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Economic Growth and Environmental Sustainability determinants: a panel ARDL evidence for EU Countries

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Abstract - Economic growth and environmental sustainability nowadays are considered to be of particular importance, so understanding the main contributing factors is very important as well. This paper aims to examine the common determinants of economic growth and environmental sustainability, inspect the relationship between these key elements, and check their significance in economic growth and environmental sustainability. With data from EU member states for a period of ten years (2011-2020) the panel autoregressive distributed lag technique (ARDL) is used for the aim of this paper. Common determinants such as recycling and environmental taxes were found to be the major contributors to economic growth in the long run. Recycling is found to be a major contributor to environmental sustainability as well, however, environmental taxes are detected to have a negative impact on environmental sustainability in the long run, but none of these determinants have any impact in the short run.

Keywords -Economic growth, environmental sustainability, ARDL, sustainable development

I. INTRODUCTION

Developed countries are currently facing the challenge of managing risks that affect the environment during their economic growth, which is also a measurement of life standard. Different countries deal with this challenge in different ways. Due to COVID-19 in 2021, global economic growth has declined mainly due to supply constraints. This challenge was then followed by the challenge of using energy, namely fossil fuel, which undoubtedly affects the environment. In addition to the many factors that influence economic growth that are well studied and analyzed in the economic literature, there are not many studies about those factors that simultaneously influence environmental stability.

Recent debates relating to Environmental sustainability, highlighting CO2 emissions, natural resources, and social welfare, have increased since the eighteenth century, when there were negotiated environmental quality agreements (Hunter, 2021).

Despite the agreements, frameworks, and many other documents signed to support and emphasize the importance of environmental issues through the years and even though it is continuously being studied and devoting much more importance to the quality of the environment, the identification of the key factors that affect the environment natural still remains as a general dilemma and also as a field that still has room for study in the economic literature (Wang, Fan, & Zhou, 2022).

Because economic development will definitely affect the environment, it is necessary to take measures to protect the environment from the negative impact of the risks that economic development carries. In addition to these, trade openness is one of the very important factors that affect the environment. Since the globalization of trade is almost impossible, then the rational use of energy for industrialization and at the same time economic growth without polluting the environment, understanding the relation and the impact of these factors is very important. Although the efforts in this direction are continuous, the results from these efforts are not at the same level with which the concerns about global environmental sustainability are growing (Eluwole, Akadiri, Alola, & Etokakpan, 2019).

Since a complete separation between economy and the environment is impossible (Esty, 2023), during economic activity different amounts of resources are consumed which in one way or another affect the environment. However, there are also theories that criticize this view, such as the one from Hartwick-Solow (Gutes, 1996), which gives importance to the concentration in substitution effects and global technologies which would affect the reduction of waste that damages the environment, furthermore also the material balance hypothesis (Dykes, Strickland, Demarais, Reynolds, & Lashley, 2020).

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Considering different points of view, the factors that affect environmental sustainability are increasing as an important subject of analysis and interest of economists, however, there is still a gap in the literature studying such similar factors that sometimes have an impact on economic growth at the same time.

To make a contribution in this area, this paper explores and analyzes the common determinants of economic growth and environmental sustainability, investigates the relationship between these key elements, and assesses their impact on economic growth and environmental sustainability. This will be accomplished by utilizing data from EU member states over a period of ten years (2011-2020) and applying the panel autoregressive distributed lag technique (ARDL) for analysis. The study aims to identify the major contributors to economic growth and environmental sustainability and evaluate the impact of factors such as CO2 emissions, resource productivity, recycling and environmental taxes on both aspects in the short and long term.

II. LITERATURE REVIEW

A. Main determinant factors for economic growth and environmental sustainability practices

Environmental problems during the last decades are a constant challenge today. Understanding the factors that affect environmental sustainability is becoming more important every day, both for economists and for environmental policymakers, so that green practices and decarbonization are mostly tried to benefit society.

Many of the daily operations of companies produce pollution that affects environmental sustainability, and therefore, government bodies and consumers constantly put pressure on their management as best as possible in terms of reducing the negative impact on environmental sustainability (Yu, Tianshan, Rehman, Sharif, & Janjua, 2020).

The theory of ecological modernization, which states that the harmful effects on environmental sustainability can be reduced through the use of green practices in businesses, is ultimately quite applicable to business operations (Sharif, Afshan, Chrea, Amel, & Khan, 2020). As it is stated by the laws of thermodynamics, (Genovese, Acquaye, Figueroa, & Koh, 2017) the economy and environment are inseparable because every economic activity uses some resources. (Gutes, 1996) Stated that the higher the productivity, the more it affects the environment.

An analysis done in studying the relationship between sustainability practices and economic performance carried out for 20 years on corporations has resulted in a positive impact of sustainability practices on the economic growth of a firm (Vachon, 2007), (Tamayo-Torres, Gutierrez-Gutierrez, & Ruiz-Moreno, 2019). Another analysis was done by (Miroshnychenko, Barontini, & Testa, 2017) which resulted in an improvement in firm performance and in the environment save at the same time when they apply eco-friendly practices.

The impact of economic growth on environmental sustainability was studied and concluded with different results. For example, research done by (Salahuddin, Alam, & Ozturk, 2016) for 20 years till 2012 in OECD countries using the PMG method has resulted in no significant impact of economic growth in the short and long–term on carbon emissions. Meanwhile, research by (Kais & Sami, 2016), (Narayan, Saboori, & Soleymani, 2016) done on 181 grouped regions countries resulted in a negative significant impact of growth in the environment in Europe.

One of the most challenging current factors that have the greatest impact on the environment is considered the emission of CO2, which also is the major cause of environmental damage and global warming (Nunes, 2023) so there are continuous efforts to reduce and eliminate it (Godil, Sharif, & Khan, 2021). Research has shown that there is a connection between CO2 emissions and environmental health, notably in the top ten emitting nations (Shen, et al., 2020), (Su, Umar, & Khan, Does fiscal decentralization and eco-innovation promote renewable energy consumption? Analyzing the role of political risk, 2020), (Su, Li, Umar, & Lobonţ, 2022). The emission of CO2 is highly increased because of globalization and the activities related to, (Balsalobre-Lorente, Shahbaz, Murshed, & Nuta, 2023), affecting generally the well-being in the future.

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Many studies have also shown that costs related to health and environmental pollution are significantly reduced when renewable energy is used (Khan, Ponce, & Yu, 2021). Using renewable energy sources to produce energy and saving natural resources is one of the main points to archieve the sustainability of economic growth (Schmalensee, 2012). Renewable energy sources are also seen as the ideal responses to energy security and climate change (Khan, Ali, Umar, Kirikkaleli, & Jiao, 2020). In investigating the impact of energy consumption on environmental sustainability (Alola, Yalçinera, Alola, & Akadiri, 2019) studying Europe's largest states resulted in granger causality for CO2 emission and renewable energy consumption variables. Furthermore (Isiksal & Assi, 2022) imply a positive relationship between renewable energy consumption and environmental sustainability.

The impact of humans in the environment is obvious especially by the increase of world population which is accompanied by the increase in municipal waste. It is very logical that if recycling is not used and no attention is paid to waste management, then this will affect the disappearance of many natural resources. Taking this into consideration, recycling is very important for environmental sustainability, and it is among the most important objectives of developed economies. A study done in EU member states using panel cointegration and causality analyses has resulted in no significant interaction between recycling rate, renewable energy, and CO2 emissions (Bayar, Gavriletea , Sauer, & Paun, 2021). In the other hand recycling and innovative resources as well are considered to add value to sustainable economic growth also in environmental protection too (Apostu, Gigauri, Panait, & Martín-Cervantes, 2023), (Trica, Banacu, & Busu, 2019). Other studies such as (Yilmaz & Koyuncu, 2023) (Trica & Papuc, 2013), (Banacu, Irimescu, & Dobrea, 2014) have concluded in the positive impact of recycling on economic growth.

Further on investigating the determinants of economic growth, environment, and sustainability (Balasoiu, Chifu, & Oancea, 2023), (Abdullah & Morley, 2014), (Fullerton & Kim, 2008) argues the correlation of environmental taxes with economic growth as another important indicator affecting the environment. So within the triple bottom line as the base of green and sustainability (Ahmad, Wong, & Butt, 2023), (Khan & Qianli , 2017), fairer taxation is considered as a social benefit. Environment taxes in BE are considered a tool for environmental improvement (Dahmani, 2023), which at the same time produce a double positive effect on the economy (Bosquet, 2000). Other authors as (Wolde-Rufael & Mulat-weldemeskel, 2023), (Fisher & Marrewijk, 2006) also support the opinion of the positive effect of environmental taxes on economic improvement.

However, some studies, such as (Myles, 2000), have also pointed out cases when the tax system may not be efficient and may not affect the overall improvement of the environment and may not have a positive effect on the economy, but the only aim is to tax those who cause pollution. Based on the (Vasilyeva, et al., 2023)study, the overall impact of environmental taxation on economic growth appears to be mixed with both positive and negative elements, but it leans towards being limitedly positive.

This study aims to investigate the factors influencing economic growth and environmental sustainability. It seeks to identify common factors that impact both economic growth and environmental sustainability. The study seeks to answer the important question of how changes in CO2 emissions, renewable energy consumption, recycling, and total environmental taxes, which are significant indicators, affect environmental sustainability and economic growth.

The paper consists of the following: starting with the introduction and literature review, continuing with part three, which consists of methodology and data analysis, followed by empirical results and discussions, and concluding with the final results.

III. METHODOLOGY AND DATA ANALYSIS

A. *Data Description and Measurement*

This research employs a panel data analysis approach to investigate the key determinants of the green economy in 27 EU countries over a ten-year period from 2011 to 2020. The data is sourced from (EuroStat) and the (World Bank), ensuring a robust and comprehensive dataset. Given that the variables exhibit a combination of I(0) and I(1) processes, we utilize the panel autoregressive distributed lag (ARDL) model, as proposed by (Pesaran, Shin, & Smith, 1999).

This model's flexibility allows us to handle variables that are purely I(0), purely I(1), or a mix of both. To ensure the stationarity of the time series, we conduct unit root tests, including Harris-Tzavalis, Breitung, Fisher-type Dickey-Fuller, and Phillips–Perron tests. After confirming stationarity and the absence of I(2) processes, we perform the Pedroni co-integration test to establish long-run equilibrium relationships among the variables.

The ARDL model is then used to estimate the impact of explanatory variables such as CO2 emissions, renewable energy consumption, recycling, and total environmental taxes on economic growth and environmental sustainability. This comprehensive methodological framework allows for a detailed and reliable analysis of the EU's green economy determinants.

In Table 1. below is presented descriptive and summary statistics for the variables used in the model of this paper.

Table 1: Descriptive Statistics and Variable Explanation

Variable name	Unit of measurement	Variable Code	Description	Source	Obs	Mean	Std. Dev.	Min	Max
Trade (% of GDP)	Exports + Imports /GDP	T	Aggregated import and exports expressed and as a share of GDP.	(World Bank)	260	130	69	5	80
Resource productivity	Gross domestic product (GDP) over domestic material consumption (DMC) (Euro per kilogram)	RP	The relation between economic activity and consumption of material resources	(EurOStat)	270	2	1	[illegible]	[illegible]
CO2 emissions (metric tons per capita)	metric tons per capita	CO2	Emissions derive from fossil fuels burns, cement manufacture, consumption of solid, liquid, and gas fuels and gas flaring.	(World Bank)	243	7	3	[illegible]	1
Renewable energy consumption	% of total final energy consumption	REC	Renewable energy share from total final energy consumption.	(World Bank)	243	20	12	[illegible]	3
Recycling	Kilograms per capita	R	The processing of waste materials into products, except for the energy recovery and reprocessing into materials that will be used as fuel	(EurOStat)	270	181	106	0	19
Total environmental taxes	Percentage of gross domestic product (GDP)	TET	Environmental tax revenue by tax category as energy, transport, pollution, and resource taxes broken down by economic activity.	(EurOStat)	270	3	1	[illegible]	[illegible]

In measuring the environmental performance and economic growth our model used two dependent variables: Trade and Resource Productivity (T, RP), and explanatory variables which are among the main factors of the green economy (REC, CO2, R, TET) are examined to see the relationship between environmental

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performance and economic growth as these explanatory variables seem to have an impact on both two dependent variables.

Panel Unit Root and Co-integration Test

Investigating this relationship between variables it is important to specify if the time series contains a unit root so that if they are stationary or not. If the time series are not stationary, by using the differencing process, we have led to stationarity as we have presented below on the table. Performing (Harris & Tzavalis, 1999), (Breitung, 2000), and Fisher-type (Choi, 2001) both Dickey–Fuller and Phillips–Perron Panel Unit Root Tests presented in Table 2 below it turn out that stationary for all variables is achieved at lever or after differencing each variable once. This means that each of the variables is integrated at level or at order one so to test our research aim we can use the autoregressive distributed lag (ARDL) approach, proposed by (Pesaran, Shin, & Smith, 1999).

Table 2: Panel Unit Root Tests

Variable name	**Harris-Tzavalis**		**Breitung**		**Fisher-type**			
					Dickey–Fuller		**Phillips–Perron**	
	p-value		p-value		p-value		p-value	
Stationary level	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
Trade (% of GDP)	0.6534 *	0.0000**	0.3417	0.0003 **	0.9140	0.0693 *	0.9141	0.0693 *
Resource productivity	0.8896 *	0.0000**	0.9997	0.0000** *	0.0002 ***	0.0000**	0.0002***	0.0000**
CO2 emissions	0.8467 *	0.0000**	0.9739	0.0000** *	0.0280 ***	0.0000**	0.0280***	0.0000**
Renewable energy consumption	0.6055 *	0.0000**	0.9999	0.0000** *	0.0001****	0.0000**	0.0001 *	0.0000**
Recycling	0.9986 *	0.0000**	0.9984	0.0000** *	0.9337 *	0.0000**	0.9337 *	0.0000**
Total environmental taxes	0.5138 *	0.0000**	0.9480	0.0000** *	0.2706 *	0.0000**	0.2706 *	0.0000**

*** p<0.01, **p<0.05, *p<0.1

Once we establish whether the variables are integrated of order 0 or 1, based on the specific unit root test we use, it's essential to determine if there exists a long-term equilibrium relationship among the related variables. This is because if we look at the short run sometimes it might have deviations between variables but they also can be connected to each other in the long run because of the impact of different economic forces. This can be proved by performing the co-integration test of the panel.

After the determination of variable integration as above that there's no variable of order I(2) at this point we continue to check if there is a long-run equilibrium relationship in dispersion through the underlying variables. By providing the Pedroni Test of co-integration we've verified the presence of co-integration of these economic variables and we continue with Panel ARDL to proceed with the estimation.

The theoretical model in examining the effect of explanatory variables (CO2, REC, R and TET) on economic growth and environmental sustainability is presented in Figure 1 below.

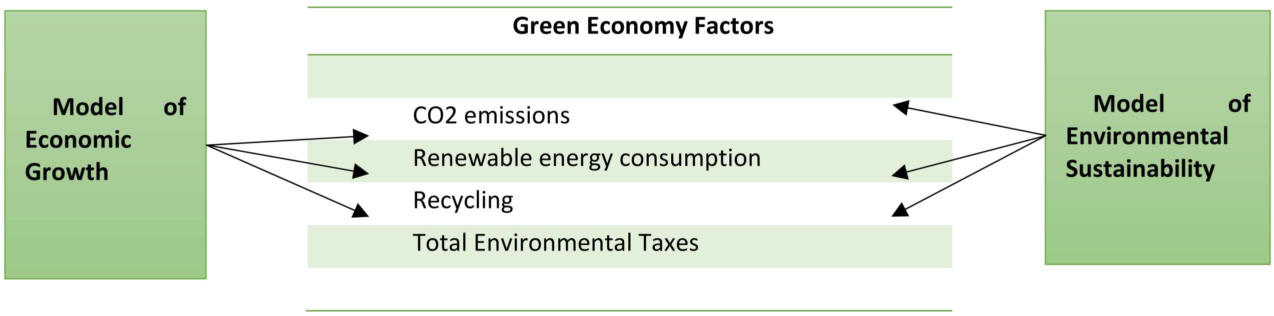

Figure 1: Theoretical model of the relationship between Economic Growth and Environmental Sustainability

Model of Economic Growth

Based on the growth model principles the functional form of this model is presented as:

$$EG = f(CO2, REC, TET, R) \tag{1}$$

$$EG_{it} = \beta_0 + \beta_1(REC_{it}) + \beta_2(TET_{it}) + \beta_3(R_{it}) + \mu_{it} \tag{2}$$

where Economic Growth is (EG), Renewable Energy Consumption (REC), Total Environmental Taxes (TET) and Recycling is (R).

$$\Delta EG_{it} = \sum_{j=1}^{p} \alpha_{ij} EG_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}{}' X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{3}$$

Cross-sectional units are represented with i in the equation form, followed by t which is the period of time, optimal lags are defined with j, and with $X_{i,t}$ are presented the independent variables in the equation as REC, TET and R. In the end fixed effect is presented with μ_i. Furthermore, if the panel is unbalanced the p and q would show the unbalance.

If we group the variables in level, the equation above can be rewritten in the form of error correction as below:

$$\Delta EG_{it} = \varphi_i\left(EG_{i,t-1} - \beta_i' x_{it}\right) + \sum_{j=1}^{p-1} \alpha_{ij}^{*} \Delta EG_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij'}^{*} \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{4}$$

Where the long-run equilibrium is $\emptyset_i$ and the long-run parameters is β_i'. The speed of adjustment which is the speed of intersection of the dependent variable because of the impact of the explanatory variables is shown with $\emptyset_i\, ECT$.

Model of Environmental Sustainability

$$ES_{it} = \beta_0 + \beta_1(CO2_{it}) + \beta_2(TET_{it}) + \beta_3(R_{it}) + \mu_{it} \tag{5}$$

$$\Delta EG_{it} = \sum_{j=1}^{p} \alpha_{ij} EG_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}{}' X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{6}$$

Same as in the Economic Growth model, cross-sectional units are represented with i in the equation form, followed by t which is the period of time, optimal lags are defined with j, and with $X_{i,t}$ are presented the independent variables in the equation as CO2, TET and R. In the end fixed effect is presented with μ_i. Furthermore, if the panel is unbalanced the p and q would show the unbalance.

If we group the variables in level, the equation above can be rewritten in the form of error correction as below:

$$\Delta ES_{it} = \varphi_i\left(ES_{i,t-1} - \beta_i' x_{it}\right) + \sum_{j=1}^{p-1} \alpha_{ij}^{*} \Delta ES_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij'}^{*} \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{7}$$

Where the long-run equilibrium is $\emptyset_i$ and the long-run parameters is β_i'. The speed of adjustment which is the speed of intersection of the dependent variable because of the impact of the explanatory variables is shown with $\emptyset_i\, ECT$.

IV. EMPIRICAL RESULTS AND DISCUSSION

A. *Impact of main determinant factors on economic growth and environmental sustainability*

In Table 3 are presented the long-run and short-run relationships between the dependent variables (Trade and Resource Productivity) and green economy factors as independent variables. These relationships were estimated using the Pooled Mean Group (PMG) method, as the Mean Group (MG) could not converge to test the null hypothesis (H0) by the Hausman test.

Table 3: The long-run and short-run relationship

	Model of Economic Growth			Model of Environmental Sustainability		
	D.T	Coef.	P>z	D.RP	Coef.	P>z
__ec						
	REC	-2.9944	0.0000***	CO2	-0.0757	0.0000***
	R	0.3645	0.0000***	R	0.0022	0.0000***
	TET	23.1194	0.0000***	TET	-0.1302	0.0000***
SR	D.RP					
	__ec	-0.1434	0.0510*	__ec	-0.5469	0.0000***
	REC	0.4747	0.3840	CO2	-0.0126	0.6700
	R	0.0323	0.6210	R	-0.0008	0.6200
	TET	-12.2715	0.0150	TET	0.1011	0.3940
	_cons	10.7648	0.2690	_cons	1.0260	0.0000***

*** p<0.01, **p<0.05, *p<0.1

B. *Long-Run Impact on Economic Growth*

The positive and significant coefficients of R (Recycling) and TET (Total Environmental Tax) on economic growth underscore the potential benefits of green economy practices. The coefficient of 0.3645 for R suggests that recycling efforts contribute to economic development by reducing waste and providing secondary raw materials for production, thus alleviating the need for virgin material extraction. This finding aligns with (Platon, et al., 2023) (Siebert, Eichenberger, Gronych, & Pethig, 1980), who highlighted the economic benefits of recycling in reducing environmental strain and supporting sustainable resource use. Additionally, increased recycling can lead to the development of new industries and job creation, further stimulating economic growth.

Similarly, the significant positive impact of TET, with a coefficient of 23.1194, indicates that environmental taxation can incentivize reductions in pollution and promote cleaner production methods. This supports the notion proposed by (Liu & Ge, 2023), (Ono, 2003) that environmental taxes can enhance productivity by improving environmental quality, which indirectly fosters economic growth. However, policymakers must balance these taxes to avoid imposing excessive burdens on industries, particularly those heavily reliant on non-renewable resources.

However, the negative coefficient of REC (Renewable Energy Consumption), -2.9944, introduces a counterintuitive element. While renewable energy is typically seen as a cornerstone of sustainable development, its negative impact on growth in this context could be attributed to initial high costs, technological challenges, or inefficiencies in the transition phase from fossil fuels to renewable sources. This observation is consistent with (Dogan, Altinoz, Madaleno, & Taskin, 2020), who also found a negative short-term impact of renewable energy on growth. Over time, as technologies mature and become more cost-effective, the positive impacts of renewable energy might become more pronounced. This transition period requires strategic investments in research and development to reduce costs and improve the efficiency of renewable technologies.

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C. *Long-Run Impact on Environmental Sustainability*

The analysis reveals a nuanced picture in terms of environmental sustainability. The positive coefficient of 0.0022 for R indicates that recycling positively contributes to resource productivity, which is crucial for long-term environmental sustainability. This positive influence highlights the importance of efficient waste management and recycling programs in reducing resource extraction and conserving natural resources. The development of a circular economy, where materials are reused and recycled continuously, could further enhance sustainability.

Conversely, both CO2 emissions and TET are found to have a negative impact on environmental sustainability. The negative coefficient of -0.0757 for CO2 emissions underscores the detrimental effects of high carbon output on resource productivity, reaffirming findings by (Máté, Novotny, & Meyer, 2021). This highlights the urgent need for stringent carbon reduction policies to mitigate the adverse effects of CO2 on environmental health. Investments in clean technologies, such as carbon capture and storage, and renewable energy sources, are critical in this regard.

The negative coefficient of -0.1302 for TET on environmental sustainability presents a paradox. While environmental taxes are designed to reduce pollution and enhance sustainability, in certain contexts, such as Slovakia, Czech Republic, Poland, and Hungary, as noted by (Taušová, Tauš, & Domaracká, 2022), they might lead to unintended consequences. These could include increased costs for businesses that rely on resource-intensive processes, potentially reducing their resource productivity. Policymakers must consider these impacts and design supportive measures, such as subsidies for green technology adoption or phased tax implementations, to minimize adverse effects.

D. *Short-Run Analysis*

In the short run, the absence of significant impacts of R, TET, and REC on both economic growth and environmental sustainability suggests that the benefits of green economy measures manifest more prominently over a longer period. The speed of adjustment coefficients, 14% for economic growth and 54% for environmental sustainability, indicate that deviations from the long-run equilibrium are corrected gradually. This gradual correction underscores the lagged effects of environmental policies and investments in green technologies, which require time to yield substantial benefits. It also highlights the importance of stable and consistent policy frameworks to support long-term environmental and economic goals.

The findings suggest several policy implications. First, enhancing recycling infrastructure and programs can have the dual benefit of supporting economic growth and improving environmental sustainability. Second, while environmental taxation is effective in the long run, policymakers need to consider potential short-term economic disruptions and design supportive measures for businesses transitioning to greener practices. Third, addressing the negative impact of CO2 emissions on sustainability remains critical, necessitating stronger carbon reduction strategies and investments in clean technologies. Additionally, promoting innovation and reducing the costs associated with renewable energy adoption can mitigate its initial negative impacts on economic growth.

V. CONCLUSION

Based on the Panel ARDL method, this empirical study investigates the links between determinants of environmental sustainability and economic growth in EU member states over a ten-year period (2011-2020). The study aims to identify the major contributors to economic growth and environmental sustainability, assessing the impact of factors such as CO2 emissions, resource productivity, recycling, and environmental taxes on both aspects in the short and long term.

The analysis reveals that recycling and total environmental taxes are significant contributors to economic growth and environmental sustainability as well in the long run. Renewable energy consumption, although influential, has a negative impact on growth, suggesting that while renewable energy is crucial for sustainability, its current deployment may not yet be fully optimized for economic benefits. In the short run, however, these variables do not show a significant impact on economic growth. Overall, it was found to have a positive impact on economic growth as a group of determinants.

On the other hand, Recycling was found to be a major contributor to environmental sustainability, too. Total environmental taxes are a common determinant of economic growth, and CO2 emissions, another variable added to the model, are detected to have a negative impact on environmental sustainability in the long run. Both three variables do not impact environmental sustainability in the short run.

The study's goals were to explore and analyze the common determinants of economic growth and environmental sustainability, investigate their relationships, and evaluate their impacts in the EU context. The results affirm the interconnection between these aspects and emphasize the need for balanced policies that promote both economic growth and environmental sustainability.

VI. LIMITATIONS AND FUTURE RESEARCH

Despite its contributions, this study has limitations that open avenues for future research. One limitation is the focus on aggregate data from EU member states, which may mask country-specific nuances and policy impacts. Future studies could delve into country-specific analyses to uncover tailored insights. Another limitation is the potential lag in the impact of renewable energy adoption, which may require longer time horizons to fully capture its economic benefits.

Future research should explore the dynamic interactions between green economy variables and economic outcomes in different contexts. Longitudinal studies could provide deeper insights into how the impacts of renewable energy consumption evolve over time. Additionally, investigating the sector-specific effects of environmental taxes could help refine these instruments to maximize their positive impact on both the economy and the environment. Understanding the social implications, such as job creation in recycling and renewable energy sectors, and public health improvements due to reduced pollution, can also provide a holistic view of the benefits of green economy practices.

So, while green economy measures show promise for promoting economic growth and environmental sustainability, their implementation must be carefully managed to balance short-term challenges with long-term benefits. The positive impacts of recycling and environmental taxation and the need for effective carbon reduction strategies highlight the multi-faceted approach required to achieve sustainable development goals. Strategic investments in technology, supportive policy measures, and a focus on long-term gains can help navigate the transition to a greener economy successfully.

In summary, while this study underscores the significant relationships between key determinants and their impacts on economic growth and environmental sustainability, it also points to the necessity of continuous research to adapt and refine policies in the face of evolving environmental and economic challenges.

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Dejavniki gospodarske rasti in okoljske trajnosti: panelni avtoregresivni porazdelitveni zamik za države EU

Povzetek – Gospodarska rast in okoljska trajnost sta danes še posebej pomembni, zato je zelo pomembno tudi razumevanje glavnih dejavnikov, ki k temu prispevajo. Namen tega članka je preučiti skupne dejavnike gospodarske rasti in okoljske trajnosti, preveriti povezavo med ključnimi elementi ter ovrednotiti njihov pomen za gospodarsko rast in okoljsko trajnost. Pri članku so uporabljeni podatki iz držav članic EU za obdobje desetih let (2011-2020) in panelna tehnika avtoregresivnega porazdelitvenega zamika (ARPZ). Ugotovljeno je bilo, da sta skupni determinanti, kot sta recikliranje in okoljski davek, glavna dejavnika, ki dolgoročno prispevata h gospodarski rasti. Ugotovljeno je bilo, da tudi recikliranje pomembno prispeva k okoljski trajnosti, manj pa okoljski davki z dolgoročnega vidika. Kratkoročno pa nobena od teh determinant ne vpliva na okoljsko trajnost.

Ključne besede – gospodarska rast, okoljska trajnost, ARPZ, trajnostni razvoj