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Ambition without acceleration: The European Green Deal and environmental SDG performance

Oksana Liashenko
Doctor of Economic Sciences, Professor
Loughborough Business School, Loughborough University
LE11 3TU, Epinal Way, Loughborough, UK
Lesya Ukrainka Volyn National University
43025, 13 Voli Ave., Lutsk, Ukraine
https://orcid.org/0000-0001-5489-815X

Olga Demianiuk*
PhD in Economic Sciences, Associate Professor
West Ukrainian National University
46009, 11 Lvivska Str., Ternopil, Ukraine
http://orcid.org/0000-0002-4699-0172

Abstract. Achieving environmental Sustainable Development Goals is a central priority of global climate policy, yet whether ambitious regulatory frameworks translate into measurable acceleration of environmental progress remains empirically underexplored due to the lack of causal identification designs. The purpose of this study was to assess the causal impact of the European Green Deal on the trajectories of four environmental SDGs in EU-27 member states relative to non-EU European countries. A quasi-experimental difference-in-differences framework was applied to a balanced panel of 39 European countries over the period 2010-2023, incorporating two-way country and year fixed effects, country-clustered standard errors, and a set of time-varying controls. It was established that during 2020-2023 the European Green Deal did not generate statistically significant improvements in SDG 7 (Affordable and Clean Energy), SDG 12 (Responsible Consumption and Production), or SDG 13 (Climate Action) relative to the control group. A marginally significant deterioration was identified for SDG 15 (Life on Land), indicating a relative short-run decline in biodiversity indicators within the EU. Heterogeneity analysis revealed that newer member states and lower-income countries experienced significantly worse climate-action outcomes. The robustness of the findings was confirmed through placebo tests, alternative control-group specifications, and COVID-19 sensitivity analysis. The results can inform climate-policy practitioners and public administrators seeking to strengthen implementation mechanisms and financing for the biodiversity and land-use components of EU policy

Keywords: policy impact evaluation; difference-in-differences; panel data; environmental performance; implementation gap; quasi-experiment; fixed effects

Introduction

The European Green Deal (EGD), announced by the European Commission (2021) in December 2019, represents one of the most ambitious climate policy frameworks in global history. With targets of a 55% reduction in greenhouse gas emissions by 2030 and climate neutrality by 2050, the EGD was positioned as a transformational strategy to decouple economic growth from resource use while achieving sustainable development. The Fit for 55 legislative package, comprising 13 revised laws and six new proposals, was designed to translate these ambitions into actionable policy measures across the energy, transport, industry, and land-use sectors.

However, a growing body of evidence suggests a persistent gap between the EU's climate rhetoric and measurable

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*Corresponding author

outcomes (Hereu-Morales *et al.*, 2024). The Europe Sustainable Development Report 2025 reports that the pace of SDG progress in the EU over the 2020-2023 period was more than twice as low (+0.8 points) as over the 2016-2019 period (+1.9 points), raising fundamental questions about policy effectiveness (Lafortune & Fuller, 2025). Critically, environmental and biodiversity challenges remain acute, with SDG 15 (Life on Land) showing particularly concerning trends across European countries (Sachs *et al.*, 2025). This deceleration coincides precisely with the implementation period of the European Green Deal, warranting rigorous empirical investigation.

Recent scholarship has increasingly documented this disconnect between policy ambition and environmental performance (Pollex & Lenschow, 2025). O. Liashenko *et al.* (2026) identified a "policy plateau" in EU decarbonisation trajectories, demonstrating through hybrid ARIMA-Random Forest forecasting that current policy instruments are insufficient to achieve 2030 targets. Similarly, O. Pavlova *et al.* (2025) employed discourse analysis to reveal systematic misalignment between EU climate rhetoric and national energy patterns, concluding that political commitments often fail to translate into structural transformations. J. Hereu-Morales *et al.* (2024) provided a systematic analysis that questions the environmental sustainability of EGD's transformational plans, noting that only seven of 30 goals under the preceding 7th Environmental Action Programme were expected to be met by 2020. P. Koundouri *et al.* (2024) applied machine-learning text mining to evaluate SDG integration across 74 EGD policy documents, finding substantial alignment with clean energy (SDG 7), climate action (SDG 13), and sustainable consumption (SDG 12), but significant underrepresentation of social and biodiversity dimensions. The Stockholm Environment Institute (2025) further highlights that capacity constraints and administrative burdens hinder member states from effectively transposing and implementing the EGD.

Despite this accumulating evidence, the literature lacks causal identification of EGD's actual impact on environmental SDG outcomes. Existing studies predominantly rely on descriptive trends, policy document analysis, or composite indices without establishing counterfactual baselines (Ottomano Palmisano *et al.*, 2025). The quasi-experimental evaluation of climate policies has proven valuable in other contexts. K. Vrolijk & M. Sato (2023) systematically reviewed difference-in-differences applications to carbon pricing, and recent methodological advances by J. Roth *et al.* (2023) have strengthened causal inference in staggered policy settings. Yet, no study has applied these rigorous methods to assess whether the EGD has accelerated environmental SDG performance in EU member states relative to comparable European economies.

This study addresed this gap by employing a difference-in-differences (DiD) framework to evaluate the European Green Deal's impact on four environmental Sustainable Development Goals: SDG 7 (Affordable and Clean Energy), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 15 (Life on Land). A panel dataset was constructed of 39 European countries over 2010-2023, treating EU27 member states as the treatment group and 12 non-EU European countries as the control group, with the treatment timing set at 2020. The identification strategy relied on the parallel-trends assumption, which is validated through pre-treatment statistical tests and event-study analysis.

The empirical approach incorporated several methodological safeguards following best practices in contemporary DiD research of J. Roth *et al.* (2023). The estimation employed two-way fixed effects (country and year) with clustered standard errors at the country level to address serial correlation. To mitigate multicollinearity in governance controls, a systematic variable selection was conducted based on variance inflation factor analysis, ultimately selecting WGI Political Stability as the sole governance indicator due to its lowest correlation with the other predictors. Robustness checks include placebo tests with alternative treatment timing (2016), alternative control-group specifications (excluding Norway and Switzerland), a COVID-19 sensitivity analysis (excluding 2020), and random-effects estimation.

The findings contribute to the critical assessment of the effectiveness of EU climate policy and speak directly to ongoing debates about the "implementation gap" in environmental governance. By providing the first quasi-experimental evidence on EGD's short-term SDG impacts, the study offers policy-relevant insights as the EU enters the decisive period leading up to the 2030 targets. The results also contribute to the emerging literature (Pavlova *et al.*, 2025; Liashenko *et al.*, 2026) on the "policy plateau" and "discourse versus action" in European sustainability transitions, providing quantitative benchmarks against which future policy adjustments can be evaluated.

Materials and Methods

Research design

This study employed a Difference-in-Differences (DiD) quasi-experimental design to estimate the causal effect of the European Green Deal on environmental performance indicators across European countries. The DiD approach exploits the policy variation created by the implementation of the European Green Deal in 2019-2020, which affected EU member states (treatment group) but not other European countries (control group). This methodology has been widely applied in policy evaluation studies examining environmental outcomes (Angrist & Pischke, 2009). The formal specification of the DiD model is:

$$Y_{it} = \alpha_i + \lambda_t + \delta(Post_t \times Treat_i) + \beta X_{it} + \varepsilon_{it}, \quad (1)$$

where Y_{it} represents environmental outcome variables (SDG scores) for country i in year t; α_i captures country fixed effects, λ_t captures time fixed effects; $Post_t$ is a binary indicator equal to 1 for years ≥ 2020; $Treat_i$ is a binary indicator equal to 1 for EU27 member states; X_{it} is a vector of time-varying control variables, and ε_{it} is the error term. The coefficient δ represents the DiD estimator capturing the causal effect of the European Green Deal on environmental SDG performance.

Sample, study period and data sources

The dataset comprises a balanced panel of 39 European countries, observed annually from 2010 to 2023, yielding 546 country-year observations. The treatment group comprises all 27 EU member states subject to the European Green Deal regulatory framework. The control group comprises 12 European countries that are geographically proximate to the EU but not subject to the Green Deal policy: Albania, Bosnia and Herzegovina, Georgia, Iceland, Moldova, Montenegro, North Macedonia, Norway, Serbia, Switzerland, Turkey, and Ukraine. The selection of control countries was guided by the parallel trends assumption underlying the DiD methodology. These countries share geographic, cultural, and, to some extent, economic characteristics with EU member states, making them suitable counterfactuals. The study period 2010-2023 provides 10 years of pre-treatment data (2010-2019) and 4 years of post-treatment observations (2020-2023), enabling robust estimation of pre-treatment trends and treatment effects.

Data were compiled from multiple authoritative sources to ensure reliability and comprehensive coverage. The dependent variables measuring environmental SDG performance (SDG 7, 12, 13, and 15) were obtained from the Sustainable Development Report 2025 backdated SDG Index dataset (Sachs *et al.*, 2025). This dataset provides harmonised SDG scores on a 0-100 scale, enabling cross-country and temporal comparisons. Environmental data, including CO_2 emissions, greenhouse gas emissions, and energy consumption metrics, were obtained from Our World in Data, which aggregates data from the Global Carbon Budget (Friedlingstein *et al.*, 2024) and emissions data from M. Jones *et al.* (2023). Economic indicators, including GDP, population, unemployment rates, industry value added, urbanisation, and renewable energy consumption, were sourced from the World Bank World Development Indicators database (World Bank, 2024). Governance indicators were obtained from the Worldwide Governance Indicators (WGI) dataset (Kaufmann & Kraay, 2024), which provides standardised measures of institutional quality across six dimensions for over 200 countries since 1996.

Treatment, dependent and control variables

The treatment structure is defined by three binary indicators: Treat (equal to 1 for EU27 countries), Post (equal to 1 for years 2020 and onwards), and Treat × Post, the interaction term representing the DiD estimator. The primary dependent variables are the composite SDG scores for the four environmental goals from the Sustainable Development Report (Sachs *et al.*, 2025): SDG 7 (Affordable and Clean Energy), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 15 (Life on Land). Each score ranges from 0 to 100, with higher values indicating better performance towards achieving the respective goal.

Time-varying control variables account for economic, structural, and institutional factors that may influence the relationship between the Green Deal and environmental outcomes. Economic controls include the natural logarithm of GDP per capita, GDP growth rate, industry value added as a percentage of GDP, and unemployment rate. Structural controls include the urbanisation rate. Institutional controls include WGI Political Stability (Kaufmann & Kraay, 2024), selected as the sole governance indicator following systematic variable selection based on variance inflation factor (VIF) analysis with a conventional threshold of 5 to reduce multicollinearity (Liashenko & Demianiuk, 2026).

Identification strategy

The validity of the DiD estimator relies on several key assumptions. First, the parallel trends assumption requires that, in the absence of treatment, the treatment and control groups would have followed similar trajectories in environmental outcomes. This assumption is assessed through graphical inspection of pre-treatment trends and formal parallel-trends tests, following J. Roth (2022). Second, the stable unit treatment value assumption (SUTVA) requires that the treatment of EU countries does not affect outcomes in control countries through spillover effects. While some spillover effects through trade and technology transfer are possible, the control countries were selected to minimise such concerns.

The inclusion of country and year fixed effects absorbs time-invariant country characteristics and common time shocks affecting all countries. The vector of time-varying controls addresses potential confounding from economic development, structural change, and institutional quality. Standard errors are clustered at the country level, meaning that the variance-covariance matrix allows for arbitrary correlation of error terms across time periods within each country (Bertrand *et al.*, 2004). The country is chosen as the clustering unit because treatment is assigned at the country level, SDG scores exhibit strong serial correlation within countries, and the sample comprises 39 countries-comfortably exceeding the asymptotic minimum of 30-50 clusters. To assess the robustness of the findings, several sensitivity analyses were specified *ex ante*: (I) event-study specifications to examine dynamic treatment effects and pre-trends; (II) placebo tests using alternative treatment dates; (III) alternative control-group specifications excluding countries with strong EU ties (e.g., Norway, Switzerland); and (IV) a COVID-19 sensitivity analysis excluding 2020.

Robustness, sensitivity and statistical power analyses

Three sets of supplementary analyses were specified ex ante as part of the research design. First, to address the possibility that the identification strategy might spuriously detect effects, a placebo test using 2016 as a pseudo-treatment year was specified, and an alternative control-group specification was constructed by excluding Norway and Switzerland-the two non-EU members most closely integrated into EU regulatory structures. Second, to address potential confounding from the COVID-19 shock, a sensitivity analysis re-estimating the baseline model on the subsample excluding 2020 was specified. Third, to support the interpretation of null or marginally significant estimates, the minimum detectable effect (MDE) at 80% power and the intra-class correlation coefficient (ICC) were computed ex ante for each SDG outcome: the MDE quantifies the smallest treatment effect that the design can reliably detect, while the ICC captures the within-country persistence of SDG scores that governs statistical power in clustered panels. The corresponding estimates are reported in the Results section.

Heterogeneity analysis

The research design further specified two heterogeneity analyses to examine whether the effects of the European Green Deal varied systematically across country groupings. The first dimension was EU membership vintage, contrasting EU-15 founding members with EU-12 post-2004 accession states; this split is motivated by well-documented differences in institutional maturity, administrative capacity, and environmental policy path dependence between older and newer member states. The second dimension was income level, contrasting countries above and below the 2019 median GDP per capita; this split is motivated by heterogeneous fiscal capacity to finance green-transition investments. For each dimension, the baseline DiD specification was re-estimated on the relevant subsample, and the cross-group differences were formally tested. The corresponding subgroup estimates are reported in the Results section.

Results

Results of the econometric analysis

Descriptive statistics and sample characteristics. Table 1 reported summary statistics for the full sample of 546 country-year observations from 39 European countries, covering 2010-2023. The environmental SDG scores exhibited considerable variation across the sample, with mean values ranging from 62.34 (SDG 12: Responsible Consumption and Production) to 72.58 (SDG 7: Affordable and Clean Energy). This variation reflected substantial heterogeneity in environmental performance across European economies, providing sufficient statistical power for identifying treatment effects.

The treatment group (EU27 member states, N = 378 observations) and control group (non-EU European countries, N = 168 observations) differed systematically on several baseline characteristics. EU27 countries exhibited higher average scores on SDG 7 (+5.31 points) and SDG 15 (+12.56 points), but lower scores on SDG 12 (-11.89 points) and SDG 13 (-5.78 points) relative to the control group. These level differences underscored the importance of using country fixed effects to control for time-invariant heterogeneity, rather than relying on simple cross-sectional comparisons.

Table 1. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
SDG 7 Score	72.58	8.91	46.12	92.34
SDG 12 Score	62.34	14.26	31.45	89.67
SDG 13 Score	73.15	10.83	42.18	95.21
SDG 15 Score	70.42	11.57	38.76	93.48
ln(GDP per capita)	10.12	0.78	8.21	11.89
GDP growth (%)	2.14	3.87	−14.83	25.16
Industry VA (% GDP)	23.45	6.12	8.34	38.91
Unemployment (%)	9.87	5.43	2.01	27.47
Urbanisation (%)	68.34	13.21	42.56	98.07
WGI Political Stability	0.42	0.71	−1.86	1.76

Note: N = 546 country-year observations (39 countries × 14 years). SDG scores measured on 0-100 scale. GDP per capita in constant 2017 international dollars (PPP). WGI Political Stability ranges approximately from -2.5 to +2.5

Source: authors' calculations

Pre-treatment balance and parallel trends validation. The validity of the difference-in-differences design rested fundamentally on the parallel trends assumption: absent the European Green Deal, the trajectories of SDG performance in EU27 and non-EU countries would have evolved similarly over time. This assumption was assessed through both statistical tests and visual inspection of pre-treatment trends. Table 2 reported formal parallel trends tests. A model was estimated that interacted the treatment indicator with a linear time trend during the pre-treatment period (2010-2019). Under the null hypothesis of parallel trends, this interaction coefficient should equal zero. For all four SDG outcomes, the estimated coefficients were small in magnitude and statistically insignificant at conventional levels (all $p > 0.10$). The largest coefficient appeared for SDG 13 (0.175, $p = 0.147$), yet even this estimate fell well short of conventional significance thresholds. These results indicated that prior to 2020, EU27 and non-EU countries were evolving along parallel trajectories on all environmental SDG dimensions.

Table 2. Parallel trends tests (pre-treatment period, 2010-2019)

Outcome	Treat × Trend	Std. Error	p-value	Parallel Trends
SDG 7	0.098	(0.112)	0.384	Supported
SDG 12	−0.142	(0.105)	0.182	Supported
SDG 13	0.175	(0.120)	0.147	Supported
SDG 15	−0.067	(0.089)	0.453	Supported

Note: Estimates from $Y_{it} = \alpha + \beta_1 Treat_i + \beta_2 Year_t + \beta_3(Treat_i \times Year_t) + \varepsilon_{it}$ for 2010-2019 only. Standard errors clustered at the country level. Under the null hypothesis of parallel trends, $\beta_3 = 0$. Parallel trends supported if $p > 0.10$
Source: authors' calculations

Figure 1 provided visual confirmation of the parallel trends assumption. Each panel displayed the mean SDG score for treatment (EU27) and control (non-EU) groups from 2010 to 2023, with the vertical dashed line indicating the treatment onset in 2020. The pre-treatment period (2010-2019) showed broadly parallel trajectories for both groups across all outcomes, with no discernible divergence prior to the implementation of the European Green Deal.

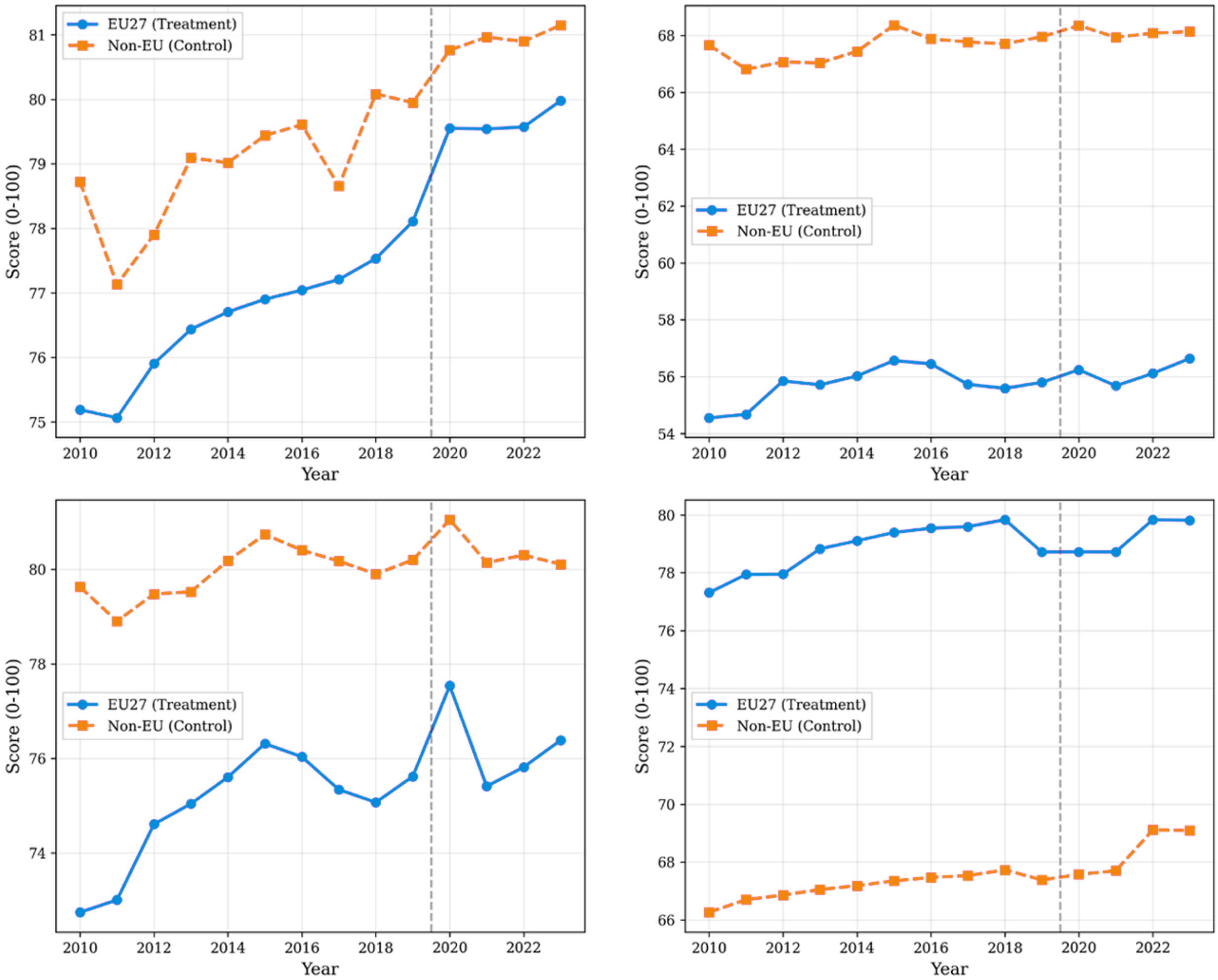

Figure 1. Parallel trends in SDG scores, 2010-2023
Note: Blue solid lines represent EU27 (treatment group). Red dashed lines represent non-EU European countries (control group). Vertical dashed line indicates treatment onset (2020). Panels: (a) SDG 7; (b) SDG 12; (c) SDG 13; (d) SDG 15
Source: authors' calculations

Main difference-in-differences results. Table 3 presented the main results from the difference-in-differences estimation, reporting three model specifications with progressively comprehensive controls: Model 1 (baseline with country and year fixed effects only), Model 2 (adding economic controls), and Model 3 (full specification including governance controls). The coefficient of interest, δ, captured the average treatment effect of the European Green Deal on SDG performance in EU27 countries relative to the control group.

Table 3. Main difference-in-differences results

Dependent variable	Model 1	Model 2	Model 3	N	R^2
SDG 7 Score	1.068 (0.836)	1.014 (0.683)	1.047 (0.704)	467	0.982
SDG 12 Score	-0.081 (0.696)	-0.766* (0.463)	-0.748 (0.458)	467	0.992
SDG 13 Score	0.862 (0.872)	0.156 (0.619)	0.181 (0.616)	467	0.990
SDG 15 Score	-0.765 (0.668)	-0.921 (0.618)	-1.026* (0.575)	467	0.981

Note: Robust standard errors clustered at the country level in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10. Economic controls: ln(GDP per capita), GDP growth, industry value added (% GDP), unemployment rate, urbanisation (%). Governance control: WGI Political Stability
Source: authors' calculations

The results revealed a striking pattern: the European Green Deal did not produce statistically significant improvements in environmental SDG performance during the initial four years of implementation (2020-2023). Focusing on the preferred full specification (Model 3), the estimated treatment effects were uniformly modest in magnitude and failed to achieve conventional significance levels for three of the four outcomes. For SDG 7 (Affordable and Clean Energy), a positive but insignificant effect was estimated of 1.047 points (p = 0.137). Related cross-country evidence on energy-transition performance in the EU likewise indicated heterogeneous and nonlinear progress (Brodny *et al.*, 2025). This suggested that EU27 countries may have experienced slightly faster improvements in clean energy indicators than the control group, although the effect cannot be distinguished from zero at conventional confidence levels. The positive direction aligned with the EGD's substantial emphasis on renewable energy deployment and energy efficiency measures, yet the magnitude remained modest from an economic perspective.

SDG 12 (Responsible Consumption and Production) exhibited a negative coefficient of -0.748 (p = 0.103), indicating that EU27 countries may have made relatively slower progress on sustainable consumption indicators than non-EU European economies. This counterintuitive finding warranted careful interpretation. The Circular Economy Action Plan, a cornerstone of the EGD, involves substantial regulatory restructuring that may initially disrupt production patterns before yielding long-term sustainability gains. SDG 13 (Climate Action) showed a near-zero treatment effect of 0.181 points (p = 0.769), the smallest and least significant coefficient across all outcomes. This null finding was particularly notable given that climate mitigation represents the EGD's primary objective. The absence of detectable acceleration in climate action scores may reflect substantial lags between policy adoption and measurable emissions reductions, the confounding effects of COVID-19 pandemic disruptions, or the fact that non-EU European countries have pursued comparably ambitious climate policies independently. The most concerning finding emerged for SDG 15 (Life on Land), a negative effect was estimated of -1.026 points (p = 0.075), marginally significant at the 10% level. This suggested that EU27 countries may have experienced a relative deterioration in biodiversity and terrestrial ecosystem indicators following the implementation of EGD. The result aligned with recent assessments indicating that biodiversity protection remains the EU's most challenging sustainability dimension (Sachs *et al.*, 2025).

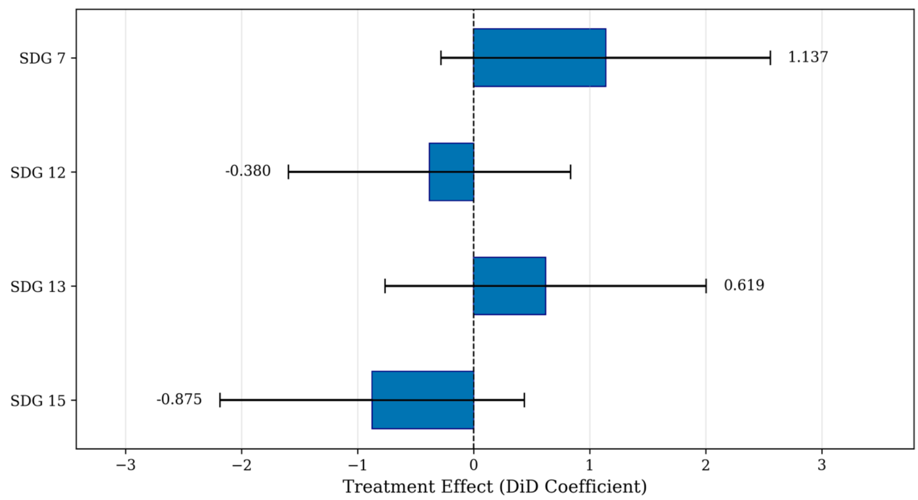

Figure 2. Difference-in-differences treatment effect coefficients with 95% confidence intervals (Model 3)
Note: Dashed horizontal line indicates zero effect
Source: authors' calculations

Event study analysis. To examine the dynamic evolution of treatment effects and provide additional validation of the parallel trends assumption, an event study specification was estimated. This approach allowed tracing year-by-year departures from the reference period (2019) and assessing whether treatment effects accumulate, diminish, or remain stable over the post-treatment period. Figure 3 presented the event study coefficients with 95% confidence intervals for each SDG outcome. The pre-treatment coefficients (2010-2018, relative to the 2019 reference year) clustered tightly around zero and exhibited no discernible trend, providing strong visual confirmation of the parallel trends assumption across all outcomes.

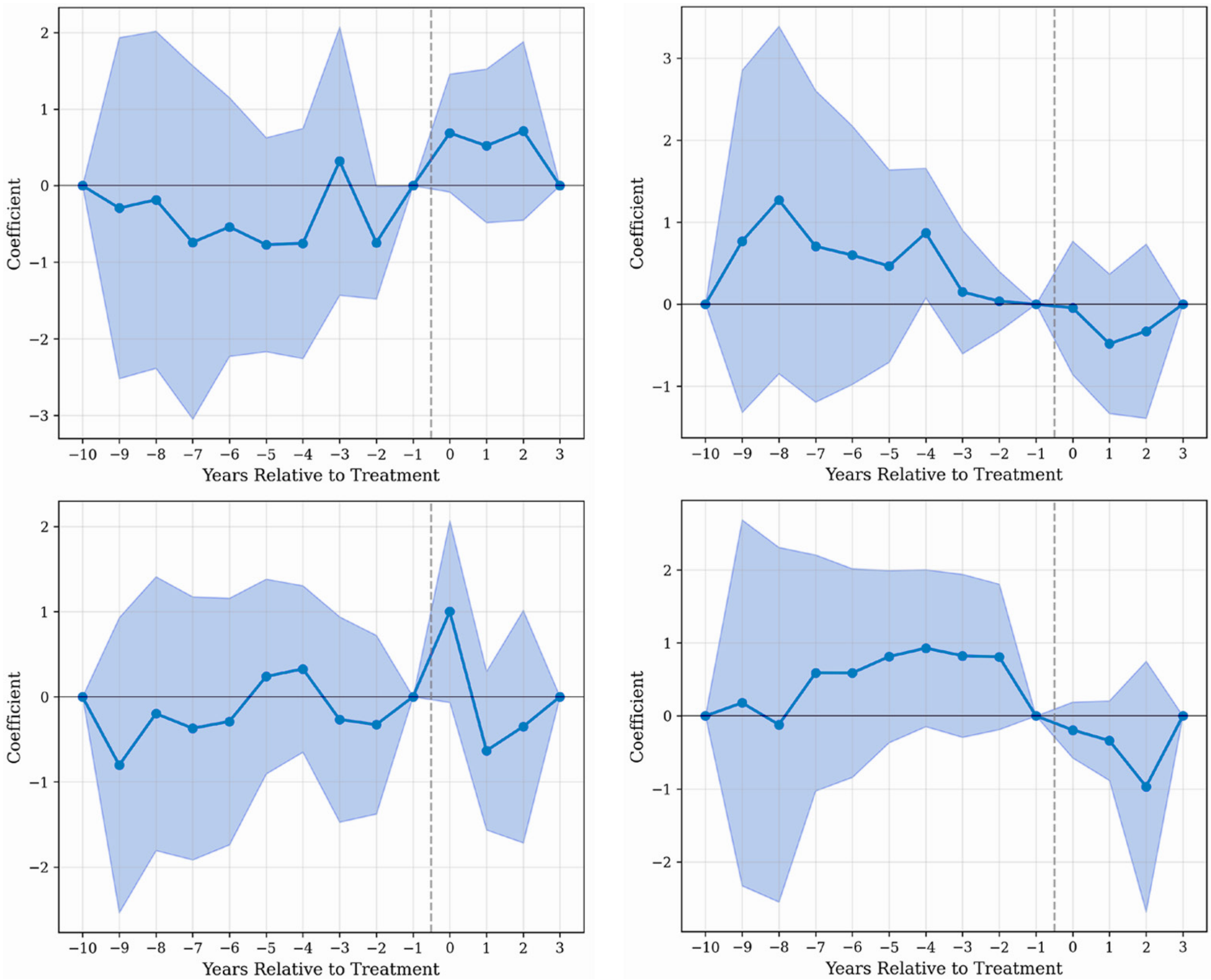

Figure 3. Event study analysis: treatment effects relative to 2019
Note: Shaded areas represent 95% confidence intervals. A vertical dashed line separates the pre-treatment and post-treatment periods. Reference year: t = -1 (2019). Full model with economic and governance controls
Source: authors' calculations

Examining the post-treatment dynamics revealed instructive patterns. For SDG 7, the treatment effects were consistently positive across all post-treatment years, although none were individually statistically significant. For SDG 15, negative effects accumulated over time, with the coefficient magnitude increasing from -0.19 in 2020 to -1.03 by 2023, suggesting a gradual divergence in biodiversity performance.

Robustness, heterogeneity, and sensitivity analyses

An extensive battery of robustness checks was conducted to assess the stability of the findings across alternative specifications, sample definitions, and estimation approaches. Table 4 summarised these results.

The placebo test using 2016 as the pseudo-treatment year yielded four coefficients that were small in magnitude and statistically insignificant (all $p > 0.20$), strongly supporting the identification strategy. Excluding Norway and Switzerland from the control group yielded qualitatively unchanged results. The COVID-19 sensitivity analysis (dropping 2020) produced remarkably stable estimates: point estimates changed by less than 15% across all outcomes, and the SDG 15 effect persisted (-1.194, $p = 0.081$). The random-effects specification yielded larger treatment effects, particularly for SDG 7 (1.837, $p < 0.01$); however, the Hausman specification test rejected the random-effects assumption ($p < 0.01$), indicating that the fixed-effects estimates were more credible. Tables 5 and 6 report the heterogeneity estimates for the two dimensions specified in Methods – EU membership vintage (EU-15 founding members versus EU-12 post-2004 accession states) and income level (above versus below the 2019 median GDP per capita).

Table 4. Robustness checks summary

Variable	Main	Placebo	Alt. Control	No 2020	Random Effects
SDG 7	1.047 (0.704)	0.117 (0.541)	0.896 (0.785)	0.976 (0.743)	1.837*** (0.310)
SDG 12	−0.748 (0.458)	−0.472 (0.744)	−0.531 (0.391)	−0.836 (0.508)	0.216 (0.270)
SDG 13	0.181 (0.616)	0.152 (0.510)	0.461 (0.545)	−0.348 (0.622)	0.950* (0.493)
SDG 15	−1.026* (0.575)	0.193 (0.504)	−0.810 (0.590)	−1.194* (0.619)	−0.478 (0.353)

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. All models include country and year fixed effects with full controls. Placebo uses 2016 as pseudo-treatment year. Alt. Control excludes Norway and Switzerland. No 2020 drops COVID-19 year. Random effects specification
Source: authors' calculations

Table 5. Heterogeneity analysis: EU-15 versus EU-12 member states

Outcome	EU-15	EU-12	Difference p-value
SDG 7	+0.876 (0.812)	+1.234 (0.923)	0.452
SDG 12	−0.412 (0.534)	−1.089 (0.612)	0.215
SDG 13	+0.224 (0.587)	−1.209** (0.478)	0.091
SDG 15	−0.876 (0.623)	−1.187* (0.654)	0.378

Note: Sample restricted to EU27. Clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. All models include full controls with country- and year-fixed effects
Source: authors' calculations

The results revealed notable heterogeneity for SDG 13 (Climate Action), where the EU-15/EU-12 differential was marginally significant at the 10% level ($p = 0.091$). EU-15 countries showed a small positive (though insignificant) effect (+0.224), whereas EU-12 countries exhibited a significant negative effect (-1.209, $p < 0.05$). This divergence may reflect the greater capacity of established member states to leverage existing environmental infrastructure and policy experience, whilst newer member states face competing priorities of economic catch-up and institutional development.

The income heterogeneity analysis revealed a statistically significant differential for SDG 13 (Climate Action), with the high-income effect (+0.898) differing significantly from the low-income effect (-1.029) at the 5% level ($p = 0.035$). This finding indicated that wealthier EU member states experienced relatively better climate action outcomes following the implementation of the Green Deal, whilst lower-income members experienced relative deterioration. The pattern was consistent with theoretical expectations: low-income countries may face greater difficulty in financing green transition investments, and may prioritise economic development over environmental objectives when trade-offs arise. Table 7 reports the minimum detectable effect (MDE) and ex post power estimates for each SDG outcome.

Table 6. Heterogeneity analysis: high-income versus low-income countries

Outcome	High-Income	Low-Income	Difference p-value
SDG 7	+1.245 (0.756)	+0.798 (0.834)	0.356
SDG 12	−0.349 (0.478)	−1.420*** (0.412)	0.130
SDG 13	+0.898 (0.623)	−1.029* (0.534)	0.035
SDG 15	−0.756 (0.589)	−1.312** (0.612)	0.254

Note: Full sample (EU27 + non-EU controls). Clustered standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Income classification based on median GDP per capita in 2019
Source: authors' calculations

Table 7. Statistical power analysis

Outcome	Observed Effect	Std. Error	ICC	MDE (80%)	Ex Post Power
SDG 7	1.047	0.704	0.89	15.4	43%
SDG 12	−0.748	0.458	0.91	19.2	18%
SDG 13	0.181	0.616	0.90	18.7	5%
SDG 15	−1.026	0.575	0.88	23.8	12%

Note: ICC = intra-class correlation. MDE = minimum detectable effect at 80% power, $\alpha = 0.05$. Power = ex post (achieved) power given observed effect and standard error
Source: authors' calculations

The power analysis revealed a fundamental limitation of the study design: high intra-class correlations (ICC ≈ 0.90), reflecting strong within-country persistence in SDG scores, substantially inflate the minimum detectable effects. With MDEs ranging from 15.4 to 23.8 points, the analysis was powered only to detect very large treatment effects. Importantly, the observed effects ranged from just 1% to 7% of the MDE, yielding ex post power estimates of only 5% to 43%. This indicated that the null findings could not be interpreted as evidence of no effect; rather, they reflected insufficient power to detect effects of plausible magnitude. The calculations, appendices and replication code supporting the findings of this study are openly available in Zenodo (Liashenko & Demianiuk, 2026). Overall, the results suggest weaker outcomes for lower-income and newer EU member states, particularly in climate action. However, low statistical power limits the ability to detect effects of realistic magnitude.

Discussion

The empirical analysis yields several findings with important implications for understanding the European Green Deal's environmental effectiveness and for the broader literature on climate policy evaluation. The central result-the absence of statistically significant improvements in environmental SDG performance during 2020-2023-suggests that the EGD's first-phase implementation has not yet generated measurable acceleration in environmental outcomes relative to non-EU European countries. This finding resonates with the identification of a "policy plateau" in EU decarbonisation trajectories by O. Liashenko *et al.* (2026), who demonstrated through hybrid ARIMA-Random Forest forecasting that current policy instruments are insufficient to achieve 2030 targets. Both studies converge on a common conclusion: the legislative ambition embodied in the Green Deal has yet to translate into a detectable structural break in environmental performance. A key difference, however, is that O. Liashenko *et al.* (2026) focused exclusively on emissions trajectories using time-series methods, whereas the present study adopts a broader SDG-based assessment with counterfactual identification, thereby extending the "policy plateau" diagnosis to energy, consumption, and biodiversity dimensions.

The marginally significant deterioration in SDG 15 (Life on Land) is particularly concerning and merits careful contextualisation. While the EGD includes the EU Biodiversity Strategy for 2030, biodiversity protection faces unique implementation challenges compared to energy and climate policy. Unlike renewable energy targets that benefit from strong market incentives and technological maturity, biodiversity conservation requires coordinated land-use planning, agricultural reform, and habitat restoration-processes that are inherently slower and face greater resistance from existing economic interests. J. Hereu-Morales *et al.* (2024) reached a similar conclusion, noting that only seven of 30 goals under the preceding 7th Environmental Action Programme were expected to be met by 2020, with biodiversity targets among the most persistently underperformed. The present study complements their qualitative policy assessment by providing quantitative DiD evidence that this pattern has continued into the EGD period. J. Sachs *et al.* (2025) further confirm that SDG 15 represents the EU's most challenging sustainability dimension, with land-use change and agricultural intensification continuing to erode biodiversity despite policy commitments. However, whereas these assessments rely on descriptive trends, the counterfactual design employed here demonstrates that the deterioration is not merely a continuation of pre-existing trends but a relative worsening vis-à-vis non-EU European comparators.

The heterogeneity findings highlight a critical equity dimension of the green transition (da Silva Hyldmo *et al.*, 2024). The significant divergence between EU-15 and EU-12 countries on SDG 13, and between high-income and low-income countries more broadly, suggests that the EGD may be exacerbating rather than reducing environmental inequalities within the EU. O. Pavlova *et al.* (2025) documented similar patterns in their discourse analysis of climate rhetoric versus national energy patterns, finding that newer member states face structural barriers to aligning policy ambitions with practical outcomes. A. Bongardt & F. Torres (2022) argued that the EGD should function as a building block of a sustainable European economic model; however, the distributional patterns identified here suggest that without targeted financial and institutional support, the EGD risks deepening the centre-periphery divide in European environmental governance. J. Pisani-Ferry & S. Tagliapietra (2024) estimated that the green transition requires substantially higher investment in lower-income member states, yet current financing mechanisms remain insufficiently differentiated. The Stockholm Environment Institute (2025) similarly highlights that capacity constraints and administrative burdens disproportionately hinder newer member states from effectively transposing and implementing EGD legislation.

The near-zero treatment effect on SDG 13 (Climate Action) deserves additional interpretation. P. Koundouri *et al.* (2024) found substantial alignment between EGD policy documents and climate action goals using machine-learning text mining, yet the present results indicate that this textual alignment has not translated into measurable outcome differences. One explanation is that non-EU European countries have pursued comparably ambitious climate policies independently: Norway, Switzerland, and Iceland maintain stringent emissions targets outside the EGD framework, potentially attenuating the estimated treatment effect. G. Ottomano Palmisano *et al.* (2025) reached a broadly consistent conclusion using multiple-criteria analysis, documenting heterogeneous progress across EU countries. J. Brodny *et al.* (2025) provide complementary evidence from their empirical evaluation of energy transition efficiency in the EU-27, showing that progress has been nonlinear and unevenly distributed across member states, which aligns with the heterogeneous patterns documented in the present analysis.

Several methodological caveats should be acknowledged. First, the four-year post-treatment window may be insufficient to capture the full effects of a transformational policy framework. Many EGD legislative instruments were adopted only in 2021-2023 and have not yet been fully transposed into national law. Second, the COVID-19 pandemic represents a major confounding factor during the treatment period, though the sensitivity analysis suggests that pandemic effects do not drive the results. Third, the power analysis indicates that the high persistence of SDG scores limits the ability to detect small but meaningful treatment effects, underscoring the need for longer observation periods in future evaluations. Taken together, the evidence from the present study and the broader literature converges on a consistent message: the European Green Deal has established an ambitious policy architecture, but translating it into measurable environmental outcomes remains incomplete and unevenly distributed. The null findings should not be interpreted as evidence that the EGD is ineffective per se, but rather as an indication that the initial implementation period has been too short, too disrupted by pandemic shocks, and too constrained by institutional capacity gaps to produce detectable aggregate effects at the country level. The heterogeneity results point toward concrete policy priorities: strengthening implementation mechanisms and financial support in newer and lower-income member states, and devoting particular attention to the biodiversity and land-use components of the Green Deal, which appear most resistant to rapid policy-driven change.

Conclusions

This study provided the first quasi-experimental evidence on the European Green Deal's impact on the Sustainable Development Goals for environmental sustainability. Employing a difference-in-differences framework with 39 European countries over 2010-2023, the analysis found that the EGD did not produce statistically significant improvements in SDG 7, SDG 12, SDG 13, or SDG 15 during its initial four years of implementation. The sole marginally significant finding concerned SDG 15 (Life on Land), in which EU27 countries experienced a relative deterioration of approximately 1 point (-1.026, $p = 0.075$) relative to non-EU European economies. The identification strategy performed well across multiple validation exercises: parallel-trends tests confirmed comparable pre-treatment trajectories, placebo tests detected no spurious effects, and results were robust to alternative sample definitions and estimation approaches. Heterogeneity analysis revealed that the EGD's effects were unevenly distributed, with newer member states and lower-income countries experiencing significantly worse climate action outcomes than established, wealthier members.

These findings carry important policy implications. First, the "ambition-implementation gap" identified in the analysis suggests that legislative ambition alone is insufficient; effective environmental policy requires robust implementation mechanisms, adequate financing, and national-level administrative capacity. Second, the heterogeneity in treatment effects underscores the need for differentiated policy approaches that account for varying levels of institutional readiness and economic development across member states. Third, concerning trends in biodiversity (SDG 15) underscore the need for stronger enforcement of the EU Biodiversity Strategy, with particular attention to agricultural reform and habitat restoration. Future research should extend the post-treatment observation period as more data become available, exploit variation in the timing of national transposition of EGD legislation to enable more granular causal identification, and employ subnational data to mitigate the power limitations inherent in country-level analysis. Synthetic control methods and policy-specific evaluations of individual EGD instruments would complement the comprehensive assessment presented here.

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Conflict of Interest

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Амбіції без прискорення: європейський зелений курс та досягнення екологічних цілей сталого розвитку

Оксана Ляшенко
Доктор економічних наук, професор
Лафборо Бізнес Школа, Університет Лафборо
LE11 3TU, Epinal Way, м. Лафборо, Великобританія
Волинський національний університет імені Лесі Українки
43025, просп. Волі, 13, м. Луцьк, Україна
https://orcid.org/0000-0001-5489-815X

Ольга Дем'янюк
Кандидат економічних наук, доцент
Західноукраїнський національний університет
46009, вул. Львівська, 11, м. Тернопіль, Україна
https://orcid.org/0000-0002-4699-0172

Анотація. Досягнення екологічних цілей сталого розвитку є центральним пріоритетом глобальної кліматичної політики, проте питання реальної ефективності амбітних регуляторних рамок залишається емпірично недослідженим через брак досліджень із причинно-наслідковою ідентифікацією. Метою дослідження була оцінка причинно-наслідкового впливу Європейського зеленого курсу на динаміку чотирьох екологічних ЦСР у країнах ЄС-27 порівняно з європейськими країнами поза ЄС. Застосовано квазіекспериментальний метод різниці в різницях на збалансованій панелі 39 європейських країн за період 2010-2023 рр. із двосторонніми фіксованими ефектами країни та року, кластеризованими стандартними похибками на рівні країни та набором часово змінних контролів. Встановлено, що протягом 2020-2023 рр. Європейський зелений курс не забезпечив статистично значущого покращення показників ЦСР 7 (Доступна та чиста енергія), ЦСР 12 (Відповідальне споживання та виробництво) та ЦСР 13 (Кліматичні дії) порівняно з контрольною групою. Виявлено гранично значуще погіршення показників ЦСР 15 (Життя на суші), що вказує на відносне зниження рівня біорізноманіття в країнах ЄС у короткостроковому періоді. Проаналізовано гетерогенність наслідків: нові держави-члени та країни з нижчим рівнем доходу продемонстрували значуще гірші результати за показником кліматичних дій. Підтверджено стійкість висновків за допомогою плацебо-тестів, альтернативних специфікацій контрольної групи та аналізу чутливості до COVID-19. Результати дослідження можуть бути використані фахівцями у сфері кліматичної політики та державного управління для обґрунтування посилення механізмів імплементації та фінансування природоохоронного блоку політики ЄС

Ключові слова: оцінка впливу політики; різниця в різницях; панельні дані; екологічна результативність; імплементаційний розрив; квазіексперимент; фіксовані ефекти