scene in international platforms particularly in 1970s and became popular after 1990s and placed human life to the forefront, across the world. This is also overemphasized in the United Nations Millennium Declaration and importance is attached to the promotion of measures supporting these attempts. In order to ensure environment-oriented sustainability, it is targeted to make improvements in social life, such as enhancing sensitivity for environment, reducing biological losses, extending access to clean drinking water. In the extent of works carried out by the United Nations since 1972, environmental actions plans were prepared, first four five-year plans were put into force and the fifth action plan was prepared covering a period of eight years. The sixth action plan was put into practice in 2002 and covered the period till 2012. Finally, an action plan covering the period till 2020 has been enforced.

In scope of the attempts of environmental protection, preservation of the natural life in a clean environment, efficient use of resources, waste management and reduction of wastes without leading to decrease in the economic value of waste or reduction of such loss, each country should fulfill its responsibilities in an attentive and serious manner. Each country has a certain responsibility for the efforts of sustainable development. Attempts to take decisions for such efforts, cooperate with other countries, protect the natural universally and reduce economic loss are governed by the top authorized bodies pursuant to the principle of social state. As the individuals and firms avoid from undertaking the costs of absorbing negative externality, arising from the principle of social state, due to economic concerns, environmental services should be provided under the supervision of the state and by means of public resources.

There are many empirical studies on the environmental economics. Among them, Environmental Kuznets Curve analysis has come into prominence as from the first quarter of 1990. In Kuznets curve involving the analysis of the relationship between the

change in countries' income levels and CO₂ emission, it is anticipated that environmental pollution will increase as the economic growth increases in the beginning and, after reaching to a certain income standard, the environmental pollution will decrease.

In this study, national income and CO₂ data of 22 OECD countries with the highest national income and 22 Non-OECD countries with the highest national income for the years 1990-2011 are used. Panel data analysis is made in frame of the study, examining the impact of the change in the income levels of these 44 countries on CO₂ emission.

2. Literature

In his study analyzing the relationship between economic growth, energy consumption and energy prices are analyzed for India, Indonesia, Philippines and Thailand, Adjaye (2000) stated that there is a unidirectional relationship from energy consumption to income for India and Indonesia and a bidirectional relationship for Thailand and Philippines in the short term.

Azomahou, Lasiney and Van (2005) made a research on the data of 100 countries for the years between 1960-1996 and determined that there is a sustainable relationship between per capita GDP and CO₂ emission.

Chebbi and Boujelbene (2008) analyzed the relationship between CO₂ emission, energy consumption and economic growth for Tunisia in consideration of the data set obtained from the data between the years 1971-2004. In frame of the findings obtained, it was concluded that economic growth had a positive impact on the energy consumption in the long run and there is a positive relationship between energy consumption and CO₂ emission.

Odularu and Okonkwo (2009) tested the relationship between energy and economic growth in their analysis on the economy of Nigeria on the basis of the data of the period between 1970-2005. Among energy items, oil, electricity and coal data were used. It was stated that there was a positive relationship between energy consumption and the increase in energy consumption led to economic growth.

Lean and Smyth (2009), made an analysis among CO₂ emissions, electricity consumption and economic growth on ASEAN countries for 1980-2006 period. They find that there is a significant positive relations between electricity and CO₂ emissions and non-linear relationship between CO₂ emissions and real output in long-term.

Li, Dong, Li, Liang and Yang (2010), made an empirical analysis on 30 different provinces in China and they find remarkable results that there is a significant relations among GNP, energy consumption and CO₂ emissions. Energy consumption is an important factor on economic growth in China. In addition, they find that a 1% increasing of per capita lead to increase CO₂ emissions between the range of 0,41-0,43 in China. From this point of view they offer the suggestion to authorities in developing countries that they would be to establish well-planned their long term energy policy systems and they can try to new methods for alternative energy sources for growth.

In their study carried out in scope of Environmental Kuznets Curve Hypothesis on the basis of the data of the period between 2000-2005 for the Mediterranean countries, Ari and Zeren (2011) determined that CO₂ emission increased in the beginning period of economic growth and decreased thereafter. However, they also stated that CO₂ emission increased again in consequence of the increase in income, population and energy consumption arising from the economic growth after a certain phase of the economic growth.

In their study on Turkey for the period between 1950-2007, Saatçi and Dumrul (2011) obtained a result of inverted-U in the analysis of Environmental Kuznets Curve Hypothesis and found out that there was a long-term relationship between CO₂ emission and income, together with fractions.

Kumar (2011), made an empirical analysis for India and he tested the relationship among energy consumption, CO₂ emissions and economic growth by Granger approach in VAR framework. He found from the VAR analysis that energy consumption, capital and population Granger-cause economic growth not the vice versa. The analysis results indicate that CO₂ emissions has positive impact on energy use and capital, but negative impact on population and GDP. Energy consumption has a positive impact on CO₂ emissions and GDP, but its impact is negative on capital and population

Arouri, Youssef, M'Henni and Rault (2012) made a research for MENA countries in scope of Environmental Kuznets Curve Hypothesis and determined that the relationship between CO₂, energy consumption and per capita real GDP had a quadratic form. It was stated that important developments occurred in terms of environmental sensitivity in many MENA countries in the last decades and a pro-active structure was established for environmental protection.

Amin, Perdaus and Porna (2012) made a test for Bangladesh and they find that there is a positive relationship among output, energy use and CO₂ emissions during the period 1976-2007. The empirical results show that there is a robust long term correlation between variables. Their results suggest that there is no causal relationship between output and CO₂ emissions and. So, Bangladesh economy can be achieved without degrading the quality of environment.

In their study for 15 Middle East and North African Countries (MENA Countries) for the period between 1973-2008, Farhani and Rejeb (2012) tested the strong relationship between economic growth and energy consumption and CO₂ emission.

In their research on China, Bloch, Rafiq and Salim (2012), the empirical results show that there is a unidirectional causality running from coal consumption to GDP in the short- and long-run under the supply side analysis, where GDP is interpreted as a measure of aggregate output in China. In addition, the findings of all the tests for the two demand-side equations, they show there is a short- and long-run bi-directional causality between coal consumption and GDP, where GDP is interpreted as a measure of aggregate income.

Çınar, Yılmaz and Fazlılar (2013) analyzed the relationship between per capita income, CO₂ emission, import and export data of polluting industrial sectors and direct foreign investments in their study on developed and developing countries. In consequence of the analysis, it was concluded that Environmental Kuznets Curve was inverted-U for developed countries and U for developing countries.

In their research on 19 OECD countries for the period covering the years 1981-2009, Han and Lee (2013) stated that impact of CO₂ emission on the economic growth decreased in the long term and the technological progress having developed in years had an impact on this result.

Yıldırım (2013) analyzed the relationship between economical span, income and CO₂ emission and concluded that there was a linear relationship between income and pollution. It was also concluded that this relationship would reverse by the influence of the developments in technology. It was expressed that Environmental Kuznets Curve would move in the shape of inverted-U and development would cause less pollution by the influence of the changes in technology.

In their study carried out with the approach of panel and non-panel data, Ong and Sek (2013) analyzed the relationship between CO₂ emission and GDP on the basis of the data countries in high-, medium- and low-income groups for the years between 1970-2008. It was concluded that there was no interaction between income and CO₂ emission for countries with high income standards; however, there was a strong relationship between income and CO₂ emission in countries with low income level.

Uçak and Usupbeyli (2013) tested the relationship between development and CO₂ emission in BRIC countries and determined that there was a positive relationship between GDP and CO₂ for Russian Federation and Turkey in the long term. In consideration to the data of GDP and CO₂ emission, they found out that there was no statistically meaningful relationship for India and Brazil.

In their study on 15 high income and 15 low-medium and medium-high income countries for the years between 1999-2009, Sarısoy and Yıldız (2013) tested the positive relationship between income and CO₂ emission for developed and developing countries. However, result of the test was not consistent with the inverted-U shape of Environmental Kuznets Curve, suggesting that CO₂ emission would decrease beyond a certain point in the income level. Results showed an N shape suggesting that CO₂ emission might increase in high income levels, depending on the income increase. Moreover, in consequence of the analysis, it was determined that there was a positive relationship between population density and CO₂ emission.

Shaari, Rahim and Rashid (2013) tested the relationship between population, energy consumption and economic growth in their analysis on Malaysia for the period 1991-2011. In consequence of the analysis, it was determined that there was a long term relationship between the variables and energy consumption was directly proportional to economic growth.

3. Data and Methodology

In this study, a panel data analysis was carried on the basis of economic growth and CO₂ emission data of 44 countries, out of which 22 are EOCED and 22 are Non-OECD countries with the highest GDP levels between the years 1990-2011. Data were compiled from the country statistics of International Energy Agency. Firstly, Levin, Lin & Chu and Im, Pesaran & Shin unit root tests were applied to the sets in the study. Upon the determination that both sets were static after taking their first differences, Pedroni and Kao co-integration tests were carried out in order to analyze the long term relationship between variables.

No	OECD Countries			Non-OECD Countries			
1	United States	12	Netherlands	1	China	12	Thailand
2	Japan	13	Turkey	2	India	13	Colombia
3	Germany	14	Switzerland	3	Brazil	14	Malaysia
4	United Kingdom	15	Sweden	4	Russian Federation	15	Venezuela
5	France	16	Belgium	5	Indonesia	16	Singapore
6	Italy	17	Poland	6	Saudi Arabia	17	Nigeria
7	Canada	18	Austria	7	South Africa	18	Pakistan
8	Spain	19	Norway	8	Argentina	19	Philippines
9	South Korea	20	Denmark	9	Iran	20	Egypt
10	Mexico	21	Greece	10	Hong Kong	21	Peru
11	Australia	22	Finland	11	United Arab Emirates	22	Algeria

Table 1: OECD and Non-OECD Countries (2011 GDP)

4. Findings and Discussion

Table 2 shows the results of Levin, Lin & Chu and Im, Pesaran & Shin unit root test. It is seen in the Table 2 that both GNP and CO₂ variables are not static at 5% level of significant according to the results of both tests; however, they are static when their first differences are taken, namely in I(1).

Variable		Levin, Lin & Chu		Im, Pesaran & Shin	
		t statistic	p value	t statistic	p value
CO ₂	Level	22.1578 *	1.0000	27.4624 *	1.0000
	The First Difference	-20.0060	0 .0000	-22.6477	0 .0000
GNP	Level	11.3268 *	1.0000	12.5659 *	1.0000
	The First Difference	-6.23337	0 .0000	-4.95764	0 .0000

*: It shows that the respective statistical value is meaningless at 5% level of significance.

Table 2: Unit Root Test Results

As both variables analyzed were static at I(1), it is possible to apply co-integration analysis on variables. Thus, Pedroni and Kao panel co-integration test was carried out and the results are shown in the Table 3. Schwarz Information Criterion (SIC) was taken as basis in the calculation of optimum lag lengths for variables and lag length was automatically found.

With regard to the results of Pedroni panel co-integration test, the null hypothesis, suggesting that there is no co-integration between variables at 5% level of significance, is denied in terms of both panel and group statistics. In other words, there is a long-term relationship between economic growth and CO₂. Similarly, the null hypothesis, suggesting that there is no co-integration between variables at 5% level of significance, is also denied and it is concluded that variables are co-integrated according to the result of Kao panel co-integration test. Accordingly, a causal relationship is addressed between variables, even if it is unidirectional.

Pedroni Co-Integration Test Results				
	t statistic	p value	Weighted t statistic	p value
Panel v	21.19148	0 .0000	21.19148	0 .0000
Panel rho	-5.650764	0 .0000	-5.650764	0 .0000
Panel PP	-13.52209	0 .0000	-13.52209	0 .0000
Panel ADF	-13.57347	0 .0000	-13.57347	0 .0000
Group rho	-2.087432	0.0184	-	-
Group PP	-12.55249	0 .0000	-	-
Group ADF	-12.60826	0 .0000	-	-

Kao Co-Integration Test Results				
	t statistic	p value		
Kao ADF	-8.104492	0 .0000	-	-

Table 3: Co-Integration Test Results

Table 4 shows the results of the error-correction model. Error correction coefficient is negative and this addresses a long-term meaningful relationship between variables. Findings prove that there is a parallel relationship between variables.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GNP	1.134724	0.029969	37.86353	0.0000
ECM	-0.339242	0.032605	-10.40460	0.0000
C	-0.024067	0.000936	-25.72540	0.0000
R²: 0.651863, D-W: 2.243692				
F-statistic: 821.0619 Prob(F-statistic): 0.000000				

Table 4: Error correction model results (CO₂)

Granger Causality Test was applied in order to analyze the causality between variables. Determination of lag length and test results are shown in the Table 5 and Table 6. According to the Table 5, lag length is 4. According to the Table 6, the null hypothesis suggesting that economic growth is not the cause of CO₂ and CO₂ is not the cause of economic growth is denied and alternative to these hypothesis is accepted. According to the result of Granger Causality Test, there is a bidirectional casualty relationship between GNP and CO₂ variables.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	3867.036	NA	1.11e-07	-10.33432	-10.32198	-10.32956
1	4154.212	572.0485	5.22e-08	-11.09148	-11.05444	-11.07720
2	4304.351	298.2695	3.53e-08	-11.48222	-11.42049	-11.45843
3	4654.861	694.4599	1.40e-08	-12.40872	-12.32230	-12.37541
4	4820.345	326.9868*	9.09e-09*	-12.84050*	-12.72938*	-12.79768*

Table 5: Determination of Lag Length

H ₀ Hypothesis	F Statistic	p value
GNP does not Granger Cause CO ₂	55.3891	0.0000
CO ₂ does not Granger Cause GNP	251.933	0.0000

Table 6: Granger Causality Test

5. Conclusion

Economic usually have a negative impact on the ecological balance. These negative impacts arising from the depletion of natural resources and release of wastes in a way to cause negative externality for the ecological order will hinder the sustainable development and economic growth in the long term. Population growth, income, income-based increases in consumption and production, qualitative changes in consumption and production components. In this study, findings obtained from the analysis on the data set composed of the data of 44 countries are in line with income-CO₂ emission relationship in the literature. It is determined that increases in the national income leads to an increase in CO₂ emission in both OECD countries and Non-OECD countries.

At the end of this paper, general literature and our findings show us some important warnings at about the relationship between economic growth and energy consumption. In the results of the large part of academic analyses, we can show that economic growth cause negative externalities and this negative effects generally irreversibly. Therefore, we can offer some suggestions for develop and developing countries. The results of analyses show that there is a close relationship among the energy consumption, increasing the total or per capita income and environmental pollution. Environmental problems increase while economies growing. Therefore, governments have to some responsibilities for environmental protection. Environmental problems and CO₂ emissions increase despite all governments have detail information and founded some national and international organizations for put up fight environmental pollution. We pointed at three alternatives at the start of paper that we have three choices. These are win-win, win-lose, and lose-lose. In terms of sustainable development, all kinds of natural resources used in the process of economic growth should be used more carefully in the long run. In the opposite case all countries will face lose-lose line.

6. References

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