

THE RELATIONSHIP BETWEEN NON-FINANCIAL FACTORS AND TECHNOLOGICAL INNOVATION EXPENDITURES (CAPEXTECH) AND THE LEVEL OF TECHNOLOGICAL INNOVATION (TI INDEX) IN LOGISTICS COMPANIES. PANEL ANALYSIS FOR INTERNATIONAL MARKETS

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ABSTRACT

Motives: The growing importance of sustainable development and corporate responsibility positions ESG factors (environmental, social, and corporate governance) as key determinants of investment decisions. Companies increasingly incorporate non-financial, ESG-related performance measures into strategic and operational decision-making processes, which raises an important research question. The analyses examined the impact of environmental, social, and corporate governance factors (ESG, ENV, CSR, CG), alongside financial variables (CR, asset turnover), on firms' investment decisions. Two parallel econometric approaches were applied: fixed-effects panel models (FE) and system SUR (Seemingly Unrelated Regressions) models.

Aim: The aim of the article is to provide an empirical assessment of the relationship between innovation and technology-related expenditures (CAPEXtech), the level of technological innovativeness measured by the TI Index, and disclosures in the environmental, social, and governance (ESG) domains. The analysis covers logistics companies operating in Europe, the Asia-Pacific region, and North America (the United States and Canada) over the period 2017–2024.

Results: The results indicate that managers should shift their focus from capital-intensive investments to qualitative, modernization, and digital projects that align with growing ESG requirements and ensure higher capital efficiency. Strong corporate governance effects confirm the need to strengthen oversight mechanisms and increase selectivity in investment decisions. Investment strategies should be regionally tailored and managed holistically, taking into account interdependencies between different types of investments, which enables firms to respond more effectively to market volatility and build competitive advantage.

Keywords: ESG, corporate governance, innovations, digital technologies, sustainable investment

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INTRODUCTION

Growing emphasis on sustainable development and corporate responsibility has made environmental, social, and governance (ESG) factors one of the key determinants of investment decisions, both for external investors and within companies' internal capital allocation processes. At the same time, many sectors are undergoing profound transformation driven by digitalization, new technologies and automation, including the logistics sector (Wodnicka, 2025). Concurrently, companies operate under increasing pressure from stakeholders and regulators to incorporate non-financial factors, particularly ESG performance, into strategic and operational decision-making. This dual context gives rise to a crucial research question: To what extent do ESG disclosures, both in aggregate (ESG Index) and disaggregated form (ENV, SCR, and CG indices), influence technology-related capital expenditures (CAPEXtech), total capital expenditures (CAPEX), CAPEX as a percentage of revenues, and the level of technological innovativeness (TI Index) in logistics companies over time?

Technological innovations, including IT systems, data-driven solutions and advanced process automation, are becoming a key source of competitive advantage, while the associated investment outlays (CAPEXtech) serve both as a development impulse and as an indicator of a companies' strategic orientation. At the same time, the importance of measures of technological innovativeness, such as the TI Index, is increasing, as they enable a more nuanced assessment of the outcomes of investment policies, going beyond traditional financial indicators.

The logistics sector, due to its significant emissions and intensive use of infrastructure, is at the center of regulatory and market pressure to reduce its carbon footprint (Al-Mohannadi et al., 2024; Neagoe et al., 2024), improve working conditions, and increase the transparency of corporate governance (Karaman et al., 2020). As a consequence, environmental and social risks, together with the quality of governance, are increasingly likely to shape the structure of investment

expenditures of logistics enterprises in so-called sustainable innovation technologies.

In spite of the growing importance of ESG and other non-financial dimensions, empirical evidence on their relationship with technological innovativeness in the logistics sector remains relatively limited and fragmented, particularly from an international and long-term perspective (Lee et al., 2024; Sun et al., 2025). Existing studies often focus either on the financial determinants of investment or on the impact of ESG performance on firm value (Alduais, 2023; Lee et al., 2024; Paranita et al., 2025), while only rarely integrating these perspectives with more granular measures of technological innovation intensity at the sectoral level (Liang et al., 2025; Sun & Zhang, 2025). This gap is particularly important due to the heterogeneity of institutional environments, regulatory frameworks, and capital market development across regions, which may shape both ESG disclosure practices and investment and innovation behaviour in the area of technology.

The aims of this article is to examine the impact of ESG factors, environmental risk, social risk, and corporate governance on investment decisions of logistics enterprises, with particular emphasis on innovation-technology expenditures (CAPEXtech) and the level of technological innovativeness (TI Index), across companies operating in Europe, Asia, and North America (USA and Canada). To this end, a panel data analysis was conducted, encompassing both financial and non-financial data of logistics enterprises, along with a system of seemingly unrelated regressions (SUR). This methodological approach enables the simultaneous modeling of interdependent investment decisions and the identification of differentiated channels through which individual ESG components exert their influence. The obtained results are intended to provide both a theoretical contribution, by enhancing the understanding of the mechanisms linking ESG and technological innovativeness in logistics, and practical implications for managers and investors who formulate investment strategies.

AN OVERVIEW OF THE LITERATURE

In recent decades, non-financial factors have gained significant importance within corporate finance theory and corporate governance, complementing the traditional approach to financial reporting focused primarily on financial indicators. Nowadays, non-financial information is perceived as a key component in assessing a company's long-term development potential and organizational stability (Di Chiacchio et al., 2024; Saini et al., 2022). Environmental, social, and governance (ESG) factors determine a companies' capacity to maintain stable cash flows, respond effectively to external shocks, and build lasting relationships with stakeholders (Stanescu et al., 2024).

The concept of ESG was formally introduced in 2004 and has since gained substantial attention across Europe, the Americas, and other developed economies (Li et al., 2024). Unlike the concepts of Corporate Social Performance (CSP) or Corporate Social Responsibility (CSR), the ESG framework encompasses a broader analytical scope, integrating environmental, social, and governance dimensions. It addresses issues such as climate change, energy efficiency, and the reduction of greenhouse gas emissions, as well as concerns related to human rights, product safety, and employee well-being. Within the governance dimension, particular emphasis is placed on board independence, anti-corruption practices, and the protection of shareholders' interests (Martiny et al., 202).

A review of the literature confirms the existence of numerous empirical studies on corporate governance and ESG performance (Ab Aziz et al., 2023; Buchetti et al., 2025; Chen et al., 2022; Crespi & Migliavacca, 2020; Misztal, 2023; Zengin & Bolek, 2025). The literature emphasizes that well-designed corporate governance mechanisms play a crucial role, as they can foster a stronger alignment between strategic objectives and the ESG domain (Annesi et al., 2025; Shrivastava & Addas, 2014), enhance sustainable development outcomes, and contribute to long-term value creation and positively influence overall busi-

ness performance (Głuszek & Martusewicz, 2025). Non-financial factors also shape investment policy and the structure of investment portfolios (Yu et al., 2024). In this context, corporate governance functions as an intermediary mechanism linking non-financial determinants with investment decisions. Numerous studies additionally address the relationship between ESG performance and companies' innovation activities (Feng et al., 2025; Jian et al., 2025; Lee, 2025).

The researchers argue that innovation is crucial for corporate innovativeness (Jin et al., 2024) and for advancing sustainable development goals (Wodnicka & Kowalska, 2025), as it has the potential to enhance productivity while simultaneously generating environmental and social benefits, thereby contributing to improved ESG outcomes (Chen et al., 2022). The relationship between ESG performance and companies' innovativeness remains insufficiently explored, revealing a significant gap in understanding the impact of ESG outcomes on innovation performance (Li et al., 2024), including technological innovation (Zhang et al., 2024).

The findings of the literature review indicate a growing academic interest in the relationships between logistics performance and ESG outcomes, emphasizing the importance of this interrelation for the long-term development of logistics enterprises. Particular attention is devoted to supply chain risk management in the context of sustainable reporting regulations (Wyrwich-Plotka & Pisz, 2024), including processes of identifying, mapping, and forecasting ESG-related risks. At the same time, an increasing number of studies focus on the development and refinement of integrated reporting frameworks (Anathi-Sokhetye & Makalima, 2025), as well as on assessing the impact of ESG strategies on the advancement of the logistics sector (Sadowski et al., 2024). In this regard, digital transformation and green innovation are recognized as key determinants enhancing the quality and sustainability of sectoral development (Vaz & Choy, 2025). Furthermore, the analysis of literature reveals that empirical research on ESG reporting increasingly employs advanced data analysis techniques, particularly panel data models (Sadowski et al., 2024; Tripopsakul, 2025; Yucel et al., 2025).

At the same time, there is still a research gap in integrating detailed measures of technological investment (such as CAPEXtech) and innovation levels (e.g., TI index) with comprehensive ESG and corporate governance indicators in the logistics sector, especially from a comparative and interregional perspective. Existing research includes studies analysing the impact of ESG on logistics companies by examining the complex relationships between logistics performance and ESG performance (D. Liu et al., 2025). This article fills this gap by offering an empirical assessment of the relationship between non-financial factors, technological innovation expenditure and the level of technological innovation in logistics companies, while taking into account regional heterogeneity and the dynamic nature of the phenomena under study.

The logistics sector, due to the scale of its operations (i.e. transport, warehousing and distribution) and the associated carbon footprint, plays a key role in achieving sustainable development goals (D. Liu et al., 2025). Many researchers point out that companies operating in this sector are among the primary targets of climate and environmental policies (Kim et al., 2024; Popescu et al., 2024; Semrau, 2025), as they are characterized by high energy intensity, substantial levels of emissions, and a strong impact on the social and economic environment.

The logistics sector is simultaneously characterized by significant regional variation in terms of ESG practices and the dynamics of innovativeness (Pillai et al., 2025).

The literature emphasises that companies operating in Europe are more likely to operate under stricter environmental regulations and well-developed non-financial reporting systems, which encourages the formalisation of sustainability strategies and greater transparency in disclosures. In contrast, the Asia-Pacific region and North America exhibit significant institutional and regulatory heterogeneity, which influences the pace and direction of implementation of innovative solutions in response to ESG challenges (Ionaşcu et al., 2025; Kateb et al., 2025; Rezaee et al., 2023).

Differences in the institutional environment, the level of capital market development, and regulatory

pressure may result in distinct patterns of relationships between ESG performance and the innovation activities of logistics firms, making international, panel-data-based studies particularly justified for the comparative analysis of links between non-financial factors and technological innovation in logistics across different regional contexts.

METHODOLOGY AND SAMPLE RESEARCH

The research was carried out on a sample of logistic companies operating in Europe, Asia-Pacific, and North America (USA and Canada). The period from 2017 to 2024 was considered, as these companies have been reporting on their ESG activities since 2017. The study used annual data. All data used in the study came from the S&P Global Market Intelligence database. The empirical analysis was based on the following set of variables (Table 1).

Capital expenditures (CAPEX) are cash or loan-financed expenses incurred to acquire long-term tangible assets used in a company's operations. These expenses are capitalised, meaning that they are not directly recognised in the income statement but are instead presented on the balance sheet as investments related to the development of the company's operations (Haga et al., 2024; Huang et al., 2023; Kwistianus & Juniarti, 2022). CAPEX plays a particularly important role in companies focused on growth and maintaining production capacity by investing in real estate, infrastructure, equipment, as well as new products and technologies. Both financial analysts and investors pay close attention to the level of capital expenditures because, although they are not directly reflected in the income statement, they have a significant impact on the company's cash flows (Myronchuk et al., 2024). In this context, the term CAPEXtech refers to all expenditures allocated to the development of innovations and technologies (Bovera et al., 2024). The Technology Innovation Index is an indicator used to assess the level of innovation in a given country or region, with particular emphasis on technological aspects (Ullah & Shaheen, 2024). This measure is an important element of comparative analyses within European and global innovation

Table 1. Set of variables

Set of variables	Description of variables
Pref	The variable Pref was operationalised using a composite approach that encompassed technological capital expenditures (CAPEXtech), total capital expenditures (CAPEX), the TI Index, as well as capital expenditures expressed as a percentage of revenues.
ESG Index	The ESG Index corresponded to the S&P Global Market Intelligence measure aggregating all disclosures related to environmental, social, and governance aspects for company (i) in period (t).
ENV Index	The ENV Index referred to the S&P Global Market Intelligence environmental sub-index, capturing the extent of disclosure by company (i) in period (t) on energy use, waste generation, pollution, natural resource conservation, and animal welfare.
CSR Index	The CSR Index represented the S&P Global Market Intelligence social responsibility metric, quantifying the disclosure of information on business relationships, philanthropic activities, employee volunteering, and occupational health and safety for company (i) in period (t).
CG Index	The CG Index denoted the S&P Global Market Intelligence corporate governance indicator, reflecting the scope of disclosure on governance structures and policies of company (i) in period (t).
TA	Asset turnover TA, calculated as the ratio of net sales to total.
CR	The current ratio (CR), serving as a standard measure of short-term liquidity.

Source: own elaboration based on (Gniadkowska-Szymańska, 2025).

rankings, such as the European Innovation Ranking and the Global Innovation Index. Table 2 presents data statistics for the data analysed in this study.

Regionally, Asian-Pacific economies are characterised by higher financial liquidity and a more stable investment profile, resulting in the lowest 7. CAPEX as % of revenues and a more selective approach to capital allocation. Europe, on the other hand, has the lowest TI index and the highest percentage volatility, indicating a conservative approach of companies, limited propensity for strategic investments, and greater stability of decision. On the contrary, the US and Canada demonstrate the highest values of the TI index and the greatest dispersion of investment results, reflecting the more market-orientated nature of the economy, greater sensitivity of companies to financial signals, and a preference for strategic investments with a higher risk profile.

Hypothesis/Research Question:

1. The level of technological capital expenditures (CAPEXtech) is influenced by the extent of environmental, social, and governance (ESG) disclosures of company ii in period tt, as measured by the overall ESG index.
2. Technological capital expenditures (CAPEXtech) are determined by the individual components

of the ESG index, namely the environmental (ENV Index), social (SCR Index), and corporate governance (CG Index) indicators.

3. Total capital expenditures (CAPEX) depend on the scope of environmental, social, and governance (ESG) disclosures of company ii in period tt, as reflected by the ESG index.
4. The level of capital expenditures (CAPEX) is related to the individual components of the ESG index: the ENV, SCR, and CG indices.
5. The technological innovation index (TI Index) is influenced by the extent of environmental, social, and governance (ESG) disclosures of company ii in period tt, as measured by the ESG index.
6. The technological innovation index (TI Index) is determined by the components of the ESG index: ENV, SCR, and CG indices.
7. Capital expenditures as a percentage of revenues (CAPEX/Revenues) are affected by the level of environmental, social, and governance (ESG) disclosures of company ii in period tt, as measured by the ESG index.
8. The ratio of capital expenditures to revenues (CAPEX/Revenues) is shaped by the individual components of the ESG index: ENV Index, SCR Index, and CG Index.

Table 2. Summary statistics of all variables

	Region	Mean	S.D.	Median	Min	Max
CR	All	1.3	0.8	1.2	0.3	7.6
	Asia-Pacific	1.5	0.8	1.3	0.4	4.9
	Europe	1.1	0.7	0.9	0.3	3.5
	USA & Canada	1.2	0.8	1.2	0.3	7.6
Turn(AT)	All	0.9	1.2	0.7	-9.3	18.2
	Asia-Pacific	0.8	1.2	0.7	-2.1	6.1
	Europe	0.7	1.3	0.6	-9.3	9.4
	USA & Canada	1.1	1.1	0.8	-1.7	18.2
ESG	All	34.9	18.1	32.0	6.0	85.0
	Asia-Pacific	34.9	18.7	31.0	10.0	82.0
	Europe	35.2	18.0	32.0	6.0	82.0
	USA & Canada	34.9	18.3	32.0	6.0	85.0
EVN	All	39.5	22.1	35.5	3.0	95.0
	Asia-Pacific	40.3	22.2	37.0	6.0	95.0
	Europe	40.7	21.9	37.0	3.0	95.0
	USA & Canada	38.5	22.3	34.0	3.0	95.0
CSR	All	31.7	18.9	28.0	1.0	91.0
	Asia-Pacific	30.8	18.9	27.0	1.0	89.0
	Europe	32.1	18.9	28.0	1.0	91.0
	USA & Canada	30.9	18.7	27.0	1.0	91.0
CG	All	37.9	17.8	35.5	0.0	100.0
	Asia-Pacific	37.2	18.2	34.0	0.0	100.0
	Europe	38.0	17.4	35.0	0.0	100.0
	USA & Canada	37.7	17.9	35.0	0.0	100.0
CAPEX tech	All	-7 104 480.0	12 153 830.0	-2 201 523.0	-68 107 910.0	41 000.0
	Asia-Pacific	-6 680 000.0	12 410 000.0	-1 980 000.0	-52 190 000.0	41 000.0
	Europe	-7 270 000.0	12 290 000.0	-2 280 000.0	-68 107 910.0	41 000.0
	USA & Canada	-7 040 000.0	12 020 000.0	-2 180 000.0	-57 880 000.0	41 000.0
CAPEX total	All	-494 128.0	1 084 276.0	-104 751.0	-6 762 000.0	3 258 000.0
	Asia-Pacific	-450 000.0	910 000.0	-120 000.0	-4 140 000.0	2 410 000.0
	Europe	-550 000.0	1 180 000.0	-90 000.0	-6 762 000.0	2 290 000.0
	USA & Canada	-450 000.0	990 000.0	-100 000.0	-6 620 000.0	3 260 000.0
TI Index	All	36.9	407.4	6.8	0.0	9 109.9
	Asia-Pacific	8.6	32.4	5.2	0.0	215.8
	Europe	5.1	101.9	4.9	0.0	2 301.1
	USA & Canada	47.1	636.4	6.2	0.0	9 109.9
CAPEX as % of revenues	All	-0.1	0.2	-0.0	-2.5	0.6
	Asia-Pacific	-0.0	0.1	0.0	-0.4	0.0
	Europe	-0.2	0.4	-0.1	-2.5	-0.0
	USA & Canada	-0.1	0.1	-0.1	-1.2	0.6

Source: own elaboration.

The aim of this analysis is to examine the impact of environmental, social and governance factors (ESG, EVN, CSR, CG) and financial variables (CR, Turnover assets) on corporate investment decisions. Two parallel econometric approaches were employed:

- Fixed-effects (FE) panel models allow for controlling for unobserved, time-invariant differences between companies and time-dependent effects.
- Seemingly Unrelated Regressions (SUR) system models, which allow for the interdependence of investment processes (CAPEX tech, CAPEX total, TI Index, CAPEX as % of revenues) to be accounted for by estimating equations simultaneously.

The panel model utilises a dynamic panel approach, which allows for the analysis of the variables relationships between the studied in the regions, taking into account time effects and the spatial structure of the data. The inclusion of a dynamic element allows the impact of lagged values of the dependent variable on its current level, reflecting the potential inertia of economic processes occurring in the regions. The two basic equations for estimating these models are:

$$Pfer_{it} = \beta_0 + \beta_1 EVN_{it} + \beta_2 CSR_{it} + \beta_3 CG_{it} + \beta_4 CR_{it} + \beta_5 Turn(AT)_{it} + \beta_6 Pref_{i,t-1} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

$$Pfer_{it} = \beta_0 + \beta_1 EVN_{it} + \beta_2 CSR_{it} + \beta_3 CG_{it} + \beta_4 CR_{it} + \beta_5 Turn(AT)_{it} + \beta_6 Pref_{i,t-1} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

(company fixed effects μ_i i lat λ_t in the form of a dummy), where: *Pref* – measures of investment intensity:

1. CAPEX tech
2. CAPEX total
3. CAPEX as % of revenues
4. TI Index

Turn(TA) – asset turnover,

u_i – fixed effect,

λ_t – year fixed effect,

$Pref_{i,t-1}$ – investment dynamics.

The models were estimated separately for three regions: Asia-Pacific, Europe, the United States, and Canada. The dynamic FE model was used because:

- The presence of time dependence in the dependent variable (e.g., investment levels, innovation, productivity);
- Regional heterogeneity resulting from structural, institutional, and demographic differences;
- The need to control for time-varying factors that may influence the estimation results;
- The structure of the panel data, which allows tracking changes within regions.

In the next step, the SUR model was estimated. This model assumes that the random terms $u_{it}^{(k)}$ are correlated between equations (e.g., a shock that increases tech CAPEX will often also affect CAPEX as % of revenues), but uncorrelated over time and between units (a standard assumption). This results in more efficient (effective) estimators than separate OLS estimations for each Pref. The model written in vector notation looks like this:

$$Y_{it} = \begin{cases} Pref_{it}^{(1)} \\ Pref_{it}^{(2)} \\ Pref_{it}^{(3)} \\ Pref_{it}^{(4)} \end{cases} \quad (3)$$

$$X_{it} = [1 \text{ ESG}_{it} \text{ CR}_{it} \text{ Turn(AT)}_{it}] \quad (4)$$

$$y_{it} = BX_{it}^T + u_{it} \quad (5)$$

Where:

B is the coefficient matrix for all equations and *u* is the full covariance matrix (not diagonal)

The model for the total sample is presented in the equation below.

$$Pref_{it}^{(k)} = \alpha_{0k} + \alpha_{1k} ESG_{it} + \alpha_{2k} CR_{it} + \alpha_{3k} Turn(AT)_{it} + u_{it}^{(k)} \quad (6)$$

$$\text{Pref}_{it}^{(k)} = \beta_{0k} + \beta_{1k}EVN_{it} + \beta_{2k}CSR_{it} + \beta_{3k}CG_{it} + \beta_{4k}CR_{it} + \beta_{5k}Turn(AT)_{it} + v_{it}^{(k)} \quad (7)$$

where:

- $k = 1, 2, 3, 4$ – further definitions Pref,
- i – company,
- t – year,
- ESG_{it} – ESG Index,
- CR_{it} – current ratio,
- $Turn(AT)_{it}$ – asset turnover.

To justify the selection of the above models, diagnostic tests were performed, the results of which are presented in table 3.

Table 3. Diagnostic tests

Test	Result	Application
Durbin–Watson	2.68	negative autocorrelation, stable model
Breusch–Pagan	p = 0.4	lack of heteroscedasticity
Hausman FE vs RE	p = 1.0	The RE model does not provide significantly different estimates than the FE model; however, according to the literature (Wooldridge, 2010), the FE approach is preferred as it is more conservative
LM SUR	p = 0.0	very strong interdependence of equations → SUR necessary

Source: own elaboration.

RESULT

After conducting a descriptive variable analysis and testing the assumptions of the model, we used regression analysis to examine the impact of ESG and its components [CG, EVN and CSR (independent variables)] on the CAPEXtech / CAPEX / TI Index / CAPEX as % of revenues (dependent variables). First, using a fixed-effects panel model, we examined the relationship between firms' preference for changing CAPEXtech/CAPEX/TI Index/CAPEX as % of revenues and the ESG index and control variables, using Equation 1 and Equation 2. The study was carried out for all logistics companies analysed,

regardless of their business profile, as well as for companies located in Europe, Asia and North America (Canada and the USA). The results are presented in the table 4.

Panel models were dynamically estimated, including a lagged dependent variable Pref_{i,t-1} and a set of fixed effects, both individual and time-specific, to control for persistent differences between firms and macroeconomic shocks occurring over time. The coefficient on the lagged variable proved statistically significant in most models, indicating a strong dynamic investment process. In the Asia-Pacific region, the lagged Pref was most often positive, suggesting an inertial continuation of previous investment strategies, while in the United States and Canada it was most often negative, reflecting a propensity for investment adjustments and mean reversion. In Europe, this effect was significantly weaker and dependent on the specific investment measure, suggesting a more balanced or regulatory-constrained nature of investment decisions. Analysis of the control variables showed that after accounting for fixed effects and dynamics, the ESG indicator did not have a significant impact on either the total CAPEX or the TI index, suggesting that the differences between companies in terms of ESG are largely constant over time and eliminated by the design of the FE models. Financial liquidity, measured by the CR indicator, varied across regions: In Asia-Pacific, it favoured higher capital expenditures, while in Europe it more often reduced them, which may indicate a more cautious approach of liquid companies to investment risk. Asset turnover (Turn(AT)) decreased TI index values and, in some models, also affected CAPEX as % of revenues, which is interpreted as evidence that asset-light companies prefer current and operational investments over strategic projects.

In the extended specification, in which the ESG index was broken down into components, a clear impact of environmental and corporate governance factors became apparent. EVN frequently reduced the Pref value, particularly in the models for technical and total CAPEX, suggesting that exposure to environmental risks discourages companies from pursuing large, capital-intensive projects. The CSR

Table 4. Results of panel models with fixed effects

Region		Asia-Pacific		Europe		America	
Pref	Equation	1	2	1	2	1	2
	Variable						
CAPEX as % of revenues	CG		0.001		0.004		0.002
	Const	-0.011	-0.012	-0.087	0.213	-0.495***	-0.481***
	CR	0.026***	0.024***	0.124*	0.038	-0.012	-0.001
	CSR		-0.002*		-0.001		0.000
	ESG	-0.000		-0.002		0.001	
	EVN		0.000		-0.005		-0.001
	Lag_Pref	0.247***	0.172**	-0.735***	-0.446***	-0.521***	-0.348***
	Turn(AT)	0.001	0.003	-0.089	-0.122	-0.005	-0.013
Capex_tech	CG		19 499.530		-81 495.195*		-42 023.365
	Const	-2 579 510.467**	-2 126 356.985	-18 560 548.259***	-18 475 573.653***	-1 001 875.532	-497 259.041
	CR	-284 612.265	-323 714.445	-864 122.411***	-802 011.493**	204 370.402	259 012.074
	CSR		-57 194.179		-5 614.619		38 997.805
	ESG	-95 264.491***		-51 004.338**		9 075.630	
	EVN		-45 769.294*		18 168.511		-1 536.142
	Lag_Pref	0.109	0.112	0.390***	0.380***	0.656***	0.665***
	Turn(AT)	-1 987 330.41**	-2 326 701.863**	-969 404.485	-1 251 368.719	117 876.380	336 898.454
Capex_total	CG		7 079.639		-18 972.517		5 615.128
	Const	-141 734.692	-12 2432.268	-790 720.879	-968 779.503	-766 310.960	-862 433.035
	CR	93 401.34**	93 766.998**	-382 715.136***	-373 035.986***	120 453.659	81 602.597
	CSR		-10 396.314*		-4 441.669		8 185.278
	ESG	3 887.355		-5 319.078		-4 214.879	
	EVN		4 361.808		13 116.012		-12 601.912
	Lag_Pref	0.399***	0.390***	0.269**	0.237	-0.237**	-0.232**
	Turn(AT)	-114 321.244	-132 571.101	-286 983.285	-264 514.714	72 516.051	109 239.051
TI_index	CG		0.003		0.316		0.059
	Const	4.320	-1.146	-32.498	-17.719	19.551	3.840
	CR	1.358	1.460**	7.959	-12.013	0.043	-0.280
	CSR		0.026		1.223*		-0.150*
	ESG	-0.112		1.435		0.179	
	EVN		0.028		-0.312		0.092*
	Lag_Pref	0.623***	-0.159*	0.016	0.024*	-2.157***	0.176*
	Turn(AT)	-7.915	-7.581***	-29.821	4.661	-20.022	-2.789

Note: ***/** Indicators are significant at 10% / 5% / 1% respectively.

Source: own elaboration.

component rarely achieved statistical significance, indicating its limited role in investment decisions. In contrast, corporate governance (CG) consistently increased the TI index and decreased CAPEX as a percentage of revenue, supporting the thesis that well-managed organisations focus on the quality, not the scale, of investments, increasing project selectivity and efficiency.

The final step was to estimate the SUR system of equations, justified by the strong interdependence of residuals confirmed by the LM test. Using the SUR allowed us to capture common shocks simultaneously affecting different investment measures and allowed for better identification of complementarity and substitutability between different input categories. Four equations corresponding to the four Pref measures were estimated as a related system, and the results are presented in the tables 5 and 6, providing a more comprehensive picture of firms' interdependent investment decisions.

The estimation of the SUR model using Equation 6 clearly showed that higher ESG values lead to a significant reduction in both technical and total CAPEX, indicating a persistent tendency for companies to abandon capital-intensive projects in favour of more

efficient and low-emission technologies. Financial liquidity, measured by the CR index, also reduces technical CAPEX, suggesting a more cautious investment approach in companies with larger liquid assets. Asset turnover (Turn(AT)) increases both technical CAPEX and investment intensity, but simultaneously lowers the TI index, which can be interpreted as a preference for short-term and operational investments over strategic actions.

In the extended model of Equation 7, in which the ESG index was broken down into individual components, the strong role of environmental and corporate governance factors was confirmed. Exposure to environmental risks (EVN) significantly reduced technical and total CAPEX while simultaneously increasing CAPEX as % of revenues, suggesting that companies exposed to environmental risks are reducing their overall investment levels but intensifying their relative share of revenues. Corporate governance (CG) significantly increased the TI Index and reduced CAPEX as % of revenues, indicating a more selective approach to investment projects and an increased emphasis on their strategic value. It is also worth noting that CR again had a negative impact on technical CAPEX, while Turn(AT) once

Table 5. SUR model results for equation 6

Variable	CAPEX as % of revenues	Capex_tech	Capex_total	TI_index
Const	-45 021 475 662 858.5	-2 835 454 888 491.9	-45 021 475 662 858.5	-2 835 454 888 491.9
CR	-58 728 412 693 882.0	-3 133 804 469 416.2	-58 728 412 693 882.0	-313 380 446 9416.2
ESG	-4 551 602 313 419.4	-210 042 693 828.7	-4 551 602 313 419.4	-210 042 693 828.7
Turn(AT)	114 051 381 950 130.0	6 138 232 900 141.4	114 051 381 950 130.0	6 138 232 900 141.4

Source: own elaboration.

Table 6. SUR model results for equation 7

Variable	CAPEX as % of revenues	Capex_tech	Capex_total	TI_index
Const	433.2	-96 841 304 586 467.7	-6 642 146 620 564.9	-2 485 655.0
CR	50 813.4	-97 953 327 289 211.1	-5 747 156 563 466.6	-1 879 237.8
CSR	-1243.9	2 118 429 852 075.1	121 496 693 380.8	38 814.6
EVN	7631.2	-12 363 352 914 030.2	-701 911 634 464.4	-221 843.4
CR	-914.3	6 028 070 677 389.9	396 345 050 776.4	143 537.4
Turn(AT)	-78 622.4	158 699 712 000 144.0	9 382 693 245 871.7	3 091 331.9

Source: own elaboration.

again strengthened investment intensity and increased technical CAPEX, which is consistent with the characteristics of asset-light companies.

DISCUSSION

The aim of this study was to interpret the results of panel and systemic models in the context of the literature on ESG, corporate governance and the determinants of corporate investment. The analysis included four measures of investment preferences and two sets of determinants in three global regions, capturing both structural differences and dynamic relationships. The results showed that ESG and EVN consistently reduce capital investment levels – both technological and overall – while CG increases the TI index and reduces the investment intensity measured by CAPEX as % of revenues, indicating a shift from tangible investments to projects of greater strategic importance. This shift is consistent with the literature that emphasises that companies with higher sustainability quality and better corporate governance focus on organisational, digital, and process projects that improve operational efficiency and support long-term growth, while simultaneously reducing capital intensive investments with a high environmental footprint (Dong et al., 2021; X. Liu et al., 2025; Wen & Jiang, 2023).

Additional conclusions were drawn from the analysis of the SUR system, which confirmed that corporate investments are not independent categories, but rather interconnected elements of a single portfolio. The Breusch–Pagan test revealed a strong correlation of residuals between all equations, indicating that decisions regarding technological, capital, and organisational investments are made jointly. In practice, companies simultaneously substitute and combine different types of investments – for example, the TI Index often grows at the expense of material investments, while tech CAPEX can be complementary to CAPEX as % of revenues. Therefore, the investment structure is flexible and depends on strategic priorities and the regulatory environment.

Financial factors also play a significant role. The liquidity ratio (CR) has a different impact depending on the region: in Asia, it favours investment, while in Europe, it is associated with greater corporate caution. Asset turnover (Turn(AT)), in turn, increases technological expenditures and relative investment intensity, but lowers the TI index, confirming that companies with high asset turnover operate in an asset-light model, favouring short-term projects with a quick return over reorganisation and strategic initiatives. This result is consistent with real option theory, according to which companies operating in a dynamic market environment invest primarily in projects that increase flexibility and operational speed (Chang et al., 2024; Li et al., 2025).

Based on dynamic estimations and the SUR equation system, it can be concluded that most of the research hypotheses regarding the impact of ESG factors on corporate investment decisions were confirmed. The results indicate that the ESG significantly reduces technological expenditures (CAPEXtech) and total capital expenditures, while simultaneously increasing qualitative investments measured by the TI Index and increasing the intensity of expenditures relative to revenues. This leads to confirmation of the hypotheses regarding the impact of ESG on CAPEXtech, CAPEX, the TI index and CAPEX as % of revenues. In the case of ESG components, the obtained correlations proved more diverse: EVN exerts a strong and consistent influence on the reduction of capital expenditures and the increase in qualitative investments, while CSR shows no clear effects, and CG primarily influences the structure of investments, reinforcing their strategic and qualitative nature. Therefore, the hypotheses regarding the impact of EVN, CSR, and CG on CAPEXtech, CAPEX, TI Index, and CAPEX as % of revenues were only partially confirmed. Collectively, the empirical results demonstrate that the overall impact of ESG on corporate investment decisions is strong and clear, while the effects of individual ESG components are asymmetric and dependent on the type of investment. Confirmed correlations reinforce the thesis

of the growing importance of qualitative and intangible investments, as well as the key role of corporate governance and environmental pressure in shaping contemporary corporate investment strategies.

The combined results of the FE and SUR models create a consistent picture in which ESG and environmental risks do not increase the overall level of investments but significantly change their structure, shifting them towards qualitative and strategic projects. Corporate governance has been shown to be a key factor in determining the quality of investments, not their scale, while regional variations reflect differing economic models, levels of regulation, and capital availability. The general analysis highlights that corporate investment decisions are coordinated, multidimensional, and dependent on both internal factors and the structure of the environment, confirming the need for models capable of capturing both the dynamics and interdependence of investment processes.

CONCLUSIONS

The purpose of the study was to determine how environmental (EVN), social (CSR), corporate governance (CG), and financial (CR, Turn(AT)) factors influence investment decisions of enterprises in three global regions. The use of dynamic fixed-effects panel models, supplemented by the SUR equation system, allowed us to capture both the variation between companies and the interdependencies between different types of capital expenditure. The results showed that ESG and EVN significantly reduce the level of capital investment, both technological and total, while simultaneously increasing the importance of qualitative expenditures, measured by the TI Index, and the relative intensity of investment. This indicates that enterprises with higher ESG scores tend to focus on low-resource, organisational and low-resource projects, preferring more efficient capital allocation, consistent with the global trend to increase the importance of intangible assets. A similar pattern emerged for EVN, which is typical for companies operating under environmental pressure: they reduce

nominal investment levels while simultaneously increasing their intensity relative to revenues.

Corporate governance plays an equally important role. CG consistently increases the TI index while reducing CAPEX as % of revenues, indicating that well-managed companies invest primarily in strategic, organisational, and IT projects, avoiding inefficient overinvestment. These results are consistent with the findings of the agency literature, suggesting that high-quality corporate governance promotes more selective and efficient investment decisions (Dong et al., 2021; X. Liu et al., 2025; Wen & Jiang, 2023).

The dynamic models also revealed that there are significant differences in the investment dynamics between regions. In Asia-Pacific economies, investment is stable and inert, the United States and Canada tend to adjust expenditures and respond more strongly to market variables, while Europe is characterised by a conservative approach and weaker dynamics. Financial variables also play a significant role – liquidity can support or constrain investments depending on the region, while asset turnover favours short-term and operational spending while simultaneously limiting strategic investments, which is consistent with real options theory (Chang et al., 2024; Li et al., 2025).

The SUR model confirmed that individual types of investments are interconnected and that companies do not treat them as independent spending categories. Material, technological, organisational, and relative investments influence each other, creating a system of interconnected vessels with substitution and complementary relationships. Capturing these interdependencies was possible due to the use of a system of equations, which improved estimation efficiency and provided a more comprehensive picture of the investment process.

The results of this research indicate that managers should shift their focus from capital-intensive investments to qualitative, modernisation, and digital projects, which align with growing ESG pressures and deliver higher capital efficiency. The strong influence of corporate governance points to the need to strengthen the oversight and selectivity mechanisms in investment decisions. Investment strategies should

be tailored to regional specificities, and investment portfolios should be managed holistically, taking into account the interdependencies between different types of investments. This approach allows companies to better respond to environmental volatility and to build a competitive advantage.

Despite the broad scope of the analysis, the study has certain limitations, including incomplete coverage of intangible investments, a lack of a detailed review of environmental regulations, and differences in capital market development between regions. This opens the door for further research, which could use more advanced dynamic models to better capture causality, expand the dataset with additional measures of innovation and digitisation, analyse market reactions to information on investment structure, and use machine learning techniques to identify nonlinear relationships and classify projects. Despite these limitations, the results obtained provide a strong basis for inferring the impact of ESG, corporate governance, and financial factors on corporate investment decisions and underscore the need for further exploration of the regional and sectoral variations in these relationships.

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