

SUSTAINABILITY IN HIGHER EDUCATION: PARTICIPATION IN INTERNATIONAL RANKINGS AND THE RELATIONSHIP BETWEEN ESG AND FINANCIAL PERFORMANCE OF UNIVERSITIES

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SUMMARY

The integration of sustainability principles into higher education raises questions about the relationship between universities' environmental, social, and governance (ESG) performance and financial performance. This study examines participation in the QS Sustainability rankings from 2023 to 2026 across six world regions and assesses the ESG–financial performance relationship among Eastern European universities. Regional participation was analyzed using growth indices. The relationship was tested using Kernel Canonical Correlation Analysis (Kernel CCA), permutation tests, bootstrap confidence intervals, five-fold cross-validation, the Hilbert–Schmidt Independence Criterion (HSIC), and distance correlation. ESG performance was represented by Environmental Impact, Social Impact, and Governance; financial performance by Financial Efficiency Ratio, Solvency, and Assets Turnover. Participation increased substantially in every region, although growth varied considerably. Kernel CCA identified a statistically significant, moderately strong multivariate association in both the cleaned ($N = 46$) and full ($N = 52$) Eastern European samples, supported by permutation and bootstrap analyses. However, HSIC and distance correlation reached conventional significance only in the cleaned sample after correction for multiple testing, while cross-validation showed greater instability in the full sample. Exploratory bivariate results suggested somewhat more consistent associations for environmental and social indicators than for governance, but the block-level analysis does not establish their separate contributions. The findings provide early evidence of an ESG–financial performance association in Eastern European universities and a framework for examining it. The association should not be interpreted as causal or necessarily nonlinear, and its robustness depends on sample composition.

Keywords: *ESG assessment, Kernel Canonical Correlation Analysis, multivariate dependence, non-linear modelling, QS Sustainability Rankings*

INTRODUCTION

Under current conditions of profound social, economic, and environmental transformation, the mission of universities has expanded beyond satisfying the interests of specific stakeholder categories (students, employers, public authorities, the economic environment), as the reconfiguration of society's value system increasingly positions higher education institutions as agents of change, called upon to contribute to broad–impact public interest objectives relevant both to society as a whole and to the global community. Within this context, sustainability has acquired the status of a guiding principle of university development—simultaneously a mission, a strategic objective, and a reference framework for educational, research, knowledge transfer, and community–engagement activities—reflecting universities' assumption of an active role in institutionalizing the notion that promoting sustainability constitutes the “right job to do” (De Villiers et al., 2025); according to the same authors, universities that themselves prioritize sustainability are more likely to be effective in promoting it on a broad scale.

The inclusion of sustainability–related indicators in global university rankings is further justified by the role assigned to education and research in Principles 19 and 20 of the Declaration of the United Nations Conference on the Human Environment, adopted in Stockholm, 5–16 June 1972 (United Nations, 1972), which task environmental education with shaping informed opinion and responsible behaviour toward protecting the environment, and research with sustaining the free flow of scientific information and the transfer of environmental technologies to developing countries.

On this basis, the literature identifies three key

responsibilities of universities as agents in the operationalization of the 2030 Agenda: educating the younger generation and adults in the spirit of sustainability; organizing research based on sustainable development principles; and adopting sustainable behaviour in the management of their own resources.

Regarding universities' role in educating human resources in the spirit of sustainability, the specialized literature reveals broad consensus on their responsibility to prepare future leaders, entrepreneurs, and decision–makers capable of responding to the challenges of sustainable development (Giannetti et al., 2025). In this respect, universities are seen as knowledge providers and agents of social change (Hamdan et al., 2024; Schimperna et al., 2025), tasked with shaping competencies, attitudes, and behaviours oriented toward adopting more sustainable ways of living and producing. Researchers emphasize that integrating sustainable development principles into study programs and adapting university curricula are essential conditions for fulfilling this mission (Burmman et al., 2021; Abo-Khalil, 2024; Hamdan et al., 2024), requiring a move beyond strictly disciplinary approaches toward interdisciplinary learning, systems thinking, and competencies for solving the complex problems of contemporary society.

The transformation of the educational process must, by implication, be supported by intensified research activities and the transfer of knowledge and solutions on environmental issues and sustainable development (Burmman et al., 2021), as well as by implementing extensive research initiatives (Abo-Khalil, 2024). A university can be considered genuinely sustainable only to the extent that it succeeds in coherently integrating

sustainability principles into both its research and teaching activities (Fiorani & Di Gerio, 2022).

The third dimension of universities' role concerns the adoption of sustainable behaviour in the management of their own resources and institutional processes. Munaro & John (2025) argue that higher education institutions must exercise leadership and serve as examples of good practice in adopting sustainability principles. Buckner & Zhang (2026), in turn, define sustainability as an internal organizing principle that shapes activities and practices at the university campus level. This approach entails integrating sustainability into the university's operational management through the efficient use of energy and material resources, carbon footprint reduction, responsible management of water and energy consumption, the implementation of green procurement policies, and the promotion of an organizational culture oriented toward social and environmental responsibility (Hamdan et al., 2024). The university thus represents not merely a space for producing and transmitting knowledge on sustainable development, but also a living lab in which sustainability principles are tested, applied, and demonstrated through the institution's own practices.

Beyond the role they play in implementing sustainable development principles, universities are increasingly motivated to integrate sustainability into their institutional strategies and practices owing to the benefits this can generate for their own organizational development. The adoption and promotion of sustainable practices contribute, first, to enhancing the university's image and reputation in relation to its principal stakeholder categories—students, faculty, research partners, employers, public authorities, and the community at large (Dabija et al., 2017; Forleo & Palmieri, 2017; Kobylińska et al., 2024). Universities perceived as responsible institutions engaged in addressing societal challenges tend to enjoy higher levels of trust and social legitimacy (Porancea-Răulea, 2022; Castro-Gómez et al., 2024), with the reputation associated with sustainability performance capable of constituting a source of competitive advantage (Atici et al., 2021; Kassar & Al-Saqal, 2022). Integrating sustainable development principles into teaching, research, and institutional management processes increases the university's attractiveness to students—including through an enhanced capacity to attract students from beyond the local geographic area—facilitates the attraction and retention of high-performing academic staff, creates opportunities to expand national and international collaborations, and facilitates access to projects and funding sources oriented toward sustainable development objectives. For smaller universities or those in less favorable socioeconomic contexts, intensifying inter-institutional partnerships not only support sustainability implementation but also provides access to resources, knowledge, and practices that would otherwise be unavailable, with positive effects on overall organizational performance. Sustainability thus enables higher education institutions

to differentiate their institutional offering, expand their beneficiary base, and improve their positioning in the education market (Rotondo et al., 2025).

In the specialized literature, research on the impact of sustainability practices and sustainability reporting on financial performance is more abundant in the economic domain and the corporate environment, where the relationship between these dimensions has been extensively investigated, with most studies pointing to a positive association (Ershadi et al., 2024; Almohanna & Alhussayen, 2024; Saeed et al., 2025; Lehenchuk et al., 2023), though not in the absence of contrary or nuanced evidence. In the case of higher education institutions, the financial effects of sustainability have been investigated considerably less extensively, and the available results converge, unlike the corporate literature, toward a substantially less homogeneous picture. Recent empirical studies confirm, on the contrary, the complex, context-dependent, and in certain respects counterintuitive nature of this relationship: Rotondo et al. (2025) show that a sustainability orientation can negatively affect revenues and operating costs in generalist public universities, particularly in regions with less favorable socioeconomic conditions, with positive effects being more pronounced exclusively in specialized and larger institutions, which benefit from economies of scale and scope in implementing sustainability initiatives. This heterogeneity of results suggests that, unlike the corporate sector, the relationship between sustainability and university financial performance cannot be presumed a priori to be positive or linear, being conditioned by a multitude of structural and contextual factors—institutional size, degree of specialization, the socioeconomic position of the region, and, possibly, the still-incipient stage of integration of sustainable principles into universities' financial practices. Although the implementation of sustainable development principles may, in principle, contribute to strengthening institutional image and increasing universities' attractiveness to students, partners, and funders (Miotto et al., 2026), the translation of these reputational benefits into measurable financial outcomes remains, based on the available literature, an uncertain and empirically under-documented process—which is why the direction and intensity of the ESG-financial performance relationship in the higher education sector constitute, rather than a confirmed hypothesis, an open research question.

In this context, participation in international sustainability rankings serves as a relevant benchmark for assessing how far universities integrate sustainable development principles into their education, research, and institutional governance. However, this participation is not, by itself, a direct indicator of associated financial performance. One of the most representative evaluation instruments is the QS Sustainability Rankings, which assesses university performance in terms of impact across the Environmental, Social, and Governance (ESG) dimensions. Analysis of university participation in this ranking thus offers a relevant picture of the

degree to which sustainable development objectives are embraced and implemented (Miotto et al., 2026). It allows identification of current trends in universities' orientation toward sustainability, independent of whether these efforts translate into immediate financial outcomes.

Against this background, the present study addresses two interconnected research questions. First, how has university participation in the QS Sustainability Rankings evolved since the introduction of this assessment framework? Second, is ESG performance

associated with the financial performance of universities participating in this system of sustainability evaluation? The first question establishes the broader context of sustainability institutionalization within higher education. In contrast, the second examines whether sustainability performance, as captured through ESG indicators, is associated with institutional financial outcomes. Together, these analyses provide both a contextual and an empirical perspective on the emerging relationship between sustainability assessment and university performance.

THEORETICAL FRAMEWORK

The theoretical foundations of this research rest on three complementary theories, each underpinning a distinct component of the empirical research: signalling theory supports the analysis of participation dynamics in international rankings, while stakeholder theory and legitimacy theory jointly underpin the test of the ESG–financial performance relationship.

Signalling theory (Spence, 1973) interprets voluntary university participation in a globally recognised ranking as a large-scale signalling strategy, through which institutions publicize commendable environmental, social, and governance practices within an increasingly marketised educational offering, enhancing their institutional image, attracting international partnerships and funding, and creating opportunities for academic exchange. This lens is particularly suited to explaining the accelerated growth in participation observed in regions with comparatively limited prior engagement in sustainability initiatives, as documented through the regional growth indexes.

Stakeholder theory (Freeman, 2010) accounts for the expansion of the university mission toward broader groups of beneficiaries, requiring alignment with the interests of society as a whole rather than solely of students, employers, and local authorities. Building on this premise, universities adopt sustainable development practices as an institutional response to the expectations of multiple, heterogeneous stakeholder groups—which justifies treating environmental impact, social impact, and institutional governance as distinct dimensions in the empirical component of the study,

each corresponding to a differentiated stakeholder domain (the natural environment, the social community, and internal governance mechanisms, respectively). The theory does not presuppose that these three domains contribute equally to any given outcome; rather, it allows for differentiated weight across domains depending on the specific relationship under investigation, a premise consistent with the differentiated empirical contribution of the ESG components identified later in the study.

Legitimacy theory (Suchman, 1995; Dowling & Pfeffer, 1975) explains why organizations seek congruence between the social values implied by their activities and the norms of accepted behaviour within the broader social systems of which they are part, and why disparities between these value systems threaten organizational legitimacy. Applied to universities, it explains why institutions must pursue sustainability—related legitimacy regardless of financial efficiency, even when this involves additional costs: conformity to emerging sustainability norms is intended to generate trust and social legitimacy among stakeholders, despite the fact that financial allocations—particularly in the environmental and social domains—may not translate into proportionate short-term financial gains. This theoretical strand is directly relevant to the second empirical component of the study, providing an explanatory framework for a systemic association between ESG performance and financial performance whose direction is not presumed a priori, and motivates the case for future research conducted over a longer time horizon.

DATA AND METHODS

The research combines two complementary components. The first is descriptive, examining university participation dynamics in the QS World University Rankings: Sustainability (2023–2026) across six regions.

The second component is inferential and investigates the relationship between ESG performance (Environmental, Social, Governance) and three financial indicators: Financial Efficiency Ratio (R/C), Solvency ((A–L)/A), and Assets Turnover (R/A), for Eastern European

universities included in the QS Sustainability 2025 edition. Although published in 2025, the underlying ESG scores reflect institutional activity from approximately 2023 to early 2024, which is reasonably proximate to the 2024 fiscal year covered by the financial data.

Of the 79 universities in the reference population, we retained 52, for which complete 2024 financial reports were publicly available; the remaining 27 institutions were excluded solely due to data unavailability. We

calculated financial indicators from revenues, expenses, assets, and liabilities collected manually from annual financial statements. Because reporting formats differed across the seven countries in the sample, we harmonized financial data through a uniform aggregation procedure adapted to each national reporting system. Despite this harmonization, differences in accounting frameworks, asset valuation practices, funding models, and institutional profiles may affect comparability. To mitigate these issues, the analysis relies on relative rather than absolute financial indicators, which are less sensitive to differences in institutional scale, reporting currency, and accounting structure. Nevertheless, some degree of cross-country and cross-institutional heterogeneity inevitably remains.

The analytical objective was to examine whether a multivariate relationship exists between two multidimensional variable blocks: ESG performance and financial performance. Given the nature of the research question and the possibility that the relationship between the two blocks may be nonlinear, Kernel Canonical Correlation Analysis (Kernel CCA) was selected as the primary analytical method. Kernel CCA extends classical canonical correlation analysis to a reproducing kernel Hilbert space and is specifically designed to detect nonlinear associations between multidimensional sets of variables without requiring assumptions of multivariate normality or linear dependence.

Preliminary analyses were conducted to characterize the statistical properties of the data and to assess the suitability of alternative linear approaches. These procedures included descriptive statistics, Shapiro-Wilk normality tests, Pearson and Spearman correlation coefficients, and variance inflation factors (VIF). The

results indicated departures from univariate normality for several variables and generally weak pairwise linear correlations, suggesting that any potential association between ESG and financial performance may not be adequately captured by conventional bivariate or linear techniques. Before model estimation, variables were standardized using z-scores separately for each sample and variable block. A Gaussian radial basis function (RBF) kernel was applied to both the ESG and financial-performance blocks. Kernel bandwidth parameters (γ) were calibrated automatically from the data, while the regularization parameter was fixed at $\kappa = 1.0$. Outliers were identified using the Minimum Covariance Determinant (MCD) procedure and robust Mahalanobis distances. Sensitivity analyses were performed across alternative values of the MCD support fraction parameter, and support fraction = 0.85 was retained for the main analysis. Results are therefore reported for both the complete sample ($N = 52$) and a cleaned sample ($N = 46$), allowing an assessment of the robustness of the findings to outlier treatment.

Statistical significance was assessed through permutation testing, while bootstrap confidence intervals were used to evaluate estimation uncertainty. Model stability was examined through five-fold cross-validation. Two additional nonparametric dependence measures, the Hilbert-Schmidt Independence Criterion (HSIC) and distance correlation (dCor), were employed as robustness checks. Because multiple tests were conducted for the same research hypothesis, p-values were adjusted using the Holm and Benjamini-Hochberg procedures.

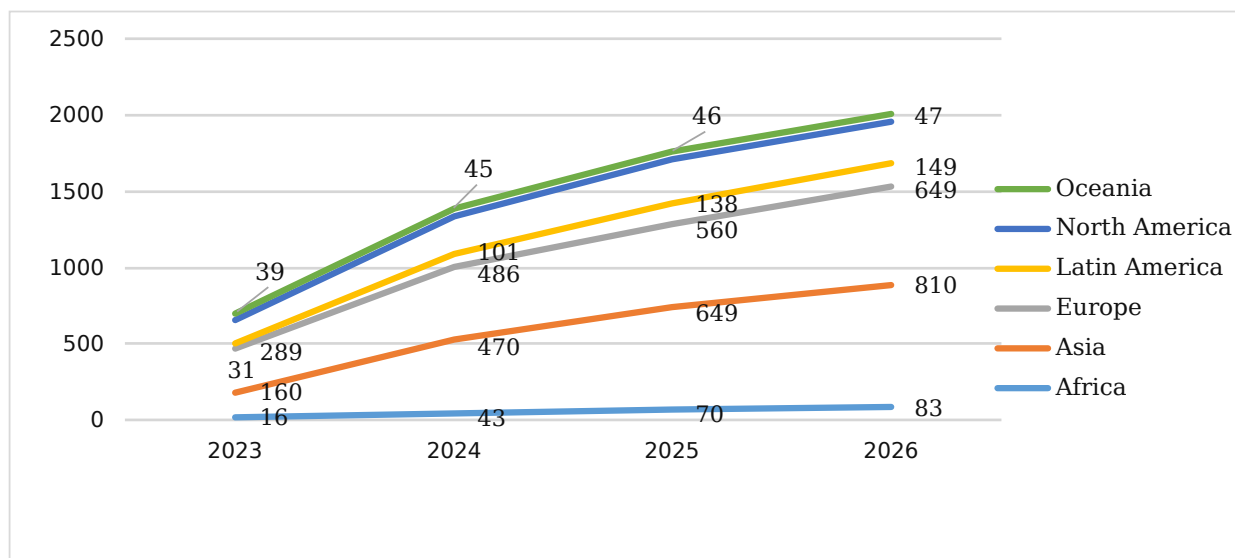
The analysis was designed to identify multivariate statistical dependence rather than causal effects.

PARTICIPATION OF HIGHER EDUCATION INSTITUTIONS IN INTERNATIONAL SUSTAINABILITY RANKINGS

Launched in 2022 as a pilot edition, the QS World University Rankings: Sustainability included, from its first edition, 700 higher education institutions and evaluated their performance through two main categories of indicators: Environmental Impact and Social Impact. Starting with the 2023 edition, the ranking methodology expanded by introducing the Governance dimension, which completed the sustainability assessment

framework and provided a more comprehensive approach to how higher education institutions contribute to sustainable development (QS World University Rankings, 2023). A retrospective analysis of the number of participating universities reveals growing interest in the QS Sustainability Ranking, supported by a high growth rate in the number of participating universities over 2023–2026 (Figure 1).

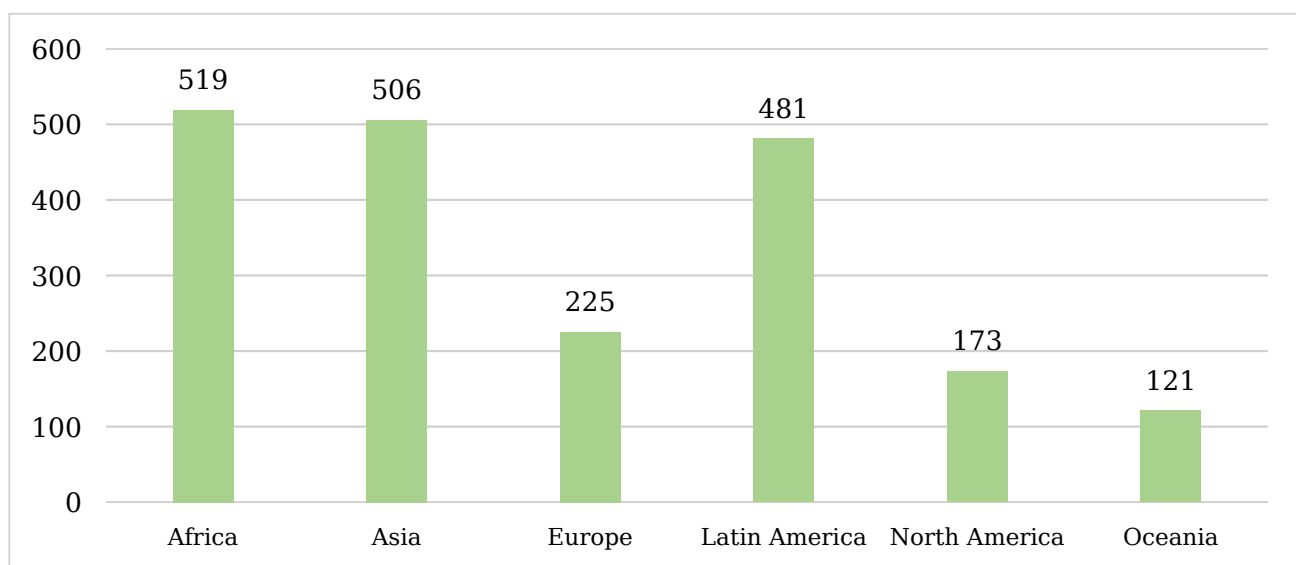
Figure 1. Dynamics of the number of participating universities in the QS Rankings, Sustainability, by region, 2023–2026



Source: compiled by the authors based on (QS World University Rankings: Sustainability 2026)

To provide a more rigorous assessment of the intensity of growth in the number of participating universities, we calculated the total growth index over the entire analysed period, allowing the expansion to be quantified in relative terms (Figure 2).

Figure 2. Total growth index of the number of universities, by region, participating in the QS World University Rankings, Sustainability, 2023–2026 (%)



Source: QS World University Rankings: Sustainability 2026

Note: the total growth index of participation over the entire period was calculated for each region, defined as the ratio of the number of participating universities in 2026 to the number recorded in 2023, expressed as a percentage.

Data on the evolution of the number of universities participating in the QS Sustainability Rankings over 2023–2026 indicate a general increase across all analysed regions, albeit at different rates. Africa records the highest total growth index (519%), followed by Asia (506%) and Latin America (481%), reflecting very rapid expansion in these regions. Europe records a growth index of 225%, placing it at an intermediate level. North America (173%) and Oceania (121%) record the lowest growth index over the analysed period. Overall, the participation dynamics highlight significant regional differences in the pace of expansion.

While it is true that fluctuations in the number of ranked institutions may partly reflect QS's evolving methodological scope, this observation does not, by itself, undermine the interpretive value of participation growth as an indicator of sustainability orientation. Two features of the QS Sustainability methodology warrant this qualification. First, inclusion in the ranking is not merely a function of registration or eligibility: an institution must additionally demonstrate a non-zero score on research-impact indicators linked to the UN Sustainable Development Goals — specifically, a non-zero score on the *Research Impact on SDGs for Environmental Research* indicator, together with a non-zero score in at least two of the four SDG-linked research metrics in the Social Impact category (QS Quacquarelli Symonds, 2026) — meaning that a substantive evidentiary threshold, rather than administrative expansion alone, governs whether an institution appears in the ranking at all. Institutions lacking demonstrable sustainability-related activity are, by design, positioned lower within the ranking or excluded from it, rather than being uniformly absorbed by methodological broadening.

Second, and this qualification matters given that the recent literature on university sustainability rankings has identified self-selection bias as a general threat to the interpretive validity of participation growth (Wilhelm et al., 2026), QS operates a data model that is neither fully opt-in nor opt-out that distinguishes it from voluntary-entry schemes: institutional inclusion does not depend exclusively on data submitted by universities but is supplemented, where submissions are absent, by publicly available and proprietary evidence (QS Quacquarelli Symonds, 2026). This structural feature reduces the likelihood that participation growth in the QS Sustainability Ranking reflects the same self-selection dynamics documented for voluntary schemes such as UI GreenMetric, where non-participation among high-prestige institutions has been shown to depress observed convergence with general prestige rankings without necessarily reflecting an absence of underlying sustainability engagement (Wilhelm et al., 2026). Since institutions cannot straightforwardly enter or avoid the QS ranking without leaving a verifiable public trace of sustainability-related activity — through research output, institutional policy documentation, or reported commitments — the self-selection concern that applies to opt-in rankings is substantially attenuated in this case.

Taken together, these two mechanisms suggest that, notwithstanding periodic methodological revisions, the expansion of participating institutions plausibly reflects a broader institutional engagement with sustainability-related activities. However, participation growth alone does not indicate whether this engagement translates into measurable sustainability outcomes or is associated with institutional financial performance—a question that requires direct empirical investigation and that motivates the second component of the present study.

THE RELATIONSHIP BETWEEN ESG PERFORMANCE AND FINANCIAL PERFORMANCE OF UNIVERSITIES: EVIDENCE FROM EASTERN EUROPE

The analysis investigates the existence of a multivariate relationship between environmental, social, and governance (ESG) performance, represented by the variables Environmental Impact, Social Impact, and Governance, and the institutions' financial performance (FPI), represented by the Financial Efficiency Ratio (R/C), Solvency (A-L)/A, and Assets Turnover (R/A). The initial sample comprises 52 universities, with no missing values for any of the six variables.

The main method of analysis is Kernel Canonical Correlation Analysis (Kernel CCA). Its selection is justified by the research question and by the structure of the data. ESG and FPI are treated as two multidimensional blocks whose components depart from univariate normality.

At the same time, the bivariate linear correlations remain weak, suggesting that any association between the two blocks is unlikely to be strictly linear. Kernel CCA extends classical canonical correlation analysis to a nonlinear framework by projecting the variables into a kernel-induced Hilbert space and is explicitly designed to capture nonlinear associations between sets of variables (Huang et al., 2009), without assuming multivariate normality or a linear relationship. The other methods applied, namely HSIC and distance correlation, are not competing alternatives to the main analytical approach but complementary procedures used to assess the robustness of the Kernel CCA results.

Table 1 presents the results of the univariate normality test for the complete sample.

Table 1. Assessment of Univariate Normality Using the Shapiro–Wilk Test ($N = 52$)

Variable	Mean	SD	Skewness	Excess Kurtosis	Shapiro–Wilk p-value
Environmental Impact	38.71	15.37	0.373	−0.836	0.0455
Social Impact	48.65	16.70	0.562	−0.349	0.0580
Governance	70.23	22.32	−1.370	0.783	< 0.001
Financial Efficiency Ratio	1.029	0.049	0.628	0.895	0.0173
Solvency (A–L)/A	0.897	0.159	−3.228	10.592	< 0.001
Assets Turnover	0.565	0.245	0.451	0.237	0.1235

Source: developed by the authors

According to Table 1, the assumption of univariate normality is rejected at the 5% significance level for four of the six variables, particularly Governance and Solvency, whose skewness and kurtosis values indicate

highly asymmetric distributions. Table 2 presents the results for the cleaned sample ($N = 46$, after removing outliers), showing that this pattern persists in the subsample used for the main analysis.

Table 2. Assessment of Univariate Normality (Shapiro–Wilk Test, $N = 46$, Cleaned Sample)

Variable	Mean	SD	Skewness	Excess Kurtosis	Shapiro–Wilk p-value
Environmental Impact	39.47	15.57	0.370	−0.919	0.0378
Social Impact	48.75	17.33	0.580	−0.451	0.0388
Governance	70.20	22.21	−1.324	0.743	< 0.001
Financial Efficiency Ratio	1.025	0.044	0.502	1.620	0.0588
Solvency (A–L)/A	0.940	0.044	−0.571	−0.909	0.0030
Assets Turnover	0.593	0.224	0.856	0.215	0.0058

Source: developed by the authors

The deviations from normality remain virtually unchanged after the removal of outliers: the p-values remain below 0.05 for the same four variables (Environmental Impact, Social Impact, Governance, and Solvency), while Assets Turnover shifts in the cleaned sample from a marginally non-significant value ($p = 0.1235$ for $N = 52$) to a significant one ($p = 0.0058$). This indicates that the removal of outliers does not, in itself,

result in a distribution that approximates normality.

The fact that departures from normality persist in both samples strengthens the methodological argument for preferring permutation-based methods, which do not rely on the assumption of multivariate normality, over classical linear approaches. Next, bivariate correlations were examined (Table 3).

Table 3. Bivariate Correlations (Pearson and Spearman, $N = 52$)

ESG Dimension	FPI Indicator	Pearson r	Spearman ρ	Spearman p-value
Environmental Impact	Financial Efficiency Ratio	−0.175	−0.173	0.2202
Environmental Impact	Solvency	−0.056	−0.240	0.0863
Environmental Impact	Assets Turnover	−0.135	−0.124	0.3817
Social Impact	Financial Efficiency Ratio	−0.180	−0.235	0.0938
Social Impact	Solvency	−0.106	−0.356	0.0095
Social Impact	Assets Turnover	−0.211	−0.168	0.2341
Governance	Financial Efficiency Ratio	−0.123	−0.269	0.0536
Governance	Solvency	0.014	−0.093	0.5117
Governance	Assets Turnover	0.095	0.066	0.6422

Source: developed by the authors

According to Table 3, the Pearson coefficients are generally weak and not statistically significant. The only notable association is observed for the Spearman correlation between Social Impact and Solvency ($\rho = -0.356$; $p = 0.0095$). The absence of strong bivariate correlations does not rule out a relationship between the two sets of variables when considered as multidimensional

constructs, since such a relationship may be nonlinear and distributed across several dimensions; we subsequently investigated this hypothesis using Kernel Canonical Correlation Analysis (Kernel CCA).

The assessment of multicollinearity (Variance Inflation Factor, VIF; $N = 52$) is presented in Table 4.

Table 4. Assessment of Multicollinearity (VIF, $N = 52$)

ESG Variable	VIF	FPI Variable	VIF
Environmental Impact	3.099	Financial Efficiency Ratio	1.024
Social Impact	2.820	Solvency	1.068
Governance	1.481	Assets Turnover	1.052

Source: developed by the authors

The data presented in Table 4 indicate that the VIF values suggest moderate but acceptable collinearity within the ESG block and virtually no collinearity within the FPI block. The Variance Inflation Factor (VIF) is primarily relevant for linear methods (regression analysis and linear CCA). It does not constitute a validity criterion for Kernel CCA, HSIC, or distance correlation (dCor).

The sample-cleaning procedure was designed as a distinct stage of the analysis, applied after assessing univariate normality in the full sample rather than as the starting point of the investigation. This approach avoided premature removal of observations before characterizing the overall structure of the data. Multivariate outliers were identified using the Minimum

Covariance Determinant (MCD) method, which robustly estimates the mean vector and covariance matrix of the six variables, independent of potentially extreme observations, and computes a robust Mahalanobis distance for each university. The reference threshold was $\chi^2(0.999; df = 6) = 22.4577$, corresponding to a very low probability that an observation drawn from a multivariate normal distribution would exceed this threshold by chance.

The number of detected outliers varies according to the support fraction parameter, which controls the proportion of observations considered to belong to the “clean” core of the distribution during the robust estimation stage (Table 5).

Table 5. Number of Outlying Observations and Remaining Sample Size According to the MCD Procedure's Support Fraction Parameter

Support fraction	Number of Outliers	Remaining Sample Size	% Removed
0.90	5	47	9.6%
0.85 (main analysis)	6	46	11.5%
0.80	7	45	13.5%
0.75	12	40	23.1%
0.70	12	40	23.1%

Source: developed by the authors

Five observations are identified as outliers regardless of the selected parameter value, indicating stable outlying behaviour rather than an artifact of parameter selection. For the main analysis, a support fraction value of 0.85 was retained, as it provides a balance between the robustness of the estimation procedure (a sufficiently

high breakdown points to withstand the influence of extreme observations) and the statistical efficiency of the estimator (avoiding the loss of an excessively large portion of the sample). This choice resulted in the exclusion of six universities and the creation of a cleaned sample consisting of 46 observations (Table 6).

Table 6. *Institutions Excluded During the Sample-Cleaning Process*

Excluded Institution	Mahalanobis Distance ²	χ^2 Threshold (0.999)
University of South Bohemia in České Budějovice	362.04	22.46
Czech Technical University in Prague	321.75	22.46
University of Miskolc	167.82	22.46
University of Pécs	54.58	22.46
Warsaw University of Technology	53.05	22.46
Kyiv National Economic University “Vadym Hetman”	26.22	22.46

Source: developed by the authors

All six excluded universities exhibit extreme values with respect to the combination of the six variables analysed simultaneously, rather than necessarily on each variable considered separately. This is characteristic of a multivariate outlier, as the robust Mahalanobis distance captures deviations from the covariance structure of the data rather than merely unusually high or low absolute values. There is no evidence to suggest that these observations result from data recording errors; rather, they most likely reflect institution-specific combinations of the ESG and financial indicators under investigation. Their removal should therefore not be viewed as an arbitrary exclusion of inconvenient observations, but rather as a robust and reproducible procedure for controlling the influence of extreme multivariate

observations on the subsequent estimation of the relationship between the two blocks of variables.

Furthermore, the choice of support fraction = 0.85 is more conservative than alternatives that would remove nearly one quarter of the sample (0.75 or 0.70). It also enables the parallel reporting of results for $N = 46$ (main analysis) and $N = 52$ (robustness analysis), thereby providing a sensitivity analysis of the conclusions with respect to the sample-cleaning decision.

The variables were standardized using z-scores, separately for each block of variables and for each sample. The γ parameter of the RBF kernel was calibrated automatically rather than selected to maximize statistical significance (Table 7) artificially.

Table 7. *Calibrated Values of the Kernel Parameter γ Across Variable Blocks and Samples*

Sample	γ ESG	γ FPI	κ
$N = 46$	0.1166	0.1008	1.0
$N = 52$	0.1184	0.1463	1.0

Source: developed by the authors

A separate analysis, using a common standardization based on all 52 observations prior to splitting the samples, produced results very similar to those obtained

through separate standardization ($\rho = 0.6311$ for $N = 46$; $\rho = 0.6275$ for $N = 52$), indicating that the main finding is not dependent on this methodological choice.

INTERPRETATION OF THE KERNEL CCA RESULTS

The Kernel CCA coefficient, defined as the first singular value of the regularized canonical correlation operator ($\kappa = 1.0$), indicates a moderately strong multivariate

association between the ESG block and the FPI block (Table 8).

Table 8. *Estimation and Validation of the Kernel Canonical Correlation Coefficient Between the ESG and FPI Blocks*

Sample	KCCA ρ	Permutation p-value	95% Bootstrap CI	CV Mean ρ
$N = 46$ (cleaned)	0.6791	0.0004	[0.5579; 0.8296]	0.6279
$N = 52$ (full)	0.6275	0.0036	[0.5452; 0.8067]	0.4329

Source: developed by the authors

In both samples, the observed coefficient exceeds the 95th percentile of the permutation-based null distribution, while the bootstrap confidence intervals exclude zero. Five-fold cross-validation confirms a moderate degree of generalizability for $N = 46$. Still, it shows considerably greater instability for $N = 52$ ($SD \rho$ test = 0.310, nearly three times higher than for $N = 46$), with one fold yielding a negative value. This difference supports the

separate reporting of the two samples and suggests that outlying observations affect predictive stability without invalidating the relationship itself.

Table 9 presents the results of the complementary dependence tests, namely HSIC (Hilbert-Schmidt Independence Criterion) and distance correlation (dCor).

Table 9. *Complementary Dependence Tests: HSIC and Distance Correlation*

Sample	HSIC	p-value (HSIC)	dCor	p-value (dCor)
N = 46	0.00658	0.0276	0.4424	0.0260
N = 52	0.00545	0.0564	0.3927	0.0992

Source: developed by the authors

According to Table 9, both tests confirm the general direction of the Kernel CCA results. For $N = 46$, statistical significance is maintained at the conventional 5% level; for $N = 52$, significance becomes attenuated, a finding that is consistent with the instability of the relationship

in the presence of outlying observations.

Since the above analysis includes multiple tests applied to the same dependence hypothesis, the raw significance levels should be interpreted in light of a correction for multiple testing (Table 10).

Table 10. *Statistical Significance of the Kernel CCA, HSIC, and dCor Tests After Holm and FDR Benjamini-Hochberg Corrections*

Test	N = 46, Holm-adjusted p	N = 46, FDR-BH adjusted p	N = 52, Holm-adjusted p	N = 52, FDR-BH adjusted p
Kernel CCA	0.0012 (significant)	0.0012 (significant)	0.0108 (significant)	0.0108 (significant)
HSIC	0.0520 (not significant)	0.0276 (significant)	0.1128 (not significant)	0.0846 (not significant)
dCor	0.0520 (not significant)	0.0276 (significant)	0.1128 (not significant)	0.0992 (not significant)

Source: developed by the authors

Taken together, the results in Table 10 support a significant multivariate association between the ESG indicator block and the financial performance indicator (FPI) block. This relationship is confirmed in both the cleaned sample and the full sample.

The findings suggest that the relationship between ESG performance and the financial performance of the universities under investigation is systemic and multidimensional. This relationship cannot be adequately captured through the isolated examination of bivariate correlations between individual variables. At the same time, the bivariate evidence suggests that the environmental and social dimensions exhibit somewhat more consistent associations with financial indicators than the governance dimension, whose individual relationships with financial performance remain relatively weak within the analysed sample. However, Kernel CCA evaluates the association between blocks of variables and does not permit the direct quantification of the individual contribution of each ESG component to the observed relationship.

The results do not provide evidence of a uniformly positive ESG-financial performance relationship, as

frequently reported in corporate settings (Ershadi et al., 2024; Almohanna & Alhussayen, 2024; Saeed et al., 2025; Lehenchuk et al., 2023). One possible explanation lies in the structural characteristics of higher education systems in Central and Eastern Europe, which are characterized by a high dependence on public funding, limited opportunities for revenue diversification, and constraints on financial flexibility (Bennetot Pruvot et al., 2020). In this context, investments associated with sustainability may generate long-term institutional and reputational benefits without producing immediate financial effects. This interpretation aligns with the conclusions reported by Rotondo et al. (2025), who found that a sustainability-oriented approach may be associated with less favorable financial outcomes for comprehensive public universities operating in less advantaged socioeconomic environments. However, variables relating to funding structures and sources were not included in the estimated model. Consequently, the explanation based on the specific characteristics of funding mechanisms should be interpreted as a plausible theoretical hypothesis rather than as a statistically verified mechanism.

CONCLUSIONS

This study pursued two complementary objectives: to analyse the dynamics of university participation in the QS World University Rankings: Sustainability and to investigate the relationship between ESG performance and financial performance among Eastern European universities included in the ranking.

The results indicate a substantial expansion in university participation in the QS Sustainability Rankings between 2023 and 2026, suggesting a growing institutional engagement with sustainability-related activities and assessment frameworks. At the same time, the findings suggest that sustainability and financial performance are linked through a multidimensional structure that conventional bivariate or linear analyses cannot adequately capture. The relationship proved robust to permutation testing and bootstrap estimation in both the cleaned and full samples; the complementary HSIC and distance-correlation tests corroborated this result in the cleaned sample after correction for multiple testing, while cross-validation indicated greater instability in the full sample.

The study contributes to the literature by providing one of the first empirical assessments of the ESG-financial performance nexus among Eastern European universities and by proposing a methodological framework suitable for investigating this relationship in a higher education context characterized by limited historical sustainability data. Given the relatively recent emergence of systematic ESG measurement in universities, the present findings should be viewed as a baseline assessment of an evolving phenomenon rather than as evidence of a mature sustainability-performance equilibrium.

From a practical perspective, and to the extent the identified association reflects genuine institutional dynamics rather than unobserved confounding factors, the findings suggest that sustainability performance may be better understood as part of a broader process of institutional development and accountability rather than evaluated solely through short-term financial outcomes.

Several limitations should be acknowledged. First, the analysis is based on a relatively small sample and a cross-

sectional research design. Second, the retained sample was determined by the public availability of complete 2024 financial reports, which may introduce a degree of selection bias to the extent that reporting availability is not independent of institutional characteristics relevant to the analysis. Third, the relationship was more unstable under cross-validation in the full sample ($N = 52$) than in the cleaned sample ($N = 46$), indicating that the strength of the association is sensitive to the treatment of multivariate outliers. Fourth, although financial indicators were harmonized through a uniform aggregation procedure and expressed as relative measures, differences in accounting frameworks, asset valuation practices, funding models, and institutional structures across the seven countries included in the sample may introduce residual heterogeneity that could not be fully eliminated. Fifth, potentially relevant institutional characteristics, including funding structure, institutional size, disciplinary specialization, institutional age, research intensity, capital intensity, and national policy environments, were not explicitly incorporated into the model and may represent alternative explanations for the observed associations. Finally, ESG performance was measured exclusively through the QS Sustainability framework.

Future research should extend the analysis to larger and more diverse samples and, most importantly, examine the relationship over longer time horizons. As more longitudinal data become available, it will be possible to assess whether the association between sustainability performance and financial performance evolves over time and whether patterns similar to those documented in the corporate sector emerge within higher education institutions.

In conclusion, the findings support a significant multivariate association between ESG performance and financial performance among the universities analysed. However, this relationship should be interpreted as associative rather than causal and viewed within the context of a higher education sector that is still in the relatively early stages of sustainability institutionalisation and measurement.

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