BUILDING A RESILIENT FUTURE THROUGH ENVIRONMENTAL PROTECTION: HOW EUROPEAN GREEN INVESTMENTS DRIVE SOCIO-ECONOMIC SAFEGUARDS

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This study examines the socio-economic implications of investments, transfers, and expenditures in environmental protection, specifically analyzing their impact on the quality of life in selected European countries. The study focuses on the key indicators, namely GDP per capita and Green GDP, with the latter offering a more sustainable and comprehensive measure of economic performance. The research posits that while GDPpc growth is a desirable outcome, GDP growth that neglects environmental considerations is an undesirable result. In order to explore this relationship, the study employs panel cointegration modeling across 15 European countries in the period from 2014 to 2021. The analysis yields two key findings: (i) a significant positive nexus between environmental investments, transfers, expenditures, and GDPpc, highlighting the potential of environmental spending to improve economic well-being; (ii) an inverse relationship between these environmental expenditures and the so-called Green GDP gap, emphasizing the importance of "green spending" in advancing sustainable economic growth. These findings suggest that socio-economic prosperity and green economy goals can coexist, with the European continent making notable strides in balancing economic growth with environmental sustainability. Moreover, this balance contributes to addressing environmental injustices and promoting social equity, illus-

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trating the broader positive effects of green investments on both economic and social outcomes.

Keywords: *European countries, green economic growth, green investments, environmental protection, panel cointegration analysis*

JEL classification: *A13, D4, D5, E1, Q5*

INTRODUCTION

This study examines the interconnections between social equality, green economic growth, and investments in environmental protection in Europe. It highlights how environmental degradation exacerbates social inequalities, disproportionately affecting marginalized communities. Conversely, investments in environmental protection can act as a critical driver for addressing these disparities, creating green jobs, ensuring access to clean resources, and enhancing societal resilience. Recognizing this nexus accentuates the need for integrated approaches to development that balance economic growth, environmental sustainability, and social fairness. By fostering synergies between these dimensions, policymakers, businesses, and communities can pave the way for a more sustainable and greener future. A green economy framework prioritizes resource efficiency, reduced carbon emissions, and the promotion of renewable energy, offering a pathway toward sustainable development and green economic growth. Within this framework, sustainability aligns ecological preservation with human well-being, highlighting the fundamental link between a healthy environment and improved quality of life for current and future generations. Moreover, addressing environmental challenges caused by global production and consumption processes necessitates acknowledging the role of environmental justice in mitigating inequalities and promoting social fairness. Hence, a relatively new concept of Green GDP supports the idea of aligning economic development with improvements in physical, human, and natural capital.

The study explores the socio-economic implications of investments, transfers, and expenditures in environmental protection, focusing on their impact on the quality of life in selected European countries. Key indicators include GDP per capita (GDPpc) and Green GDP, with the latter representing a more sustainable approach to measuring economic performance. The study adopts the view that GDPpc growth is a desirable outcome, while GDP growth without considering green aspects constitutes an undesirable output. The research approach utilizes panel cointegration modeling across 15 European countries following the

period 2014–2021, depending on the data availability. The analysis reveals two critical findings: first, a significant positive relationship between investments/transfers/expenditures in environmental protection and GDPpc, demonstrating the potential for environmental spending to enhance economic well-being; second, an inverse relationship between environmental investments/transfers/expenditures and the so-called green gap variable, affirming the role of "green spending" in advancing green economic aspirations. These findings illustrate that socio-economic prosperity can coexist with green economy aspirations, reflecting the positive implications of European countries' progress in balancing economic growth with environmental sustainability. Furthermore, this balance contributes to addressing environmental injustices and fostering social equity.

In conclusion, the study affirms that investments in environmental protection are integral to achieving sustainable economic growth while promoting societal well-being. The European "model" demonstrates the potential to harmonize economic, ecological, and social dimensions, offering valuable insights for global efforts to combat environmental injustices and build resilient, inclusive societies.

THEORETICAL BACKGROUND

In an era where the relentless pursuit of ever-higher growth rates remains unparalleled, the notion of unchecked growth faces increasing scrutiny (Stjepanović, Tomić, and Škare, 2019). Economic growth is typically assessed through changes in GDP, a key indicator measuring the flows of output and income within an economy. While GDP effectively captures the patterns and dynamics of economic expansion, this reductionist approach, prevalent in mainstream economic theory and policy, often overlooks the adverse consequences of such growth on socio-economic systems. Economic growth undeniably enhances the quality of life up to a certain threshold. However, beyond this point, it frequently has detrimental effects, a phenomenon known as the "threshold effect." When this critical juncture is exceeded, the negative externalities of growth, such as escalating income inequality, erosion of leisure time, and the depletion of natural resources, can outweigh its benefits, ultimately diminishing overall well-being. This raises a pivotal question: Can fair and sustainable development coexist with the prevailing paradigms of economic growth? Besides the ongoing discourse on reconciling well-being with economic progress, one concept emerges as particularly compelling: the pursuit of green growth. This framework seeks to integrate environmental sustainability with economic

advancement, offering a pathway to balance prosperity and ecological preservation. By emphasizing resource efficiency, inclusivity, and resilience, green growth presents a holistic approach to addressing the complex interplay between growth and sustainability in modern economies.

As the European Union endeavors to harmonize traditional methods of environmental conservation across its Member States, questions have emerged regarding its capacity to fully meet this ambitious objective. The ability of Member States to comply with EU environmental protection regulations varies significantly, ranging from advanced levels of implementation to rudimentary stages of development. These disparities are particularly pronounced in the context of recent institutional changes, wherein administrative responsibilities and regulatory enforcement have increasingly shifted from individual nations to centralized EU institutions (Alibašić and Atkinson, 2023). In response to these challenges, Member States have developed mitigation strategies to address the multifaceted issue of climate change, as articulated in their Intended Nationally Determined Contributions (INDCs) under the framework of the Paris Agreement. Concurrently, the EU and national governments have delineated long-term targets for 2050, aligning these goals with the broader objectives of the European Green Deal and EU climate priorities. This paradigm shift represents a deliberate effort to integrate economic objectives with environmental imperatives, fostering a holistic approach to sustainable development. By prioritizing resource efficiency, carbon neutrality, and socio-economic equity, these initiatives aim to establish a more resilient and inclusive foundation for societal progress, positioning the EU as a global leader in climate action and sustainability (Eurostat, 2024).

As the significance of environmentally sustainable practices becomes increasingly evident, a parallel rise in public awareness and activism surrounding environmental issues is likely to follow. This heightened awareness may prompt citizens to demand greater transparency and accountability from governments and corporations regarding their environmental footprints. Such societal pressures can drive the implementation of more ambitious climate policies and the development of robust sustainable development initiatives, fostering a collective commitment to environmental leadership. The integration of sustainable practices offers substantial benefits for public health and overall quality of life. For instance, reductions in air and water pollution, alongside improved access to green spaces, contribute to the creation of healthier, more livable urban and rural environments. These improvements not only enhance community well-being, but also lower healthcare expenditures by mitigating illnesses linked to environmental pollutants. Moreover, increased investments in environmental protection catalyze advancements in technology, policy frameworks, and sus-

tainable practices aimed at curbing environmental degradation. Such financial commitments accelerate the innovation and deployment of cleaner technologies, renewable energy solutions, and resource-efficient production methods. These developments not only address environmental challenges, but also stimulate economic growth by fostering industries centered around sustainability and green innovation, thereby promoting a circular and resilient economy.

Between 1995 and 2022, European Union expenditure on environmental protection exhibited remarkable stability, consistently ranging between 0.7% and 0.9% of GDP. Similarly, its share within total government expenditure remained relatively constant, fluctuating between 1.4% and 1.7%. In the period from 2021 to 2022, total EU government expenditure on environmental protection increased significantly, rising by €11 billion, from €119 billion to €130 billion. Despite this absolute growth, the expenditure-to-GDP ratio (0.8%) and its proportion within total public spending (1.6%) remained unchanged (Eurostat, 2024).

*Figure 1: Expenditure on environmental protection by EU members, 2018 and 2021, (% of GDP)*
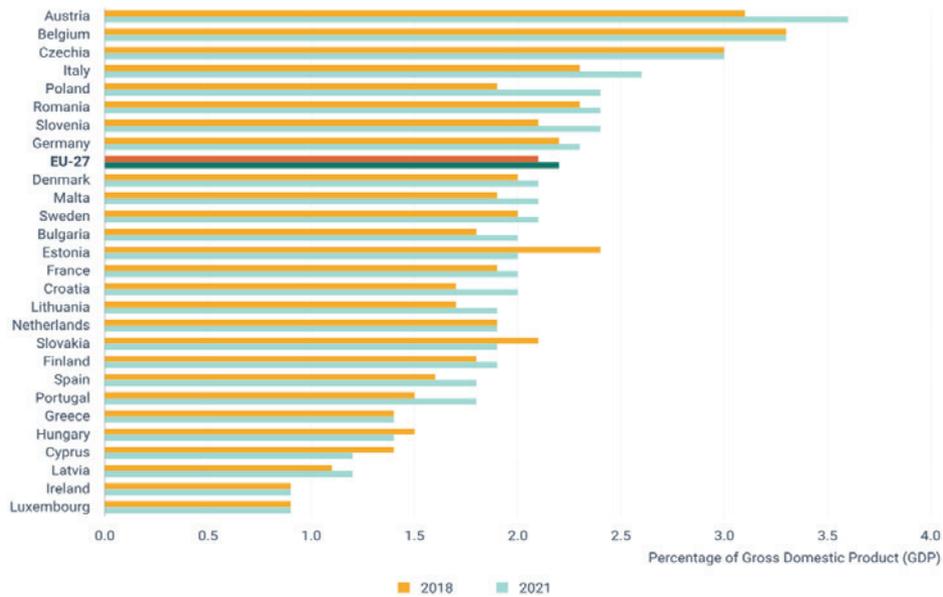
Source: European Environment Agency, 2023

From 2018 to 2023, climate and environment related expenditure within the EU expanded from €280 billion to €357 billion, representing a real-term in-

crease of 7% after adjusting for inflation (European Environment Agency, 2024). Within this timeframe, the environmental protection expenditure of general governments and non-profit institutions grew by 12%, while household contributions to environmental protection expenditures declined by 11%. A substantial portion of this spending was allocated to waste management and wastewater treatment, emphasizing the focus on essential infrastructure and pollution mitigation. The ratio of total environmental protection expenditure to GDP has remained relatively stable, hovering around 2% since 2018. However, this ratio slightly decreased from 2.2% in 2022 to 2.1% in 2023. Investments specifically designated for environmental protection constituted a modest share of the overall expenditure, accounting for 19% in 2023. In real terms (2010 prices), such investments increased from €47 billion in 2018 to €51 billion in 2022. These ratios, however, displayed significant variation among the Member States (Figure 1). For example, Austria, Belgium, and Czechia allocated over 3% of GDP to environmental investments, while Ireland and Luxembourg invested less than 1%. Notably, 17 of the 27 EU Member States reported an increase in this share during the period, with the largest gains observed in Poland and Austria (0.5 percentage points). Conversely, four countries experienced declines, with Estonia showing the largest decrease (0.4 percentage points), while six states reported no significant change. This diverse fiscal landscape underscores the heterogeneity of environmental investment trajectories within the EU (Eurostat, 2023).

Figure 2: General government expenditure on environmental protection, 2022 (% of GDP)
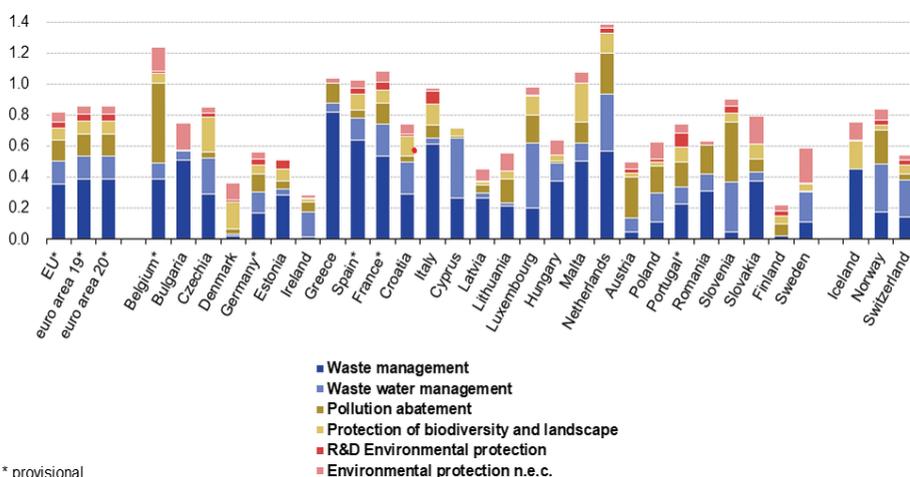
* provisional

Source: Eurostat 2024

In 2022, the Netherlands allocated the highest proportion of GDP to environmental protection among the EU Member States, dedicating 1.4% of GDP to this domain. It was followed by Belgium, France and Malta. A detailed breakdown reveals that in the Netherlands, 0.6% of GDP was directed toward waste management and 0.4% toward wastewater management. Belgium allocated 0.4% of GDP to waste management and 0.5% to pollution abatement, driven largely by tax-subsidy schemes supporting renewable energy (Figure 2). Conversely, countries with the lowest ratios of GDP devoted to environmental protection included Finland, Ireland, and Denmark. When examining specific functions of environmental protection, Greece recorded the highest ratio of GDP devoted to waste management (0.8%), followed by Spain, Italy, and the Netherlands. In terms of wastewater management, Luxembourg, Cyprus, and the Netherlands led with 0.4% of GDP. Belgium stood out with the highest ratio of GDP dedicated to pollution abatement (0.5%), primarily due to its investment in renewable energy initiatives. Regarding the protection of biodiversity and landscapes, EU countries allocated between 0.1% and 0.3% of GDP in 2022, with Malta reporting the highest expenditure at 0.3%. Expenditure on research and development (R&D) related to environmental protection was notably low across all EU Member States, amounting to 0.1% of GDP or less in 2022. This underinvestment in R&D highlights a potential gap in fostering innovation critical for advancing long-term environmental goals (Eurostat, 2024).

EMPIRICAL BACKGROUND

Next, there is a review of the most recent studies related to the research topic, highlighting the key findings and trends that contribute to a deeper understanding of the subject matter. For deeper insight into other related studies, read Tomić (2024). Georgieva (2024) examined the relationships among economic development, environmental investments, and greenhouse gas emissions in the European Union from 2008 to 2022. Through correlation and regression analyses, the study evaluated the influence of environmental protection expenditure and gross domestic product on greenhouse gas emissions. Their findings highlighted a consistent upward trajectory in environmental protection expenditure, particularly in recent years, underscoring the European Union's intensified focus on sustainable development. Hence, greenhouse gas emissions exhibited an overall decline, with the most pronounced reduction occurring between 2019 and 2020, likely attributable to the effects of the COVID-19 pandemic. Correlation analysis revealed a significant inverse association be-

tween environmental investments and emissions, affirming the effectiveness of "green" expenditure in mitigating carbon footprints. Niu (2024) used a panel Tobit model to examine the relationship between government expenditure on environmental protection and national Environmental, Social, and Governance (ESG) performance. The analysis identified a statistically significant positive association, demonstrating that increased government investment in environmental protection is correlated with enhanced ESG performance. The study also revealed that resource allocation toward environmental protection not only improves ecological and social outcomes, but also contributes to advancements in governance standards.

Čábelková et al. (2023) examined the relationships between public preferences for environmental protection, economic growth, and individual freedoms across eleven post-Soviet countries – with analyses introducing correlations, principal component analysis, and ordinal regression methodologies. Findings indicated that preferences for most personal freedoms significantly influence preferences for both environmental protection and economic growth. Specifically, higher preferences for civil rights, democratic principles, gender equality, reduced income inequality, and limiting the military's role in politics are associated with stronger support for environmental protection and economic growth. Shayegh et al. (2023) explored alternative pathways for transitioning the global economy from a fossil-fuel-dominated brown sector to a low-emission green sector. Their findings revealed that the primary challenge of the green transition centers on capital formation, accumulation, and reallocation, supported by comprehensive R&D investment aimed at enhancing the green sector's productivity. Thus, their results demonstrated that each transition pathway employs distinct mechanisms to achieve its objectives. Using provincial panel data from China spanning from 2005 to 2021, Wang and Zhou (2023) employed fixed-effect and mediating-effect models to analyze the impact of government environmental investment on green development. Their findings revealed that government environmental investment positively influences green development, and although this effect has diminished over time, the investment indirectly fosters green development by promoting green patent applications and enhancing economic agglomeration, and they also observed that the effectiveness of government environmental investment varies by region and time period. Zhang (2023) employed panel regression analysis and a two-step generalized method of moments approach to address endogeneity, examining the relationships among green finance, financial technology, and high-quality economic development in three South Asian economies from 2000 to 2018. Their findings revealed that India, Bangladesh, and Pakistan

have implemented diverse green financing initiatives, which significantly reduced commercial CO_2 emissions over the study period. These results favored green financing in advancing environmental protection and supported the concept of green economic recovery.

Arjomandi et al. (2022) utilized the Autoregressive Distributed Lag (ARDL) model to analyze the short-term and long-term effects of environmental policy stringency and environmental expenditures on pollution-adjusted GDP and productivity growth in various OECD countries. Despite notable variations in policies and outcomes among nations, the study demonstrates that, in the short term, government investments in environmental protection significantly stimulate national economic growth. Feng et al. (2022) employed data envelopment analysis and generalized method of moments to examine the relationship between government expenditure and green economic performance, utilizing panel data from 2008 to 2018 across selected BRI countries. Their findings indicated that fluctuations in the green economic performance index within BRI nations are primarily attributed to insufficiently robust government policies. Additionally, the econometric analysis revealed that government expenditure has a significant positive impact on green economic performance, suggesting that public investment in human capital and renewable energy fosters a more productive green economy by enhancing labor efficiency and advancing technical development practices, with effects varying across different countries. Yang, Gao, and Li (2022) conducted a study examining the relationship between economic development and environmental well-being, with a focus on the decoupling dynamics of economic growth and environmental impacts across 30 Chinese regions. The analysis revealed a positive trend, indicating an improving relationship between economic activities and environmental conservation. Their findings suggested that efforts towards economic growth and environmental protection have produced a mutually beneficial outcome, facilitating a "win-win" scenario.

Gan et al. (2021) employed empirical analysis to investigate the relationships between regional economic development, green corporate image, and enterprise environmental protection investment, utilizing data from A-share manufacturing firms listed in China between 2007 and 2015. Their research indicated that a strong green corporate image positively influences environmental protection investment by enterprises, with the level of regional economic development serving as a partial mediator in this relationship. Finally, their results further accentuated that a robust green image conveys positive signals to stakeholders, enhancing their loyalty and satisfaction with the enterprise's products and services. Batini et al. (2021) calculated the economic

multipliers of investments in clean energy and biodiversity conservation to guide stimulus measures for a sustainable post-COVID-19 recovery. Utilizing a newly compiled international dataset, the analysis revealed that each dollar allocated to carbon-neutral or carbon-sink initiatives yields over a dollar's worth of economic benefits (these multipliers were estimated to be 2 to 7 times higher than those of non-eco-friendly expenditures, varying by sector, technology, and time frame). Gallo and Ndiaye (2021) analyzed the data from 1995 to 2017 across 28 OECD countries in order to investigate the dynamics of strategic interactions in environmental expenditures. Using a spatial Durbin model, their study revealed a significant positive spatial dependence in environmental spending among OECD countries, suggesting that the environmental policies of neighboring nations exert an influence on each other's decisions regarding expenditure in this domain. Vavoura and Vavouras (2022) argued that the green growth strategy represents a modified version of the conventional economic growth model, incorporating specific environmental considerations within the European Union. The authors demonstrated that, while per capita income continues to rise, expenditures on environmental protection are increasing at a significantly slower rate. Notably, their analysis identified a distinct decline in investments directed towards environmental protection.

METHODOLOGY

DATA AND MODELING

This study utilizes annual data on gross domestic product per capita, environmental investments, transfers and expenditures spanning the period 2014-2021 (depending on data availability of each variable) and sourced from Eurostat (Eurostat, 2024), covering a representative sample of 15 European countries (Belgium, Bulgaria, Estonia, Greece, Ireland, Spain, France, Croatia, Italy, Lithuania, Austria, Poland, Portugal, Romania and Slovenia), due to data unavailability on the environmentally related variables from other European countries. Green GDP indicator was retrieved from the Stjepanović, Tomić and Škare (2022) database, which provides an alternative framework for evaluating sustainability and green growth (Stjepanović, Tomić and Škare, 2017). All three environmental variables are showing increasing patterns with almost similar movements across the countries and over time. Such similarities in the movements between the variables indirectly point us to the question of sample homogeneity. Thus, the presumption of homogeneity among countries suggests

that the panel data approach should be an appropriate method for answering this research question.

The primary objective of this study is to empirically assess the impact of various environmental investments on the green growth perspective, utilizing a panel cointegration approach. To achieve this, the following equation is estimated, allowing for a comprehensive analysis of the relationship between these investments and sustainable economic growth:

$$lnGDPpc_{it} = \alpha_{0i} + \alpha_{1i}\, lnEPE_{it} + \alpha_{2i}\, lnEPI_{it} + \alpha_{3i}\, lnEPT_{it} + {} \\ + \mu_{it} \quad i = 1, 2, \ldots, N; t = 1, 2, \ldots, T \tag{1}$$

$$lnGAP_{it} = \beta_{0i} + \beta_{1i}\, lnEPE_{it} + \beta_{2i}\, lnEPI_{it} + \beta_{3i}\, lnEPT_{it} + {} \\ + \mu_{it} \quad i = 1, 2, \ldots, N; t = 1, 2, \ldots, T \tag{2}$$

For analytical precision, all datasets were transformed into their logarithmic form. The variable lnGDPpc displays the logarithm of the ratio of real GDP to average population of a specific year in euros, lnGAP represents the logarithm of the deviation of Green GDP from the standard GDP measure in current U.S. dollars (the variable is in dollars due to a particularity of the calculation method), lnEPE represents the logarithm of national expenditure on environmental protection by institutional sector in euros, lnEPI stands for the logarithm of environmental protection investments of the total economy in euros, and lnEPT signifies the logarithm of environmental protection transfers categorized by activity and institutional sector in euros.

APPLIED METHOD; PANEL COINTEGRATION ANALYSIS

In order to analyze the effects of environmental investments, transfers, and expenditures on GDPpc (sample 2014–2021) and the green gap variable (2014–2019), a linear panel data cointegration analysis is applied. The integration order of the time series is determined using panel unit root tests. If the series are found to be integrated of order 1 (i.e., non-stationary), the analysis proceeds with panel cointegration testing. For determining the order of integration, several tests are employed: the LLC test (Levin, Lin and Chu, 2002), the Breitung test (Breitung, 2000), the IPS test (Im, Pesaran and Shin, 2003), and Fisher-type tests using ADF and PP statistics (Maddala and Wu, 1999; Choi, 2001).

Panel cointegration is assessed using the methods proposed by Pedroni (1999, 2004), Kao (1999), and Maddala and Wu (1999). Pedroni and Kao ex-

tend the two-step Engle-Granger (1987) framework to panel data. Pedroni introduces multiple tests for cointegration that account for heterogeneous intercepts and trend coefficients across cross-sections, offering two alternative hypotheses: the homogeneous alternative (within-dimension or panel statistics) and the heterogeneous alternative (between-dimension or group statistics). The Kao test similarly builds on Pedroni's framework, but assumes cross-section-specific intercepts and homogeneous first-stage regressor coefficients.

The long-run relationships are estimated using pooled Panel Fully Modified Least Squares (FMOLS), pooled Panel Dynamic Least Squares (DOLS), and Pooled Mean Group/AR Distributed Lag (PMG/ARDL) methods. FMOLS and DOLS provide only long-run estimates, while PMG/ARDL yields both long-run and short-run estimates. A key advantage of PMG/ARDL is its flexibility, allowing short-run dynamics to vary across cross-sections while maintaining invariant long-run coefficients. Extensions to FMOLS for panel data are proposed by Phillips and Moon (1999), Pedroni (2000), and Kao and Chiang (2000), while DOLS extensions are advanced by Kao and Chiang (2000), Mark and Sul (1999, 2003), and Pedroni (2001). The PMG/ARDL approach (Pesaran, Shin and Smith, 1999) adapts the cointegration framework of the ARDL model for panel data.

RESULTS AND DISCUSSION

The results of the unit root tests, though somewhat inconsistent, generally indicate that the variables are integrated, that is, they are non-stationary in levels but stationary in first differences (Table 1). Despite some discrepancies among the unit root tests, graphical analyses corroborate the hypothesis of non-stationarity. Overall, these series are confirmed to be non-stationary in their levels. Accordingly, panel cointegration tests are conducted.

Table 1: Panel unit root tests

Variables and tests	Level		First difference	
	Intercept	Intercept and trend	Intercept	Intercept and trend
Levin, Lin and Chu t*	Prob.**			
lnGDPpc	0.63	0.00	0.00	0.00
lnGAP	0.00	0.00	0.00	0.00
lnEPE	0.00	0.00	0.00	0.00
lnEPI	0.00	0.00	0.00	0.00
lnEPT	0.31	0.00	0.00	0.00
Breitung t-Stat.	Prob.**			
lnGDPpc	-	0.99	-	0.09
lnGAP	-	0.99	-	1.00
lnEPE	-	1.00	-	0.05
lnEPI		0.95	-	0.89
lnEPT	-	0.99	-	0.09
Im, Pesaran and Shin W-Stat.	Prob.**			
lnGDPpc	1.00	0.21	0.00	0.99
lnGAP	0.76	0.70	0.07	0.99
lnEPE	0.92	0.68	0.00	0.00
lnEPI	0.05	0.38	0.00	0.00
lnEPT	0.81	0.89	0.01	0.01
ADF - Fisher Chi-square	Prob.***			
lnGDPpc	0.99	0.02	0.00	0.00
lnGAP	0.64	0.83	0.44	0.00
lnEPE	0.86	0.99	0.00	0.00
lnEPI	0.01	0.12	0.00	0.00
lnEPT	0.69	0.99	0.12	0.09
PP - Fisher Chi-square	Prob.***			
lnGDPpc	0.94	0.00	0.00	0.00
lnGAP	0.00	0.05	0.42	0.00
lnEPE	0.56	0.00	0.00	0.00
lnEPI	0.00	0.00	0.00	0.00
lnEPT	0.51	0.72	0.05	0.00

Notes: * Heteroscedastic Consistent. ** Probabilities are computed assuming asymptotic normality. *** Probabilities are computed using an asymptotic Chi-square distribution. In the LLC, Breitung, IPS and Fisher-ADF tests, the automatic lag length selection is based on Schwarz information criterion with a maximum lag of 1. Moreover, to estimate the long-run variance in the LLC and Fisher-PP tests, the Bartlett kernel was used with maximum lags determined by the Newey and West bandwidth selection algorithm.

Source: Authors' calculations

The subsequent tables (Table 2 and Table 3) display the outcomes of Pedroni and Kao panel cointegration tests for distinct equations. It is evident that Pedroni's statistics partially reject the null hypothesis of no cointegration between variables, indicating that the long-run panel cointegration relationships between lnGDPpc, lnEPE, lnEPI and lnEPT, as well as lnGAP, lnEPE, lnEPI and lnEPT, could exist. On the other hand, Kao's panel cointegration tests reject the null hypothesis of no cointegration between observed relations indicating the existence of long-run panel cointegration relationships.

Table 2: Pedroni's and Kao's residual cointegration tests – equation (1)

Variables: lnGDPpc, lnEPE, lnEPI, lnEPT								
Pedroni test	**Intercept**				**No intercept or trend**			
	Stat.	**Prob.**	**Weigh.**	**Prob.**	**Stat.**	**Prob.**	**Weigh.**	**Prob.**
Panel v	1.19	0.01	-0.04	0.05	-3.36	0.99	-3.39	0.99
Panel rho	2.71	0.99	2.38	0.99	2.00	0.98	2.73	0.99
Panel PP	0.16	0.05	-3.41	0.00	-0.63	0.03	2.49	0.99
Panel ADF	/	/	/	/	/	/	/	/
Group rho	4.93	1.00	-4.95		3.96	1.00		
Group PP	-6.42	0.00	/		0.00			
Group ADF	/	/			/			
Kao test	**t-Statistic**				**Prob.**			
ADF	1.72				0.04			

Source: Authors' calculations

Table 3: Pedroni's and Kao's residual cointegration tests – equation (2)

Variables: lnGAP, lnEPE, lnEPI, lnEPT								
Pedroni test	**Intercept**				**No intercept or trend**			
	Stat.	**Prob.**	**Weigh.**	**Prob.**	**Stat.**	**Prob.**	**Weigh.**	**Prob.**
Panel v	-3.39	0.99	-3.39	0.99	-2.24	0.98	-3.21	0.99
Panel rho	2.13	0.98	1.92	0.97	1.17	0.09	2.31	0.98
Panel PP	-0.04	0.05	-1.99	0.02	-0.76	0.02	1.12	0.87
Panel ADF	/	/	/	/	/	/	/	/
Group rho	4.11	1.00	-3.61		3.82	0.99		
Group PP	-4.69	0.00	/		0.00			
Group ADF	/	/			/			
Kao test	**t-Statistic**				**Prob.**			
ADF	1.35				0.08			

Source: Authors' calculations

In order to gain a comprehensive understanding of the relationship between lnGDPpc, lnEPE, lnEPI and lnEPT, here are the results from the relevant pooled and group estimations across different panel cointegration methods (Table 4). Pooled estimations from FMOLS, in general, provided a statistically significant and positive relationship between the variables in both cases, with no constant and no trend (lnEPE 0.02, lnEPI 0.08 and lnEPT 0.06) and with a constant (lnEPE 0.05, lnEPI 0.16 and lnEPT 0.02). Grouped estimations from DOLS indicated a strong statistical relationship with an expected positive sign in the case with no constant and no trend (lnEPE 5.49 and lnEPT 1.08, except for EPI -2.75 which was statistically insignificant), and statistically significant coefficients from the PGM/ARDL model (lnEPE 0.04, lnEPI 0.02 and lnEPT 0.04). Zero restrictions on the long-run parameters are tested using the Wald test, confirming their statistical significance (available upon request). Following the results, it can be concluded that an increase in environmental spending has a positive effect on socio-economic well-being in the observed European countries.

Table 4: Panel cointegration results – lnGDPpc (dependent variable)

Panel Fully Modified Least Squares (FMOLS) – (lags-leads; 1,1) – pooled estimation								
	No constant and trend (FMOLS)				Constant (FMOLS)			
Variable	Coeff.	Std. Error	t-Stat.	Prob.	Coeff.	Std. Error	t-Stat.	Prob.
lnEPE	0.02	0.07	0.33	0.74	0.05	0.04	1.21	0.02
lnEPI	0.08	0.03	2.63	0.01	0.16	0.03	5.72	0.00
lnEPT	0.06	0.03	1.78	0.08	0.05	0.02	2.71	0.01
Panel Dynamic Least Squares (DOLS) – (lags-leads; 0,0) – grouped estimation Pooled Mean Group /AR Distributed Lag (PGM/ARDL)								
	No constant and trend (DOLS)				Restricted constant (PGM/ARDL)			
Variable	Coeff.	Std. Error	t-Stat.	Prob.	Coeff.	Std. Error	t-Stat.	Prob.
lnEPE	5.49	1.67	3.28	0.00	0.04	0.01	5.48	0.00
lnEPI	-2.75	1.89	-1.46	0.16	0.02	0.01	3.66	0.00
lnEPT	1.08	0.60	1.80	0.08	0.04	0.06	20.85	0.00

Source: Authors' calculations

Similarly, when evaluating the relationship between lnGAP, lnEPE, lnEPI and lnEPT, here are the results from the relevant pooled and group estima-

tions across different panel cointegration methods (Table 5). Pooled estimations from FMOLS, as expected, revealed a statistically significant and negative relationship between the variables in both cases, with no constant and no trend (lnEPI -1.66 and lnEPT -0.90; with lnEPE -4.45 being statistically insignificant), and with a constant (lnEPE -0.03, lnEPI -0.42 and lnEPT -0.06). Grouped estimations from DOLS offered a strong statistical relationship with an expected negative sign in the case with no constant and no trend (lnEPE -4.59, lnEPI -1.64 and lnEPT -0.94) and with a constant (lnEPE -2.67, lnEPI -0.63 and lnEPT -0.12), however statistically insignificant. The Wald test is used to examine zero restrictions on the long-run parameters, confirming their statistical significance (details available upon request). Based on the results, it can be concluded that an increase in investments, transfers, and expenditures in environmental protection narrows the gap between standard GDP and Green GDP, highlighting the importance of environmentally sustainable practices in selected European countries.

Table 5: Panel cointegration results – lnGAP (dependent variable)

Panel Fully Modified Least Squares (FMOLS) – (lags-leads; 1,1) – pooled estimation								
Variable	No constant and trend (FMOLS)				Constant (FMOLS)			
	Coeff.	Std. Error	t-Stat.	Prob.	Coeff.	Std. Error	t-Stat.	Prob.
lnEPE	-4.45	1.29	-3.43	0.00	-0.03	0.23	-0.15	0.88
lnEPI	**-1.66**	1.50	-1.10	0.02	-0.42	0.15	-2.83	0.01
lnEPT	**-0.90**	0.51	-1.77	0.09	-0.06	0.10	-0.56	0.05
Panel Dynamic Least Squares (DOLS) – (lags-leads; 0,0) – grouped estimation								
Variable	No constant and trend (DOLS)				Constant (DOLS)			
	Coeff.	Std. Error	t-Stat.	Prob.	Coeff.	Std. Error	t-Stat.	Prob.
lnEPE	-4.59	1.67	-2.80	0.01	-2.67	0.76	-0.35	0.73
lnEPI	-1.64	1.88	-0.87	0.03	-0.63	0.41	-1.55	0.15
lnEPT	**-0.94**	0.60	-1.57	0.09	-0.12	0.21	-0.57	0.58

Source: Authors' calculations

The consistency of results across various estimation methods and scenarios indicates a robust and stable negative relationship between national expenditure on environmental protection, environmental protection transfers, and total economy investments in environmental protection with the gap variable.

Namely, an analysis of 15 selected European countries reveals that an increase in environmental protection investments, expenditures and transfers contributes significantly to narrowing the gap between conventional GDP and Green GDP indicators. This alignment reveals the positive impact of dedicating resources to environmental protection, fostering a closer integration of economic indicators with sustainable environmental practices. The findings highlight an urgent need for governments to scale up investments in environmental protection while improving the efficiency of related processes, both in terms of inputs and outputs. Notably, heightened environmental protection investment within European countries can drive socio-economic safeguards of green economic growth, especially in nations prioritizing sustainability initiatives. Conversely, a significant positive relationship is observed between environmental protection investments, transfers, and expenditures, and GDP per capita on the other side, revealing the dual potential of environmental spending to advance both social welfare and economic prosperity.

In essence, there is a noticeable revival of the foundational principles of traditional economic growth policies. At the EU level, this trend becomes apparent through an analysis of the core elements of its green growth strategy, complemented by a review of the progression of both the national environmental expenditure index and the environmental protection investment index during the 2006-2019 period (Vavoura and Vavouras, 2022). These are the data, source and similar timeline that were observed through this analysis, therefore one has to be objective in conclusion. Vavoura and Vavouras (2022) suggested that this revelation brought about by the coronavirus pandemic represents the inherent fragility of this aspired green growth framework. The pandemic has underscored the vulnerabilities in balancing economic expansion with sustainable practices, emphasizing the need for more resilient and adaptive strategies to protect both environmental and economic objectives in the face of future crises.

However, conclusions from this study, as well as those of Čábelková et al. (2023), Yang, Gao, and Li (2022), Arjomandi et al. (2022), Batini et al. (2021), and Gallo and Ndiaye (2021) highlighted the indispensable role of investment and policy design in advancing environmental and economic objectives while enhancing societal well-being. This can be related to a few general conclusions arising from specific insight in these studies. Public support for environmental policies correlates with values of individual freedom and social equality. Governments can frame environmental protection as integral to quality of life and freedom to secure broader acceptance. Investments in clean energy and environmental conservation have demonstrated significant economic multipliers,

surpassing traditional non-green expenditures. Green spending can stimulate economic growth through job creation, innovation, and improved energy security while reducing environmental degradation. There are significant positive effects of government expenditures, particularly in R&D, green finance, and education. These investments boost green economic performance and well-being through innovation and labor productivity. Achieving a sustainable green economy requires coordinated government policies, targeted public spending, and incentivizing private investments in green infrastructure. Hence, governments should enhance fiscal support for green technologies, enforce long-term assessment mechanisms for environmental policies, and encourage regional collaboration for broader green transitions.

Based on the provided results and implications of the presented study, there are several concrete policy suggestions that the EU could consider in order to leverage these findings to enhance regional and individual country-level strategies. The first is to strengthen the investment in environmental protection, since this study highlights a positive relationship between environmental investments and GDP per capita, as well as their role in reducing the Green GDP gap. On the regional level, the EU could increase funding for cross-border green infrastructure projects (e.g., renewable energy grids or circular economy initiatives) and expand allocations within the European Green Deal, with specific sub-targets for sectors like biodiversity, renewable energy, and pollution abatement. On a national level, the EU could encourage national governments to introduce tax incentives for private investments in green technologies and implement public-private partnerships to develop green sectors and job creation. Next, since this study detects significant disparities in environmental protection expenditures across EU countries, EU policies could be more focused on reducing these disparities (for example, prioritizing environmental R&D investments in lower-performing countries to improve efficiency and foster innovation, and/or provide technical assistance for capacity building in underperforming regions, as well as provide grants for universities and private sectors to explore clean energy solutions). Finally, wider social support is crucial for ambitious environmental policies. On the EU level, there could be EU-wide campaigns to educate citizens on the benefits of green investments for both quality of life and economic resilience, and participatory platforms for citizens to contribute to environmental policy discussions. In addition, the EU could encourage local governments to host town halls focused on green transition benefits, and offer grants to NGOs that promote public awareness on green policies and practices. By implementing these targeted strategies, the EU could possibly optimize the socio-economic and environmental benefits

of green investments, ensuring a resilient, equitable, and sustainable future for its citizens.

The interplay among the variables related to environmental protection investment, GDP per capita as a variable representing universal socio-economic value, and Green GDP representing green growth aspiration, establishes a dynamic nexus that significantly influences the course of global development, societal well-being, and environmental sustainability. Central to this connection is the role of investing in environmental protection, which directly affects the health of the environment and, in turn, shapes the economic and social outcomes. Investments in initiatives such as pollution control, resource conservation, and renewable energy projects are intrinsically linked to Green GDP, an indicator that integrates economic growth with environmental considerations. This relationship displays the symbiotic bond between economic prosperity and ecological leadership, demonstrating that robust economic performance can align harmoniously with sustainable environmental practices (Tomić, 2024). Furthermore, this nexus transcends traditional economic indicators, embodying the broader principles of a green economy and sustainability. It highlights the potential for creating a balanced framework where environmental preservation serves as a catalyst for enduring economic and social advancement.

CONCLUDING REMARKS

At a time when the economy and the environment are facing unprecedented challenges, this research examines the complex relationship between investments in environmental protection and their effects on socio-economic well-being. The study analyzes the obstacles and opportunities that European countries encounter as they work toward achieving a sustainable balance between environmental health and economic stability, highlighting the importance of strategic action in shaping a sustainable future. The expanding body of research on the green economy reflects the growing global focus on sustainable development, environmental conservation, and climate change mitigation (Mo et al., 2024). As a development paradigm that harmonizes economic growth with environmental control, the green economy has become a central subject of scholarly and policy interest. It provides practical solutions to pressing environmental challenges, facilitates economic transformation and modernization, and addresses the public's increasing demand for an enhanced quality of life.

This study contributes to this growing literature by indicating, based on the sample of 15 European countries, that increased investments, expenditures, and transfers directed toward environmental protection play a critical role in reducing the disparity between conventional GDP and Green GDP indicators. This convergence highlights the transformative effect of allocating resources to environmental protection, promoting a deeper alignment of economic indicators with sustainable environmental practices. Moreover, a strong positive causal relation emerges between environmental protection spending and GDP per capita, underscoring the dual benefits of such investments. On the one hand, they contribute to advancing social welfare by addressing ecological challenges, and on the other, they drive economic prosperity, illustrating the multifaceted potential of environmental expenditures to foster both sustainable growth and societal well-being.

This study acknowledges several limitations, primarily stemming from the relatively short observation period due to data constraints for specific variables and countries. While the timeframe analyzed provides valuable insights into the key dynamics, extending the analysis over a longer period could yield more reliable and comprehensive findings. One can recognize that this research cannot fully address all aspects of international comparability regarding the growth perspectives among European countries. Differences in natural resource endowments, levels of economic development, sources of economic growth, and institutional capacities across regions pose challenges to drawing universally applicable conclusions. Consequently, the results presented are subject to a degree of uncertainty, partly attributable to data management limitations and gaps in understanding the national green growth initiatives. Future research efforts could offer greater contributions to the field by utilizing extended time series data and incorporating a broader range of countries. Such expanded analyses would enable a more thorough evaluation of the multifaceted impacts of environmental protection investments across economic, political, and social dimensions, providing valuable insights into the global implications of sustainable development practices. Future research should also prioritize the development of standardized methodologies for calculating Green GDP, ensuring greater consistency and comparability across studies and regions. Efforts should also focus on enhancing the availability and quality of data, addressing critical gaps that currently hinder comprehensive analyses. Moreover, it is essential to tackle the inherent subjectivity involved in assigning monetary values to environmental goods, striving for more objective and universally accepted valuation techniques. In addition to methodological advancements, further empirical stud-

ies are needed to evaluate the practical applicability of Green GDP across diverse economic contexts.

Even though environmental externalities, market failures, different political ideologies, conceptual, technical and ethical issues complicate the comprehension of the green growth and socio-economic wellbeing, this modelling approach can be used within conventional growth modelling to scale the sustainability of economic progress – namely, it can offer a more comprehensive understanding of how economic development can be harmonized with environmental maneuvering through investing in environmental protection, ultimately fostering long-term human welfare.

ACKNOWLEDGMENT

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