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ANALYZING THE RELATIONSHIP BETWEEN GREENHOUSE GAS EMISSION AND ECONOMIC GROWTH IN EU ECONOMIES

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ABSTRACT
It is the consensus among many econometrician and environmental economists that Greenhouse gases like CO_2, CH_4, N_2O, and O_3 are the major source of environmental degradation around the globe. EU economies are also suffering from this problem as other economies of the world. The prime objective of this paper is to analyze and gauge the environmental degradation due to economic activities in EU economies. The time series data (1961 to 2017) of economic growth (GDP per capita) has collected from world development indicator and the data of ecological footprint of consumption per capita is collected from Global Footprint Network. The results of Johansson Co-integration and Vector Error Correction model confirms the long run and short run association between both the variables. The economic activities are the main reasons of environmental degradation in the EU economies. EU economies should adopts such policies which reduces the greenhouse gas emissions.
Keywords: Greenhouse gar emission, Environmental Degradation, Economic Growth, EU

INTRODUCTION
Human activities throughout the years are one of the responsible factors for environmental concerns. Residents of every country want to use and exploit the present resources for the production of goods and services. This brings bout large pressure on the existed resources. Therefore, cause environmental issues including ecological distortion, global warming, and environmental degradation. Due to the above-mentioned concerns, the economists and environmentalists continuously endeavored to increase public awareness and encourage people towards sustainable development and environmentally safe business affairs around the globe. According to a study conducted by (Alola, 2019a, 2019b; Bekun, Alola and Sarkodie, 2019) immense attention is focused to the responses of the environment towards human activities which affect the world directly and indirectly. The influencing activities embody using energy, economic growth, and population dynamics along with other significant elements (Shahbaz and Sinha, 2018).

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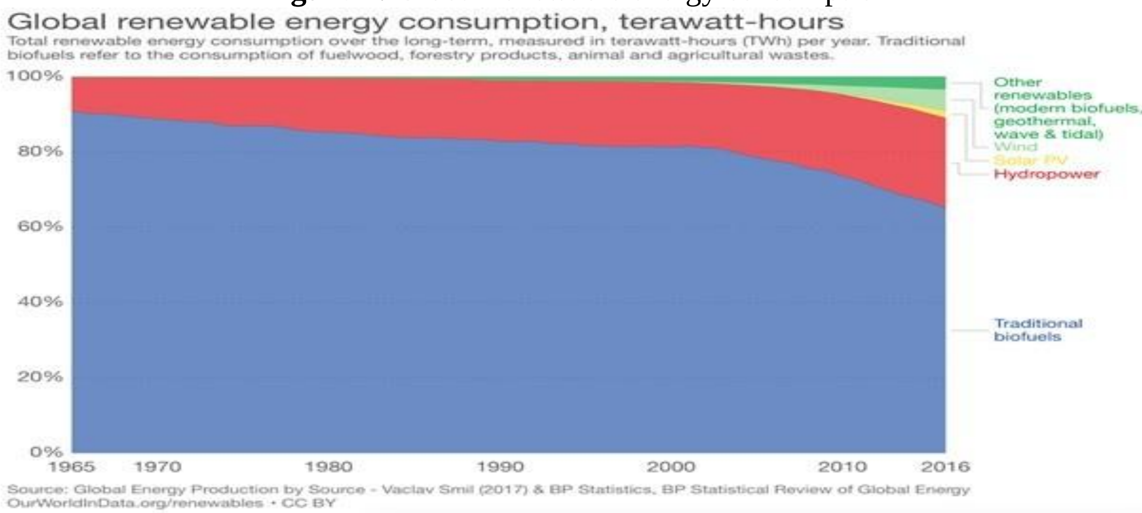
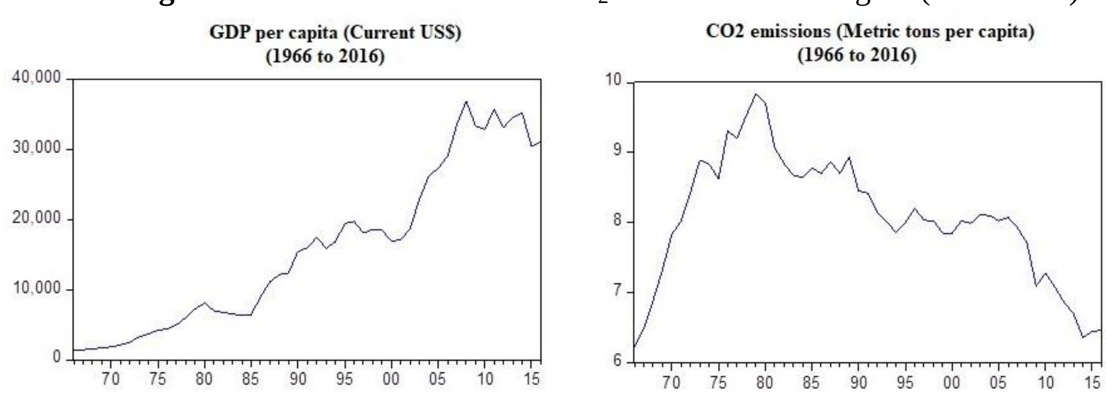
The following figure illustrates the global renewable energy consumption. As in the figure, the production of renewable energy take place in a traditional way to a large extent. About 60 to 70% sources of renewable energy is still traditional biofuels.

Figure 1: Global renewable energy consumption



Besides using carbon emission to determine the environmental quality, ecological accounting through the ecological footprint, as well as bio capacity has been implemented to furnish more comprehensive perspectives. In a report presented by inter-governmental Panel on Climate Change (IPCC) on "climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems", certainly intimates a continual effort for lessening the pressure on the worldwide environmental carrying capability (IPCC, 2017). The economic expansion of a number of countries such as, the United States of America, certain European nations and China prompts a key concern for the aforementioned impacts among the policymakers, government and environmentalist in these nations. The European Union members have set the goals namely, Sustainable Development Goals (SDGs) to gain the contribution of member countries for the attainment of sustainable development and environmental quality. The amended EU's climate change target of 2030, for instance, proposes lessening the greenhouse gas by 40%. Additionally, at least 27% of the overall energy consumption needs to be attained from renewable energy. A 27% increment in energy efficiency is suggested as well.

Figure2: Economic Growth and CO_2 emission in EU Region (1966-2016)



Source: WDI and Author's Construction

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It has been persistently a challenge for developing as well as developed nations to achieve a reasonable balance concerning economic development and global environment protection. Several studies determine that CO_2 emissions are amongst core issues for growing the environmental degradation, and greenhouse gas contributes to the global warming phenomenon. Nonetheless, the ecological footprint can be also considered as a responsible element for the environmental deterioration.

The fastest-growing cause of overconsumption is carbon dioxide, since humanity's carbon footprint currently accounts for up to 60% of humanity's demand for nature (Ali, S. R., 2020). The only sustainability instrument that tackles these interrelated problems in a single, scalable metric is the Ecological Footprint. Although a straightforward metric and uniquely detailed ecological footprint not only tests the demand of humans for the habitats of our world, it is also crucial to recognizing the interrelated stresses of climate change on the natural ecosystems on which humanity relies.

The footprint measures the biologically viable area needed to sustain all individuals require from nature: fruit and vegetables, meat, fish, timber, cotton and other fibers, as well as the absorption of carbon dioxide from the combustion of fossil fuels and building and roads (Rashid et. al., 2021). In the shape of shrinking habitats, extinction of wildlife, deforestation, water shortages, soil degradation, loss of biodiversity, and deposition of carbon dioxide in the environment, the costs of this global ecological unsustainable investment are becoming more and more evident worldwide.

Considering EU is because according to new data released by the International Comparison Program (ICP), the EU share of world GDP expressed in Purchasing Power Parities (PPPs) stabilized by about 50% between 2011 and 2017 (Ozcan et al., 2019b). In addition, EU countries consume more energy (4130.814 kg of oil equivalent per capita) than the world (1922.073 kg of oil equivalent per capita) and emit more carbon dioxide (12,004,051.89 kt) then the world (35,998.939 kt).

LITERATURE REVIEW

The function of Ecological Footprint has recently gained an immense attention in environmental economics (Hervieux, Darné. 2013; Dogan, et al., 2019). Many studies used the ecological footprint as a sign of environmental deterioration (Alola et al., 2019a, 2019b). Ecological footprints measure the extent to which humans are using the earth's bio-productive capacity. There is an immense literature in which ecological footprint has used for estimating the Environmental Kuznets Curve hypothesis (Wang et at., 2013; Ulucak & Bilgili, 2018; Destek, Sarkodie, 2019).

Table 1: Studies about Ecological Footprint

#	Study	Sample	Sample Countries	Variables	Methodology	EKC Validation
1	Manzoor Ahmad, Zeeshan Khan, Zia Ur Rahman & Shehzad Khan (2018)	1980-2014	China	CO_2, FD, GDP, UR, EU	NARDL	Validated
2	Canh Phuc Nguyen, Christophe Schinckus & Thanh Dinh Su. (2020).	1996-2014	33-emerging economies	FDI, TO, CO_2	STIRPAT model	Validated
3	Ahmad et. al., (2020)	1984-2016	MSCI	EF, GDP,	Panel unit	Validated

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			emerging market index	NR, TI.	root	
4	Mehmood, U., Tariq, S. (2020)	1972-2013	South Asian Countries	CO_2, GL	Co-integration, ARDL	Validated only for Pakistan and Bhutan
5	Mikayilov, J.I., Mukhtarov, S., Mammadov, J. et al. (2019)	1996-2014	Azerbaijan	EF, TOU, TR, EC, UR, GE, RQ	time-varying coefficient cointegration approach (TVC)	Not Validated

CO_2=Carbon dioxide emission, FD=Financial Development, UR=Urbanization, EF=Ecological Footprint, GDP=Gross Domestic Product=Economic growth, NR=Natural Resource, TO=Trade Openness, TR=Trade, EU=Energy Use, EC=Energy Consumption, GL=Globalization, TI= Technological Innovation, FDI=Foreign Direct Investment, Tou=Tourism, GE=Government effectiveness, RQ=regulatory quality.

Source: Author's construction

Many studies link the Ecological Footprint with renewable and non- renewable energy consumption (Alola et al. 2019a), liquefied petroleum gas (Murshed, 2020), export diversification (Liu et al. 2018), Tourism Development (Katircioglu et al. 2018), urbanization (Yılmaz, F., 2020), financial development (Baloch et al., 2019), Economic Growth (Uddin et al. 2017), tourism income (Ozturk et al. 2016), trade liberalization (Charfeddine, 2017), globalization (Figge et al. 2017), real income (Uddin et al. 2017) and Fertility rate (Alola et al. 2019). Even, Ecological Footprint has become the most commonly used measure of sustainability in the world in recent years, (Binningsbø et al. 2007). In many studies sustainability is measured at various levels by using Ecological Footprint like business level (Bagliani and Martini, 2012), product level (Limnios et al., 2009), sectoral level (Moore, et al., 2013), municipal level (Cano-Orellana and Delgado-Cabeza, 2015), regional level (McDonald and Patterson, 2004) and on the national level (Salvo et al., 2015).

Using the EF as an environmental variable has many significant benefits. It provided an opportunity to draw attention to direct and indirect environmental effects of manufacturing and consumption operations (McDonald and Patterson, 2004). Furthermore, due to its known limitations, and frequently, cited sustainable estimates, the Ecological Footprint (EF) is the main choice as an overall estimate of environmental quality for many researchers (Nijkamp et al., 2004). Many public officials, organizations and decision-makers using Ecological Footprint (EF) to check the ecological performance (Wiedmann et al., 2006).

DATA AND METHODOLOGY

The main objective of this study is to investigate the impact of economics growth on environmental degradation in EU economies. The time series data (1961-2017) of ecological footprint of consumption per capita is collected from Global Footprint Network. The United Nations Environment Programme (UNEP) and World Wildlife Fund (WWF) also used Ecological footprint as a policy reports (Rudolph and Figge 2017) and it is also used to track the anthropogenic activities on the biosphere (Ulucak and Bilgili 2018). In addition, economic growth is also a significant determinant of environmental deterioration (Ahmed Z, Wang Z., 2019). The data of Economic growth or per capital GDP is collected from the World Development Indicator. The summary statistics is presented in table 2.

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Table 2: Summary Statistics

	CFP	GDP
Mean	2.490739	17323.50
Median	2.627994	15086.97
Maximum	3.214074	42178.30
Minimum	1.290745	1005.282
Std. Dev.	0.497561	13546.05
Skewness	-0.830605	0.396221
Kurtosis	2.878870	1.780603
Jarque-Bera	6.588943	5.022869
Probability	0.037088	0.081152
Sum	141.9721	987439.5
Sum Sq. Dev.	13.86374	1.03E+10
Observations	57	57

Source: Author's Construction

FINDINGS AND DISCUSSIONS

Greenhouse gases are the main source of economic degradation in EU economies. The prime objective of this study is to analyze the impact of economic growth on environmental degradation in EU economies. The time series data from 1961 to 2017 is collected from various sources and different time series estimation techniques applied. First, this study analyses the stationary of the series by using The Augmented Dickey-Fuller Test (ADF) and Phillip-Perron Test (PP) and results are presented in table 3.

Table 3: Unit Root Analysis

Tests→	Augmented Dickey-Fuller Test (ADF)				Phillip-Perron Test (PP)			
Variables	Level		First Difference		Level		First Difference	
	C	C & T	C	C & T	C	C & T	C	C & T
lcfp	-2.893 [0.053]	-2.735 [0.228]	-5.902 [0.000]	-6.250 [0.000]	-2.770 [0.069]	-2.058 [0.557]	-5.950 [0.000]	-6.226 [0.000]
lgdp	-2.902 [0.013]	-1.302 [0.876]	-4.927 [0.000]	-5.399 [0.000]	-2.902 [0.052]	-0.671 [0.970]	-4.902 [0.000]	-5.239 [0.000]

Note: Probabilities in Parenthesis
Source: Author's Construction

The results of both, Augmented Dickey-Fuller and Phillip-Perron tests confirms that both variables are stationary in first difference or they are I(1) series. To establish the long run relationship between variables, we perform co-integration tests. There are two prominent co-integration tests like Engle-Granger and Johansen co-integration tests. This study uses Johansen co-integration test. For Johansen co-integration, first we estimate the optimal lag length and the result is presented in table 4.

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Table 4: lag length criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-546.9295	NA	5060260.	21.11267	21.18772	21.14144
1	-396.0976	284.2601	17850.66*	15.46529*	15.69044*	15.55161*
2	-394.8325	2.286899	19849.22	15.57048	15.94572	15.71434
3	-392.8128	3.495722	21465.02	15.64665	16.17198	15.84805
4	-385.9037	11.42648*	19265.00	15.53476	16.21019	15.79370
5	-385.2006	1.108887	21999.55	15.66156	16.48709	15.97805

Source: Author's Construction

The unrestricted VAR lag length criteria suggests optimal lag length is 1. So now for long run association between the variables we estimate the Johansen co-integration (Johansen, 1991, 1995) which analyzes the long-term relationship between the variables. More precisely, it assesses the validity of a co-integrating relationship using an approach to maximum likelihood estimates (MLE). It is often used to describe the number of interactions. We estimate Johansson co-integration and result is presented in table 5 which confirms the long run association between the variables.

Table 5: Johansen Co-integration

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Trace Probabilities	Max-Eigen Statistic	Max-Eigen Probabilities
None	0.233835	16.85034 [15.49471]	0.0311	14.38329 [14.26460]	0.0479
At Most 1	0.044658	2.467051 [2.467051]	0.1163	2.467051 [3.841466]	0.1163

Note: * Rejection of hypothesis at 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Critical values in parentheses
Source: Author's calculation

From table no. 5, the results of both, trace and max-Eigen statistic confirms that there is one co-integration equation present at the 0.05 level which shows that there is a long run relationship exist between these variables.

As all variables are stationary at first difference and co-integration exist among variables so we apply VECM. For integrated series, time series models are typically based on applying VAR to first differences. Differentiation, however, removes useful knowledge about the integrated series relationship - this is where the Vector Error Correction Model (VECM) is applicable. (Lütkepohl, H., 1991). Co-integration results reveal that long-run equilibrium relationships present between GDP and CO_2 emission. Now for the short-run relationship between the variables, we apply Vector Error Correction Model (VECM) result is presented in equation 1 and 2.

$$\boldsymbol{ECT_{t-1} = 1.0000 lgdp_{t-1} - 6.2301 lcfp_{t-1} - 2.7041} \ldots\ldots\ldots.(\mathbf{1})$$

$$\Delta \boldsymbol{GDP_t = -0.042353 EC_{t-1} + 0.210988 lgdp_t + 0.823023 lfcp_{t-1} + 0.038159} \ldots\ldots..(\mathbf{2})$$

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In causality test, both variables are dependent and independent. In Granger Causality test only two variables will be consider at a time. The result of pairwise Granger Causality test in presented in table 6.

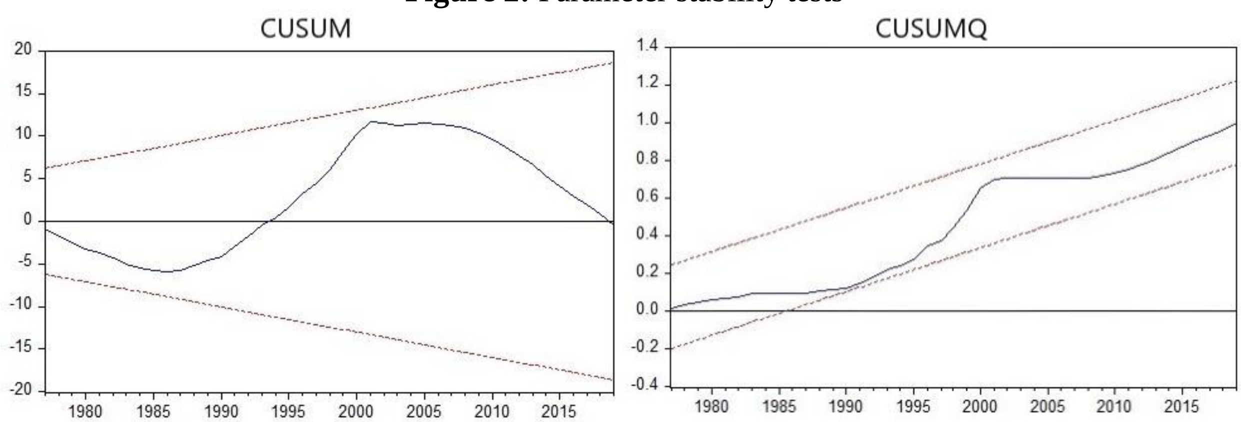
Table 6: Pairwise Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
LCFP does not Granger Cause LGDP	56	10.3288	0.0022
LGDP does not Granger Cause LCFP		0.07004	0.7923

Source: Author's Calculation

The Granger Causality result confirms that there is uni-directional causality run from lcfp to lgdp. To check the parameters stability, we apply CUSUM and CUSUMQ tests (Brown et al., 1975). Cumulative sum test helps to show if coefficients of the regression are changing systematically while Cumulative sum of squa re test is helpful to showing if the coefficients of the regression changing suddenly (Bhatti, Al-Shanfari et al., 2006). The result of both the tests shown in figure 2.

Figure 2: Parameter stability tests



Source: Author's Construction

The cumulative sum and cumulative sum of squares, in both, the CUSUM and CUSUMQ tests lie within the 5% critical lines which confirms the stability of parameters.

CONCLUSION

Greenhouse gases like CO2 are the major source of environmental degradation. The prime objective of this paper is to analyze and gauge the environmental degradation due to economic activities in EU economies. The time series data of economic growth (GDP per capita) from 1961 to 2017 has collected from world development indicator and the data of ecological footprint of consumption per capita is collected from Global Footprint Network. The results Johansen co-integration and Vector Error Correction confirm the long run and short run association between economic growth and environmental degradation in EU region. The economic activities are the main reasons of environmental degradation in the EU economies. EU economies should adopts such policies which reduces the greenhouse gases emission.

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