EXPLORING THE NEXUS BETWEEN EXPENDITURE IN ENVIRONMENTAL PROTECTION AND GREEN GPD IN THE EU

DANIEL TOMIĆ
Juraj Dobrila University of Pula, Faculty of Economics and Tourism »Dr. Mijo Mirković«, Croatia
daniel.tomic@unipu.hr

Amidst profound environmental changes and ecological uncertainty, concerns arise that the sole pursuit of economic growth alongside unsustainable patterns of production, rapid urbanization, consumer-driven behaviour, and associated lifestyle requirements may upset the delicate ecological capacity, economic stability, and socio-economic security. Embracing green growth has emerged as a strategic approach aimed at increasing the use of renewable energy sources, lowering carbon emissions, investing in R&D for green technologies and sustainable practices and etc., hence is widely acknowledged as a viable remedy to steer an economic system that aspires to improve human well-being and social equity while significantly reducing environmental risks and ecological scarcities. This study delves into the intricate interconnection between investment in environmental protection efforts and the resulting impact on a nation's Green GDP. With an increasing global emphasis on green growth and development, understanding the relationship between environmental expenditure and sustainable economic growth has gained paramount significance. The research adopts a time-series cross-sectional methodology, employing a panel cointegration analysis covering a diverse set of EU countries.

Keywords:
digital transformation, organizational change, business process digitalization, train transport, railway, maintenance, public sector management

University of Maribor Press

DOI https://doi.org/10.18690/um.fov.3.2024.72
ISBN 978-961-286-842-0

1 Introduction

Understanding the intricate relationship between expenditure in environmental protection and its impact on various facets of socio-economic indices like gross domestic product (GDP), green GDP, green economy, sustainability, ecology, human well-being, and social equity is a critical area of study in contemporary scientific discourse. The interconnection between these variables forms a nexus that shapes the trajectory of global development, societal welfare, and environmental sustainability. At its core, expenditure in environmental protection directly influences the state of the environment and subsequently impacts the economy and society. Investments in environmental protection measures, such as pollution control, resource conservation, and renewable energy initiatives, bear a direct correlation with the green GDP, a metric that accounts for economic growth while considering environmental factors. This relationship elucidates the symbiotic nature of economic prosperity and ecological preservation, highlighting that a thriving economy can coexist with sustainable environmental practices. Moreover, this nexus extends beyond economic metrics, encapsulating broader notions of a green economy and sustainability. A green economy emphasizes resource efficiency, minimization of carbon footprint, and the promotion of renewable energy sources, fostering a framework for sustainable development. It is within this context that the concept of sustainability intersects with ecological preservation and human well-being, emphasizing the intrinsic connection between a healthy environment and the quality of life for present and future generations.

Crucially, understanding this nexus also involves acknowledging the implications for social equity. Environmental degradation often disproportionately affects marginalized communities, exacerbating social inequalities. Conversely, investments in environmental protection can serve as a catalyst for addressing these disparities by creating green jobs, ensuring access to clean resources, and enhancing overall societal resilience. In essence, exploring the nexus between expenditure in environmental protection and relevant social constructs underscores the imperative for integrated approaches to development. By recognizing the interconnectedness of these elements, policymakers, businesses, and communities can work synergistically towards fostering a harmonious balance between economic growth, environmental conservation, and societal well-being, laying the groundwork for a more sustainable and equitable future.

Scarce empirics on environmental protection expenditure – green growth dynamics nexus, steered this research towards the question; how 'investments' in environment protection (expenditures and transfers in environmental protection) affect the green growth prospect? Hence, the main goal is to reveal whether spending on environmental protection indeed cuts the gap between conventional GDP and Green GDP measures. Long-run empirical assessment is founded on a panel cointegration modelling for the period 2014-2019 for the sample of 7 European countries. The results confirmed positive influence of environmental spending on green growth dynamics.

2 The relevance of environmental protection

2.1 Theoretical background on the topic

Unsustainable economic practices have widened the socio-economic disparity between developed nations and others, necessitating a pressing call for innovative synergies between economic and environmental approaches. It is imperative to reassess genuine progress and prosperity in the future context. Amidst profound environmental changes and ecological uncertainty, concerns arise that the sole pursuit of economic growth alongside unsustainable patterns of production, rapid urbanization, consumer-driven behaviour, and associated lifestyle requirements may upset the delicate ecological capacity, economic stability, and socio-economic security. Embracing green growth has emerged as a strategic approach aimed at increasing the use of renewable energy sources, lowering carbon emissions, investing in R&D for green technologies and sustainable practices and etc., hence is widely acknowledged as a viable remedy to steer an economic system that aspires to improve human well-being and social equity while significantly reducing environmental risks and ecological scarcities. Widely acknowledged, green growth presents a viable solution to steer socio-economic advancement in a sustainable direction. This paradigm shift aims to harmonize economic and environmental considerations, fostering a more balanced and resilient framework for social development (Tomić and Stjepanović, 2022). With an increasing global emphasis on green growth and development, understanding the relationship between environmental expenditure and sustainable economic growth has gained paramount significance.

Ditto, the embrace of a green economy has evolved into a prevalent value orientation guiding both societal and global economic development, driven by the imperative to enhance and safeguard ecological environments. Drastic reductions in funding for the green economy during a crisis yield detrimental consequences, contributing to societal distress. The magnitude of government expenditure within the realm of a green economy, along with the interplay between the composition of such spending and economic growth, significantly influences the execution of fiscal policy. This inquiry stems from the recognition that certain components of public expenditure exert a more pronounced influence on green economic activities than others (Feng et al., 2022).

A substantial body of literature underscores the direct influence of environmental degradation on the configuration of government fiscal expenditure (Yuelan et al., 2019). However, there remains a notable gap in comprehensive evidence regarding the relationship between green economic growth and government fiscal expenditure. Prior studies have shed light on the pivotal role of government fiscal spending as a decisive factor in promoting green economic growth. While an increase in fiscal spending contributes to the enhancement of green economic growth, it is noteworthy that such growth may experience a decline owing to heightened environmental vulnerabilities. Furthermore, fiscal spending serves as a tool to address market failures, thereby stimulating avenues for innovative technological solutions. In this context, the utilization of fiscal resources not only supports the growth of a green economy but also plays a critical role in mitigating environmental challenges and fostering advancements in technology. This multifaceted interplay underscores the intricate dynamics between government fiscal policies and the pursuit of sustainable, environmentally conscious economic development (Huang et al., 2022).

Thus, the significance of government spending extends beyond immediate economic considerations to encompass broader societal and environmental impacts. Integral to the broader spectrum of government governance, as elucidated by Feng et al. (2022), is the aspect of government spending dedicated to environmental protection. This dimension of expenditure, though sometimes overlooked, can exert a macro-level influence on a nation's Environmental, Social, and Governance (ESG) performance to a considerable extent. By investing in environmental protection initiatives, governments contribute not only to ecological well-being but also position themselves as key players in advancing national ESG goals. The nexus between government spending, societal well-being, and environmental stewardship thus emerges as a crucial element in shaping the trajectory of sustainable development (Niu, 2024). As Gallo and Ndiaye (2021) indicate, exploring potential interactions in environmental expenditures among countries holds significant implications for various reasons. Firstly, it enables the comparison of efforts made by different nations in the realm of environmental protection. Moreover, the recognition of possible expenditure externalities suggests that countries' policy decisions are interconnected rather than independent. In the context of environmental expenditures, these externalities may manifest as the ripple effects of public investments in environmental infrastructures within a particular country, extending their benefits to neighbouring nations. This interdependence underscores the need for a holistic understanding of the interconnected nature of environmental expenditures on a global scale.

This study delves into the intricate interconnection between investment in environmental protection efforts and the resulting impact on a nation's Green GDP. The assessment of 'green performance' necessitates a foundation of reliable statistical data. Meaningful international comparisons regarding environmental, sustainability, and 'green' issues hinge upon robust green data collection and indicator capacity building, as highlighted by Stjepanović, Tomić, and Škare (2022). Boyd (2006) posits that societies should be equipped to discern the impact of market consumption on the utilization of public goods. Environmentalists seek to monitor the provision of future nature's benefits, either to hold governments accountable or to benchmark their environmental situations against other nations. Economists, in turn, advocate for societal articulation of trade-offs, performance measurement, and the maximization of social well-being. Meeting these aspirations requires a comprehensive measure of GDP progress, hence the necessity for a Green GDP indicator. Such an indicator empowers countries to integrate green growth approaches into national planning, choose policy instruments that foster growth in key sectors or resources, and facilitate institutional mechanisms linking development factors for continuous improvement. Contrary to the notion that economic development and growth automatically translate into environmental sustainability, the reality, as emphasized by Stjepanović, Tomić, and Škare (2019), is that developed countries tend to consume more resources per capita than their developing counterparts, and the ecological/economic impact extends beyond national borders.

This underscores the potential of Green GDP, a variable to be utilized throughout the paper, to function as a metric for shaping sustainable progress policies and gauging the effectiveness of implementation measures for sustainability-promoting policies or programs.

2.2 Short empirical background

In this part we will mention just latest and topic related researches. Feng et al. (2022) employed data envelopment analysis and system GMM techniques to assess the correlation between government expenditure and green economic performance by using utilized panel data spanning the period from 2008 to 2018 across selected Belt and Road Initiative (BRI) countries. Authors suggest that the fluctuations observed in the green economic performance index of BRI countries stem from a lack of robust government policies. Importantly, the econometric results revealed a positive and significant impact of government expenditure on green economic performance.

Gallo and Ndiaye (2021) conducted an analysis utilizing data spanning the years 1995 to 2017 across a sample of 28 OECD countries. Their study delves into the nature and scope of strategic interactions in environmental expenditures among these countries, employing a spatial Durbin model. The results of their investigation revealed a noteworthy presence of significant positive spatial dependence in environmental spending among OECD countries. This suggested that these countries take into account the behaviour of their neighbours when formulating policy decisions pertaining to environmental expenditures. Furthermore, their study highlighted distinctive patterns, indicating that the most populous nations or those grappling with high unemployment tend to allocate comparatively lesser funds towards environmental concerns. Huang et al. (2022) explored the influence of public sector investments in education and research and development on green economic growth in specific Asian economies from 1991 to 2019. Employing FMOLS and DOLS methods, the study aimed to scrutinize the relationship between public expenditures in the education and research and development sectors and the trajectory of green economic growth. Their findings accentuated that expenditures in both education and research and development play a substantial and positive role in augmenting green economic growth across the majority of the selected Asian economies. Leveraging comprehensive indicator data on national Environmental, Social, and Governance (ESG) performance across 27 countries spanning the years

2006 to 2020, Niu (2024) conducted an examination using a panel Tobit model. Author's results revealed a statistically significant and positive correlation between government environmental protection spending and national ESG performance. Furthermore, author found that directing resources towards environmental protection not only enhances a nation's ecological and societal performance but also contributes to an improvement in governance standards and that an increase in government spending on environmental protection triggers a surge in green innovation, consequently exerting a positive impact on the overall national ESG performance.

In a recent study, Arjomandi et al. (2022) utilized the Pooled Mean Group Autoregressive Distributed Lag model to explore the immediate and prolonged impacts of environmental policy stringency and environmental spending on pollution-adjusted GDP and productivity growth across a selection of OECD countries. Despite notable variations in policies and outcomes among countries, our investigation indicates that, in the short term, governmental investment in environmental protection significantly stimulates national output. However, their long-term analysis suggests that both heightened environmental policies and increased environmental expenditure may decelerate 'green' GDP and productivity growth over time, with policy stringency exhibiting a comparatively weaker influence. Contrary to the Porter Hypothesis, their findings do not lend support to the idea that environmental regulations can spur economic growth. Instead, they align with the prevailing perspective that such policies might impede economic activity and long-term growth. Li et al. (2016) analyzed the impact of environmental protection investment on economic growth, specifically its benefits for the development of the green economy in China. Utilizing data spanning the years 2004 to 2014, the study employed a multivariate regression model to empirically assess the influence of environmental protection investment on GDP growth. Results revealed a positive effect on GDP growth attributed to investments in environmental pollution control, industrial pollution control projects, and energy-saving and environmental protection initiatives.

3 The scope of the research

3.1 Empirical approach

In order to evaluate the relationship between spending on environmental protection and green aspiration, we will use two variables to represent 'investments' in environment protection i.e. expenditures and transfers in environmental protection. On the other side, we will use the gap variable to represent green growth prospect, as the main point of this research is to reveal whether spending on environmental protection indeed cuts the gap between conventional GDP and Green GDP measures. Therefore, our formulation will be expressed through two models, one relating expenditure in environmental protection to so-called green gap and other to test and confirm the credibility of the first, relating environmental protection transfers to green gap. Finally, our models want to test the hypothesis of positive influence of environmental protection investment on green economy aspiration.

Empirical assessment will be based on a cross-country panel cointegration modelling for the period 2014-2019 for the sample of 7 European Union (EU) countries. Environmental protection expenditure witnessed a notable uptick from 2.1% to 2.3% of the GDP between 2018 and 2020 on a pan-European scale. Notably, the environmental protection expenditure to GDP ratios exhibited significant divergence among the EU members. Austria, Belgium, and Romania stood out with this kind of expenditure constituting more than 3% of their respective GDPs, while in Ireland, the proportion was less than 1%. An intriguing trend unfolded across the 27 EU countries during the 2018-2020 timeframe, with 21 countries experiencing an expansion in this ratio. Poland marked the most substantial increase, surging by 1 percentage point, closely followed by Malta, which witnessed a rise of 0.6 percentage points. In contrast, the remaining EU countries observed a decline in this share, with Lithuania and Cyprus experiencing the most significant reductions (European Environment Agency, 2023). This dynamic scenario reflects the diverse fiscal landscapes within the EU, underlining the nuanced trajectories of public expenditure across its member nations. General government expenditure in the EU on 'environmental protection' amounted to €119 billion (0.8 % of GDP) in 2021 (Eurostat, 2023). In line with this trend, we selected 7 EU countries which invested the most in environmental protection, thus exceeding 2.5% of environmental protection expenditure to GDP ratio (reflection dynamics in 2018 and/or 2020), as a respectable sample for testing our hypothesis (*Figure 1*).

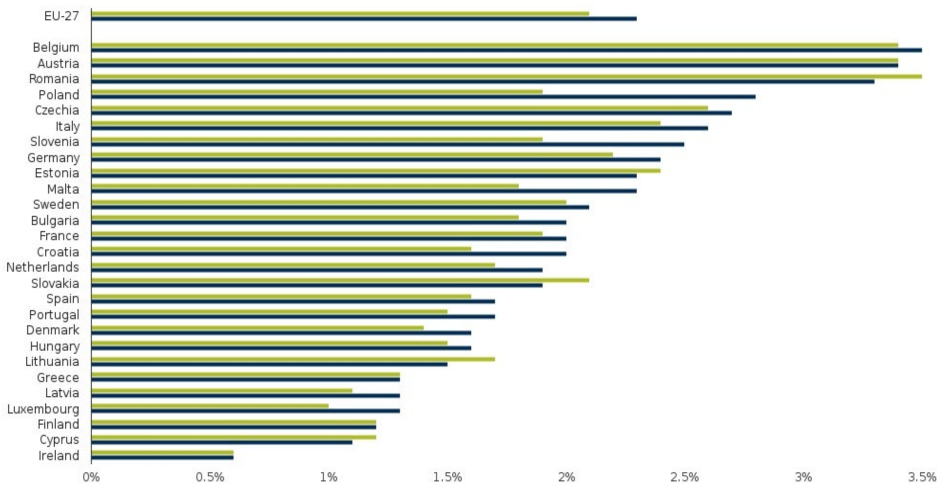

Figure 1: Expenditure on environmental protection by EU countries, 2018 and 2020, (% of GDP)

Source: European Environment Agency, 2023

3.2 Data and model selection

Annual data on environmental protection and environmental transfers, covering the period 2014-2019 for the sample of 7 EU countries (Belgium, Romania, Austria, Czechia, Slovenia, Poland and Italy), are taken from the Eurostat (Eurostat, 2024). The data for Green GDP are based on the paper Stjepanović, Tomić and Škare (2022) following their alternative approach to sustainability and green growth (Stjepanović, Tomić and Škare, 2017). Data are expressed in logarithms and presented as: lnGAP as the logarithm of the gap from Green GDP to standard GDP measure in current U.S. dollars, lnEE as the logarithm of national expenditure on environmental protection by institutional sector in euros and lnET as the logarithm of environmental protection transfers by environmental protection activity and institutional sector in total environmental protection activities.

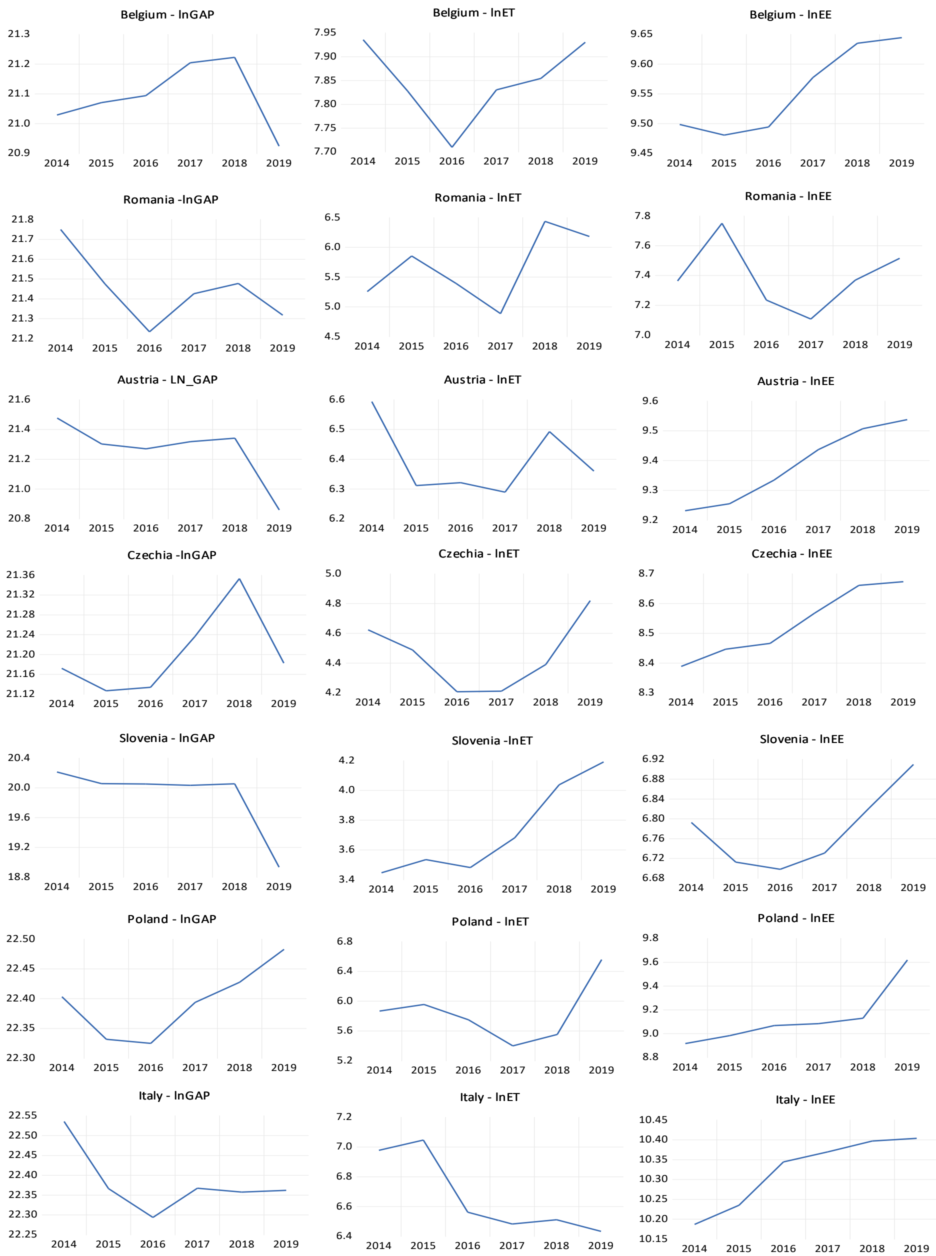

Figure 2: Variables lnGAP, lnEE and lnET by selected EU countries

Source: Authors' calculations.

Following the literature, recent trends and possible homogeneity among the EU countries, it can be anticipated that cointegration between included variables may exist. Hence, we intend to employ the cointegration method using panel data modeling. If the variables are non-stationary and integrated of the same order, the analysis can continue with testing for the panel cointegration. Following the graphical display of the variables across the countries (*Figure 2*) as well as the results of several panel unit root tests (*Table 1*), namely LLC test (Levin, Lin and Chu, 2002), Breitung test (Breitung, 2000), IPS test (Im, Pesaran and Shin, 2003) and Hadri tests (Hadri, 2000), we came to conclusion that all variables could be integrated I(1), meaning they are stationary in their first differences, which is an important property for our modelling.

Table 1: Panel unit root tests

Variable and test	Level		First difference	
	Intercept	Intercept and trend	Intercept	Intercept and trend
Levin, Lin and Chu t*	Prob.**			
lnGAP	0.00	0.00	0.04	0.99
lnEE	0.23	0.00	0.00	0.00
lnET	0.07	0.00	0.00	0.00
Breitung t-stat	Prob.**			
lnGAP	-	0.95	-	0.99
lnEE	-	0.98	-	0.97
lnET	-	0.98	-	0.99
Im, Pesaran and Shin W-stat	Prob.**			
lnGAP	0.45	0.66	0.47	0.97
lnEE	0.96	0.70	0.29	0.54
lnET	0.62	0.82	0.39	0.16
Hadri test	Prob.**			
lnGAP	0.00	0.00	0.00	0.00
lnEE	0.00	0.00	0.00	0.00
lnET	0.00	0.00	0.00	0.00

Notes: * Heteroscedastic Consistent. ** Probabilities are computed assuming asymptotic normality
Source: Authors' calculations

3.3 The model and results

Resulting from the conceptual framework and the characteristic of the data, our model can be presented as:

$$lnGAP_t = \beta_0 + \beta_1 \, lnEE_t + \varepsilon_t \quad (1)$$

$$lnGAP_t = \beta_0 + \beta_1 \, lnET_t + \varepsilon_t \quad (2)$$

therefore, they can be regarded as candidates for modelling panel cointegration. Following the research logic from Škare, Tomić and Kristek (2020), panel cointegration tests were evaluated according to Pedroni (1999, 2004) and Kao (1999), as Johansen Fisher trace and maximum eingevalue cointegration tests could not be fully obtained. Pedroni and Kao expand upon the two-step Engle-Granger framework to encompass tests related to panel data. Pedroni introduces various cointegration tests that accommodate diverse intercepts and trend coefficients across different cross-sections, presenting two alternative hypotheses: the homogenous alternative and the heterogeneous alternative. The Kao test follows the same approach as the Pedroni tests, but specifies cross-section specific intercepts and homogeneous coefficients within the first-stage regressors.

Based on the results of Pedroni's panel cointegration tests (as shown in Table 2), it is evident that when considering only the intercept or both intercept and trend, a majority of Pedroni's statistics reject the null hypothesis, indicating the presence of a long-run panel cointegration relationship between the variables, with at least one cointegrating vector. Kao's panel cointegration test, on the other hand, strongly accepts the null hypothesis, indicating the non-existence of a long-run panel cointegration relationship. Consequently, at least on residual cointegration test provide compelling evidence of a long-term cointegration between the variables in both equations. Due to the potential variation in results from Johansen Fisher panel cointegration test, depending on the number of lags and other specifications, and given the inconclusive outcomes obtained from this method, it was decided not to utilize this particular type of cointegration test.

Table 2: Cointegration tests

Variables: lnGAP vs. lnEE								
Pedroni residual cointegration test	*Intercept*				*Intercept and trend*			
	Statistic	*Prob.*	*Weighted Statistic*	*Prob.*	*Statistic*	*Prob.*	*Weighted Statistic*	*Prob.*
Panel v	0.91	0.18	0.55	0.29	-0.64	0.74	-1.13	0.87
Panel rho	-0.19	0.42	-0.02	0.49	1.87	0.97	1.67	0.95
Panel PP	-6.58	0.00	-3.32	0.00	-2.43	0.01	-1.99	0.02
Panel ADF	-6.15	0.00	-6.99	0.00	/	/	/	/
Group rho	1.43	0.92			2.65	0.99		
Group PP	-3.99	0.00			-1.69	0.05		
Group ADF	-10.27	0.00			/	/		
Kao residual cointegration test	*t-Statistic*				*Prob.*			
ADF	-0.21				0.42			

Variables: lnGAP vs. lnET								
Pedroni residual cointegration test	*Intercept*				*Intercept and trend*			
	Statistic	*Prob.*	*Weighted Statistic*	*Prob.*	*Statistic*	*Prob.*	*Weighted Statistic*	*Prob.*
Panel v	0.93	0.18	-0.17	0.57	-1.93	0.97	-1.96	0.98
Panel rho	-0.01	0.49	0.77	0.78	-0.42	0.33	-0.28	0.39
Panel PP	-2.17	0.02	-0.70	0.24	-1.02	0.15	-0.42	0.34
Panel ADF	-6.05	0.00	-5.78	0.00	-2.63	0.00	-6.83	0.00
Group rho	1.81	0.97			1.51	0.93		
Group PP	-0.99	0.16			-0.47	0.32		
Group ADF	-8.01	0.00			-4.50	0.00		
Kao residual cointegration test	t-Statistic				Prob.			
ADF	-0.74				0.23			

Source: Authors' calculations

3.4 Panel cointegration results

The long-run cointegration is estimated using the pooled and grouped Panel Fully Modified Least Squares (FMOLS) and pooled and grouped Panel Dynamic Least Squares (DOLS) estimation methods. We opted not to estimate Pooled Mean Group/AR Distributed Lag (PMG/ARDL) due to results inconsistency. FMOLS and DOLS estimation methods for panel settings allow the estimation of the panel cointegrating regression equation for non-stationary data by correcting the standard pooled OLS for serial correlation and endogeneity of regressors that are usually present in long-run relationships. In addition, the DOLS allows augmenting the panel cointegrating regression equation with cross-section specific lags and leads to eliminate the endogenity and serial correlation. Therefore, a key advantage over FMOLS and DOLS is that it permits the short-run dynamic specification to vary across cross-sections, while maintaining the constraint that the long-run coefficients remain invariant.

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

Panel Fully Modified Least Squares (FMOLS) – (lags-leads; 1,1) – grouped estimation								
Variable	*Constant*				*Constant and trend*			
	Coefficient	*Std. Error*	*t-Statistic*	*Prob.*	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
lnEE	-0.76	0.17	-4.51	0.00	-0.89	0.15	-5.94	0.00
Panel Dynamic Least Squares (DOLS) – (lags-leads; 0,0)- pooled estimation								
Variable	*Constant*				*Linear trend*			
	Coefficient	*Std. Error*	*t-Statistic*	*Prob.*	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
lnEE	-0.52	0.30	-1.72	0.10	-0.26	0.13	-2.03	0.06

Panel Fully Modified Least Squares (FMOLS) – (lags-leads; 1,1) – pooled estimation								
Variable	*Constant*				*Constant and trend*			
	Coefficient	*Std. Error*	*t-Statistic*	*Prob.*	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
lnET	-0.17	0.11	-1.62	0.12	-021	0.11	-2.02	0.05
Panel Dynamic Least Squares (DOLS) – (lags-leads; 0,0)- grouped estimation								
Variable	*Constant*				*Linear trend*			
	Coefficient	*Std. Error*	*t-Statistic*	*Prob.*	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
lnET	-0.44	0.17	-2.59	0.02	-0.27	0.14	-1.92	0.08

Source: Authors' calculations

The outcomes from nearly all estimation methods (Table 4) reveal statistically significant long-term coefficients aligning with the theoretically anticipated direction and remaining consistent with empirical dynamics. Zero restrictions on the long-run parameters are tested using the Wald test, confirming their statistical significance. Results from equation (1) reveal negative and strongly significant coefficients for variable lnEE varying from -0.52 to -0.76 in the case with constant, and from -0.26 to -0.89 in the case for constant with linear trend. Results from equation (2) display statistically significant negative relationship for variable lnET, varying from -0.17 to -0.44 in cases with constant, and from -0.21 to -0.27 in cases with constant and linear trend. Hence, one can infer that an escalation in both environmental protection expenditure and environmental protection transfers serves to reduce the disparity between conventional GDP and Green GDP measurements for 7 selected EU countries. This suggests that allocating resources to environmental protection activities has a positive impact on aligning economic indicators with environmentally sustainable practices, reflected in the convergence of these GDP metrics. The findings indicate a critical need for the government to augment its investment in environmental protection and enhance the efficiency of both input and output processes. This strategic approach is essential for fostering sustained, rapid, and healthy development in the national economy, as well as driving advancements in social well-being (Stjepanović, Tomić, and Škare, 2019). Specifically, a heightened investment in environmental protection within the EU is poised to yield positive outcomes for green economic growth, particularly for those countries committed to investing in sustainability.

4 Beyond conclusion

Based on this research it can be concluded that an increase in the environmental protection expenditure and environmental protection transfers curtails the gap between the conventional GDP and Green GDP measures for 7 EU countries (Belgium, Romania, Austria, Czechia, Slovenia, Poland and Italy). While the environmental laws and investments in environmental protection in the examined nations operate independently, the realization of a comprehensive environmental strategy is crucial to bring about distinct economic and environmental impacts. Our findings underscore the imperative for countries to formulate robust environmental policies and strategies; however, the successful implementation of such plans necessitates collaboration among all economic stakeholders.

It's important to note that this study has certain limitations, such as the relatively limited number of observed years. Although the observed time frame captures unique dynamics, a more extensive analysis over a broader period would likely yield more robust results. Furthermore, relying solely on Standard GDP as a measure of economic success and growth has its limitations, particularly regarding its failure to adequately account for the environmental component.

Ultimately, while our ability to offer extensive international evidence on the comprehensive impact of investments in environmental protection is limited, it is noteworthy that the observed relationship exhibits a high level of statistical significance and robustness. We aspire to make a modest contribution to advancing the understanding of the practical and methodological dimensions of this relevant green topic. It's important to note that our approach and the deductions presented herein represent our current perspective and are subject to potential revisions in the future.

Acknowledgements

"This paper is a result of the scientific projects "The Impact of Artificial Intelligence and New Digital Technologies on the Financial Market" and "Labour Market and Evidence-based Policy Making" supported by the Faculty of Economics and Tourism "Dr. Mijo Mirković", Juraj Dobrila University of Pula. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the author(s) and do not necessarily reflect the views of the Faculty of Economics and Tourism "Dr. Mijo Mirković" Pula."

References

Arjomandi, A., Gholipour, H. F., Tajaddini, R. and Harvie, C. (2022). Environmental expenditure, policy stringency and green economic growth: evidence from OECD countries. Applied Economics, Vol. 55, No. 8, pp. 869-884.

Breitung, J. (2000). The Local Power of Some Unit Root Tests for Panel Data. In B. Baltagi (ed.), Advances in Econometrics, Vol. 15: Nonstationary Panels, Panel Cointegration, and Dynamic Panels, Elsevier Science Inc.

Boyd, J. (2009) Green GDP: 'Seeing' the Hidden Economy of Nature. Resources for the Future, a part of Research Paper 09-35 with Alan Krupnick. Washington, DC. Available at: http://www.cirano.qc.ca/icirano/public/pdf/GDPMontreal2.pdf.

European Environment Agency (2023). Environmental protection expenditure; Analysis and data. Available at:https://www.eea.europa.eu/en/analysis/indicators/environmental-protection-expenditure-8th-eap.

Eurostat (2024). Eurostat database. Available at: https://ec.europa.eu/eurostat.

Eurostat (2023). Eurostat Statistics. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Government_expenditure_on_environmental_protection.

Feng, H., Liu, Z., Wu, J., Iqbal, W. and Ahmad, W. (2022). Nexus between government spending and green economic performance: Role of green finance and structure effect. Environmental Technology and Innovation, Vol. 27, August 2022, p. 102461.

Gallo, L. J. and Ndiaye, Y. (2021). Environmental expenditure interaction among OECD countries, 1995-2017. Economic Modelling, Vol. 94, No. 2, pp. 244-255.

Hadri, K. (2000). Testing for Stationarity in Heterogeneous Panel Data. Econometrics Journal, Vol. 3, No. 2, pp. 148–161.

Huang, X., Huang X, Chen, M. and Sohail, S. (2022). Fiscal spending and green economic growth: fresh evidence from high polluted Asian economies. Economic Research, Vol. 35, No. 1, pp. 5502-5513. doi:10.1080/1331677X.2022.2029714

Im, K. S., Pesaran, M. H. and Shin, Y. (2003). Testing for Unit Roots in Heterogeneous Panels. Journal of Econometrics, Vol. 115, No. 1, pp. 53–74.

Kao, C. (1999). Spurious Regression and Residual-Based Tests for Cointegration in Panel Data. Journal of Econometrics, Vol. 90, No. 1, pp. 1–44.

Levin, A., Lin, C. and Chu, C. (2002). Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. Journal of Econometrics, Vol. 108, No. 1, pp. 1–24.

Liu, C., Luo, L., Xue, Y., Liu, X., Zhang, M. and Zhang, W. (2016). Study on the influence of environmental protection investment on GDP in China. International Conference on Education, Management and Computer Science (ICEMC 2016). Available at: https://www.atlantis-press.com/proceedings/icemc-16/25856625.

Niu, B. (2024). Government environmental protection expenditure and national ESG performance: Global evidence. Innovation and Green Development, Vol. 3, No. 2, p. 100117.

Pedroni, P. (1999). Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. Oxford Bulletin of Economics and Statistics, Vol. 61, Special Issue, pp. 653–70.

Pedroni, P. (2004). Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis. Econometric Theory, Vol. 20, No. 3, pp. 597–625.

Pesaran, M. H., Shin, Y. and Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. Journal of the American Statistical Association, Vol. 94, No. 446, pp. 621-634.

Stjepanović, S., Tomić, D. and Škare, M. (2022). A new database on Green GDP; 1971-2019: a framework for assessing the green economy. Oeconomia Copernicana, Vol. 13, No. 4, pp. 949-975. doi:10.24136/oc.2022.027

Stjepanović, S., Tomić, D. and Škare, M. (2019). Green GDP: An Analysis for Developing and Developed Countries. Economics and Management (E&M), Vol. 22, No. 4, pp. 4-17. doi:10.15240/tul/001/2019-4-001

Stjepanović, S., Tomić, D. and Škare, M. (2017). A New Approach to Measuring Green GDP: A Cross-country Analysis. Entrepreneurship and sustainability issues, Vol. 4, No. 4, pp. 574-590. doi: 10.9770/jesi.2017.4.4(13)

Škare, M., Tomić, D., Kristek, I. (2020). Terms of trade impact on international trade: A panel cointegration analysis, Transformation in Business and Economics, Vol. 19, No. 3, pp. 136-158.

Yuelan, P., Akbar, M. W., Hafeez, M., Ahmad, M., Zia, Z. and Ullah, S. (2019). The nexus of fiscal policy instruments and environmental degradation in China. Environmental Science and Pollution Research International, Vol. 26, No. 28, pp. 28919–28932.