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The Impact of Economic Growth and Biocapacity on Ecological Footprint in EU Countries

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INTRODUCTION

Starting in the 1990s, many studies have been conducted to explain the relationship between economic growth, energy consumption, and environmental pollution. Particularly, the impact of climate change has led policymakers to shift from a simple pursuit of economic growth to what can be described as ecologically sustainable economic growth. This shift occurred because the effects of climate change have led to an increase in air temperatures, the melting of glaciers, rising sea levels, a decrease in agricultural production, the extinction of wildlife, and a reduction in labor productivity. In earlier studies, CO2 emissions were used as an indicator of environmental pollution. However, when reviewing recent studies, it is observed that the ecological footprint has replaced CO2 emissions as a more comprehensive indicator of environmental degradation.

The aim of the research is to examine the impact of economic growth and biocapacity on the ecological footprint for 27 European Union countries over the period of 1993-2023. We have two basic objectives: (i) to analyze how economic growth and biocapacity affect ecological footprint, and (ii) to evaluate the relationship between economic growth and environmental sustainability.

The methods of the research We use the Augmented Mean Group Estimator (AMG) model, Common Correlated Effects Mean Group (CCEMG) model to estimate the impact of economic growth and biocapacity on ecological footprint in EU Countries.

Theoretical background: The ecological footprint is the area of biologically productive land and water required to produce the resources consumed and dispose of the waste created by an individual, community or activity with current technology and resource management. Biocapacity is an indicator of the capacity of a geographical area to produce renewable natural resources. When the per capita ecological footprint exceeds the global per capita biological capacity, it means that natural resources are being used unsustainably. Ecological Footprint and Biocapacity are calculated in terms of area and expressed in "global hectares" (gha) which includes infrastructure and the areas required for vegetation to absorb waste CO2.

In the last three decades, numerous studies have focused on the relationship between economic growth, energy consumption and environmental pollution (The Environmental Kuznets curve -EKC- analyses). In recent studies, the ecological footprint as a more comprehensive indicator is used to examine environmental degradation. While some studies focus on the relationship between income and ecological footprint (Aşici & Acar, 2015; Charfeddine & Mrabet, 2017; Mrabet & Alsamara, 2016; Özturk et al., 2016; Ulucak & Bilgili, 2018; Destek & Sarkodie, 2019; Danish et al., 2019) and other studies examine the effect of financial development (Mrabet et al., 2017; Baloch et al., 2019), foreign direct investment (Solarin and Al-mulali, 2018) and the tourism (Özturk et al., 2016; Katircioglu et al., 2018) on ecological footprint. In addition to these studies, Özcan et al. (2019) show the long-lasting effect of ecological footprint. Solarin (2019) and Adebola et al. (2019) analyses the convergency of ecological footprint.

Data Set and Model: The data set consists of annual data of 27 European Union member countries for the period 1993-2023. Variables are used in logarithmic form. The data set is gathered from the World Bank Database and York University Database.

The panel data model used in the study is given below:

$$lefcper_{it} = \alpha_0 + \alpha_1 lbiocapper_{it} + \alpha_2 lgdpper_{it} + \varepsilon_{it}$$

Empirical Findings: Before determining the unit root test to be used in the stationarity analysis, cross-sectional dependence in the panel should be investigated. In cases where cross-sectional dependence is present, analyses should be performed with second-generation unit root tests. Since N>T for the panel data set used in the study, Pesaran (2004) cross-sectional dependence test was applied to the regression residuals. Accordingly, the null hypothesis of no-cross-section dependence in the regression model residuals is rejected at 1% significance level.

Test	Cd-Test	P-Value
CD-test for cross-sectional dependency	33.007	0.0000

In panel data models, the degree of stationarity of the cross-sectional series is very important for the estimator to be used in the model. Since there is cross-sectional dependence in the study, Peseran (2007) CIPS unit root test, which is one of the second generation unit root tests, is used.

Variables	Level	First Diferences
lefcper	-1.832	-5.779***
lbiocapper	-1.985	-6.049***
lgdpper	-1.935	-3.549***

Note. Constant Term Critical Values: **0.10:** -2.04 **0.05:** -2.11 **0.01:** -2.23 *** p<0.01, ** p<0.05, * p<0.1

When the CIPS unit root test was applied to the variables in the panel data model, the series were found to be integrated of order one, I(1).

After the unit root test, diagnostic tests should be conducted. For this purpose, the Wald test was applied to examine the presence of heteroskedasticity. According to the results of the Wald (1939) test, the null hypothesis that there is no heteroskedasticity in the panel dataset is rejected. Therefore, it is concluded that heteroskedasticity is present within the panel data set.

Test	Chi-Square	Chi-Square Degree of Freedom	P-Value
Modifed Wald test for groupwise heteroscedasticity	429.89	38	0.0000

Another necessary test to conduct is the autocorrelation test. The Wooldridge (2002) autocorrelation test was performed. The test statistic provides evidence of the presence of an autocorrelation.

Test	Test Statistic	P-Value
Wooldridge test for autocorrelation	17.358	0.0003

The results of the conducted tests reveal the presence of cross-sectional dependence, heteroskedasticity, and autocorrelation. Upon examining the unit root test results, it was concluded that the series are integrated of order one, I(1).

Test	Test Statistic	P-Value
Westerlund Cointegration Test	-2.5510	0.0054

The results suggest that the null hypothesis is rejected at the 1% significance level. As a result, a significant long-term relationship between the series is observed. Additionally, the variance ratio test confirms the existence of cointegration. Based on these findings, the appropriate estimators to be used are AMG and CCEMG.

Variables	AMG	CCEMG
lbiocapper	0.4609***	0.3039***
	(0.0621)	(0.0983)
lgdpper	0.5402***	0.7555***
	(0.1207)	(0.1428)
Constant	-4.0525***	-0.6403***
	(0.0035)	(0.1387)

Empirical results show that economic growth has a positive and significant effect on ecological footprint. Biocapacity also has a positive and significant effect on ecological footprint. Our results are consistent with the theoretical framework in the literature.

MAIN RESULTS AND CONCLUSIONS

According to the findings, there is a long-term relationship between the variables. Increases in economic growth lead to an increase in the ecological footprint. Additionally, it has been concluded that an increase in biocapacity also contributes to the rise in the ecological footprint. Therefore, it is observed that the current resources are insufficient to absorb pollution and improve the ecological footprint. Based on the findings of the study, it is recommended that policymakers develop policies to reduce the unsustainable resource consumption model, considering the impacts of economic growth and resource use on ecosystems.

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