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Strategic Impact of EU Taxonomy on Pharmaceutical Firms' Performance

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ABSTRACT

Sustainability has become a central concern in economic policy and corporate governance, increasingly formalised through regulatory frameworks of the European Union (EU). The European Commission has published the EU Taxonomy, which allows economic activities and their contribution to sustainability to be analysed, taking into account indicators and variables related to the environment. With the aim of assessing the impact of this system, its repercussions on performance and awareness in the pharmaceutical industry are analysed for the period 2024 using variables obtained from Thomson Reuters Eikon. To this end, the partial least squares structural equation modelling (PLS-SEM) model is used, which allows us to highlight that alignment with the EU Taxonomy does not influence financial performance, while the environmental, social and governance (ESG) sustainability profile does have a positive effect on such performance. However, there is no evidence of a mediating effect between the EU Taxonomy and business performance through the ESG sustainability profile, which could lead to a lack of knowledge or understanding of these measures within organisations. These results are therefore key for business leaders, as they enable them to raise awareness of current regulations and understand the importance of integrating sustainable practices that not only meet regulatory requirements but also drive competitiveness and long-term value creation. Evidence shows that ESG indices have a greater impact on the awareness and practices of stakeholders than other reporting frameworks promoted by the EU. At the same time, it is essential to continue analysing these types of variables in the various economic activities of society, with the aim of raising awareness and analysing their true impact on the organisation and competitiveness of businesses.

1 | Introduction

Climate change is a long-term problem, and policies should focus on long-term solutions (Gillingham and Stock 2018). In the current business context, the value and success of an organisation depend not only on its profits but also on the influence of the external environment (Smith 2008). Corporate social responsibility (CSR) has been an ongoing area of focus over the years, reflecting its important role in society and its contribution to medium- to long-term sustainability. In that sense, CSR remains a key business concept widely adopted by large corporations worldwide, although its definition has often been considered ambiguous (Welford 2005). One of the advanced forms of CSR primarily consists of voluntarily adopting responsible business practices (Nussbaum 2009). In this context, indices evaluating environmental, social and governance (ESG) aspects have emerged and become key tools for measuring and managing companies' sustainable impact. The ESG approach constitutes an evaluation framework that integrates the ESG dimensions of firms, assessing environmental aspects such as resource usage and emissions reduction; social aspects such as respect for human rights, employment quality, product responsibility and community relations (Kao and Le 2022). In that sense, the economic impact of strategies and measures focused on these variables could be significant for most organisations, as they can directly influence key financial indicators, such as return on assets (ROA) measures the efficiency of asset use, while return on equity (ROE) measures profitability for shareholders, Tobin's Q—a ratio that measures the relationship between a firm's market value and the replacement cost of its assets—or perceived firm value, and, more generally, the overall financial performance of the organisation. Accordingly, CSR is generally more debated than enhancing environmental performance, as it involves ethics, stakeholder accountability and core value considerations (Welford 2002).

The pressure of climate change and the application of sustainable development principles have prompted the EU to design new common instruments in Europe to classify activities and standards that enable efficiency and sustainable practices to be analysed according to their impact on sustainability. Thus, in March 2020, the European Commission published the EU Taxonomy, understood as a classification system for economic activities that can be considered environmentally sustainable (European Commission 2025). The purpose of this tool is to assess the extent to which the various economic activities carried out by a company are environmentally sustainable and to determine the degree of sustainability of the business as a whole, considering the specific contribution of each activity to the overall performance of the organisation (Lucarelli et al. 2020).

The ESG approach has been the subject of extensive research, considering its impact on different territories, on ESG business awareness and on financial repercussions, with the first findings dating back to the 1970s (Friede et al. 2015). Currently, this term has particular relevance both in academia and in companies, due to the influence it exerts on the sustainability of territories and the impact derived from various economic activities on society in general. By studying this area more deeply, numerous authors have established a connection between this concept and financial performance, linking it to different financial performance indicators. This relationship has sparked growing interest in the scientific literature, spurring debates and strategies on how companies integrate these approaches into their strategies, recognising that sustainability can become a determining factor in competitiveness and long-term value creation.

Pharmaceutical companies face increasing management complexity, as the need to balance environmental, economic and social sustainability with cost control has pushed firms to integrate sustainability considerations into their core business and financial decision-making (Milanesi et al. 2020). In that sense, this industry is highly intensive in both energy consumption and CO_2 emissions (Bruni et al. 2023), leading to the importance of sustainability and improving energy efficiency. However, as pointed out by Belkhir and Elmeligi (2019), the pharmaceutical sector has received little attention in sustainability debates, despite generating higher carbon emissions than the automotive industry. Authors such as Okereke (2021) highlight that the pharmaceutical industry contributes significantly to the climate problem but also has the potential to be part of the solution. Thus, the environmental impact generated by the pharmaceutical sector is significant, given its high consumption of non-renewable materials and energy, as well as the extensive generation of by-products and waste, despite its critical life-saving role (Belal et al. 2025). Given the importance of the pharmaceuticals industry, academics such as Min et al. (2017) analyse whether CSR adds value to the financial performance of this type of company. The pharmaceutical industry stands out from other sectors in the coverage of its CSR reports, with relatively consolidated and standardised disclosures in areas such as environmental performance and labour relations, while other issues, including human rights and supply chain practices, still lack uniformity (Demir and Min 2019).

This article is structured as follows. Section 2 analyses the theoretical framework related to the EU Taxonomy and its influence on the pharmaceutical industry, as well as its impact on financial performance. In Section 3, the variables that corroborate this influence are examined in detail. In Section 4, a statistical analysis of the impact of the EU Taxonomy on pharmaceutical firms' performance is conducted, and the results are presented. Finally, the findings are discussed considering their impact on society, and the implications of the study, conclusions and limitations are presented. In addition, future lines of research are proposed to continue and complement this research.

2 | Theoretical Background

Information on corporate sustainability performance has become a critical input to economic decision-making, reflecting broader theoretical perspectives that link organisational responsibility to long-term firm stability and societal value creation. Despite its high energy intensity, in recent years, the pharmaceutical industry has received more attention in terms of sustainability, along with growing awareness of the progress that the sector can still achieve (Bruni et al. 2023).

The growing importance of sustainable development principles, together with pressure from the effects of climate change, has driven the formulation of new policy instruments within the EU (Brabec and Macháč 2025). Consequently, due to international concern for sustainability and the environment, the EU Taxonomy has emerged as a means of classifying sustainable economic activities to guide investments towards the green transition and meet the objectives of the European Green Deal and climate neutrality by 2050. This taxonomy thus makes it possible to direct investments towards key sustainable activities (Tonnarello et al. 2025) linked to climate change mitigation and adaptation. However, it is essential to analyse the impact that different environmental actions have on organisations.

This taxonomy, which emerged in 2020, sets out key conditions that all activities considered environmentally sustainable must meet. The following objectives are therefore highlighted: (a) climate change mitigation; (b) climate change adaptation; (c) sustainable use and protection of water and marine resources; (d) transition to a circular economy; (e) pollution prevention and control; and (f) protection and restoration of biodiversity and ecosystems.

2.1 | Sustainability and Climate Change

There is a strong scientific consensus that the global climate has already undergone substantial changes over the past century and that these changes are expected to continue in the future as long as human-generated greenhouse gas emissions persist (Brunetti et al. 2021). In a global context where climate change poses an imminent threat, companies play a crucial role in mitigating greenhouse gas emissions and promoting sustainable practices (Firmino and Peixoto 2025).

Over the years, it has been shown that CSR can add value to business performance, making it essential for top management to be committed to ensuring that CSR programmes are sustainable over time (Min et al. 2017). Specifically, CSR involves voluntary actions that extend beyond the firm itself (Nussbaum 2009). Thus, the activities undertaken by organisations are fundamental both for their performance and for their social contribution.

At the international level, there is considerable disparity in ESG performance between countries, as well as within the same country over time. Differences in ESG performance can reveal the factors that drive strong outcomes and, therefore, serve as a basis for future improvement strategies and policies (Daugaard and Ding 2022). Consequently, the concepts of CSR and ESG have been the focus of numerous studies in recent years due to their influence and relevance in the international economic landscape. ESG indices have a much longer track record, which has allowed them to consolidate and build trust among investors, companies and society at large. In contrast, the EU Taxonomy constitutes a relatively novel framework, whose indicators are still in the process of being assimilated and disseminated.

Given that pharmaceutical companies manage complex and globalised supply chains across industries, they are key for analysing ESG integration (Bade et al. 2024). Consequently, CSR in the pharmaceutical industry has become established as standard practice, which is expected to continue expanding as it gains importance and is progressively integrated into various strategic areas of business management (Nussbaum 2009).

The impact of greenhouse gas emissions is so significant that the debate on climate change and sustainable development is becoming increasingly intense. Balancing economic growth and carbon emissions is critical to managing irreversible climate change (Long and Feng 2024). Academics such as Treepongkaruna et al. (2024) point out different challenges in the lack of uniformity in ESG criteria; for that reason, regarding environmental aspects, they address variables associated with carbon emissions, particularly carbon dioxide (CO_2) emissions, which are among the most significant factors contributing to climate change. Other researchers highlight a positive relationship between higher ESG scores and better performance in terms of greenhouse gas emissions (Firmino and Peixoto 2025). Although high ESG ratings, particularly in the environmental (E) pillar, may suggest strong sustainability performance, evidence shows that these scores do not always translate into actual reductions in carbon emissions. This discrepancy highlights the need for investors to critically assess companies' tangible environmental outcomes, rather than relying solely on ESG ratings (Treepongkaruna et al. 2024). At the same time, it is difficult for organisations to implement strategies focused on reducing carbon emissions as the costs of such reduction pose several challenges (Gillingham and Stock 2018). An analysis carried out in the Chinese pharmaceutical industry determined that the growth in CO_2 emissions is mainly explained by the scale of production and the intensity of investment, while reduction comes mainly from energy efficiency and research and development (R&D) (Gao et al. 2019).

Academics such as Moriarty and Honnery (2012) emphasise that it is essential for the transition to renewable energies to be accompanied by a significant reduction in total energy consumption. For that reason, energy efficiency is essential due to rising energy prices and uncertainty in supply (Müller et al. 2014). While governance-related CSR positively affects business efficiency, social responsibility initiatives are negatively associated with efficiency, likely due to high implementation costs, ineffective execution and insufficient institutional support limiting stakeholder recognition (Kao and Le 2022). Therefore, considering the efforts made at the governmental level and the road maps generated, it is essential to analyse the influence of these pillars and their impact on the financial performance of this type of organisation.

2.2 | Financial Performance

Pharmaceutical companies must go beyond efficient and sustainable production by also incorporating social factors into their operations. By combining environmental responsibility—through reduced energy consumption and waste generation—with social commitment and financial sustainability, these companies enhance their reputation, reduce operational costs and attract more investors (Amaraveni and Chandana 2024). Consequently, there is growing awareness that achieving global climate and sustainability goals requires finance to be aligned with sustainability (Monasterolo 2020). Scholars such as O'Riordan and Fairbrass (2008) have highlighted the increasing pressure on pharmaceutical companies to address the challenges posed by CSR. According to Lopez-Toro et al. (2021), multinational pharmaceutical firms direct their investments towards sustainability and actively manage controversies in order to strengthen market visibility and increase firm value.

Financial decisions around the world are increasingly influenced by resource scarcity and climate change (Calvet et al. 2022). To achieve the goal of climate neutrality by 2050—an economy with net-zero greenhouse gas emissions—proposed by the EU under the European Green Deal, companies and investors must be well informed about which investments avoid greenhouse gas emissions and can therefore be classified as sustainable (Schütze et al. 2020). Investments continue to be largely directed towards economic activities that are not aligned with climate objectives and conflict with the definition of sustainable finance (Monasterolo 2020). However, some studies show that environmental practices, while their effects on ROA may not be immediate, generate a positive long-term impact on financial performance by reducing energy costs and emissions, aligning with regulations and enhancing customer loyalty and brand image (Amaraveni and Chandana 2024).

The organisation's financial variables have been a concern for various researchers over the years. It should be noted that Velte (2017) used ROA and Tobin's Q as key elements to analyse the link between performance and ESG variables. Other academics, such as Lopez-Toro et al. (2021), analyse the relationship between environmental, social, governance and controversy indicators and financial performance, measured through ROA, ROE, and Tobin's Q. Thus, following the main variables selected by Lopez-Toro et al. (2021), these variables are used to analyse the impact on the financial performance of the pharmaceutical industry. Although many studies have explored the impact of ESG on financial performance, the recent introduction of the EU Taxonomy makes it crucial to understand its strategic effects on the financial results of pharmaceutical companies, as this knowledge can help guide sustainable practices and strengthen the sector's competitiveness.

In line with the above, this analysis uses several latent variables and their respective indicators to assess the relationship between sustainability and financial performance. Taxonomic alignment is measured by the percentage of aligned revenue, capital expenditure (CapEx) and operating expenditure (OpEx). The ESG sustainability profile is captured by emissions intensity, the renewable energy use (REU) ratio and ESG scores. The company's financial performance is assessed using traditional financial indicators such as ROA, ROE, return on sales (ROS) and Tobin's Q. In addition, company size is represented by the logarithm of revenue, employees and total assets, while leverage is measured by the company's leverage ratio.

Considering the relevance of ESG/CSR variables in the pharmaceutical industry, it is important to examine their impact on financial performance. Accordingly, the following research hypotheses, which structure the study, should be taken into account:

H1. *Alignment with the EU Taxonomy has no influence on financial performance.*

H2. *The ESG sustainability profile has a positive influence on financial performance.*

H3. *There is a mediating effect between the EU Taxonomy and financial performance through the ESG sustainability profile.*

3 | Methodology

3.1 | Research Design

This study evaluates the effects of EU Taxonomy alignment and the ESG sustainability profile on financial performance in the pharmaceutical industry, incorporating size and leverage as control variables. To test the theoretical model, we employed partial least squares structural equation modelling (PLS-SEM), a variance-based method suitable for exploratory research and predictive models with complex latent constructs (Hair et al. 2019; Sarstedt et al. 2021). PLS-SEM was implemented using SmartPLS v4.1.1.5 (Ringle et al. 2022), with Mode A composites, as this approach is robust to nonnormal data distributions and allows simultaneous inclusion of control variables.

3.2 | Research Model

The research model (Figure 1) operationalises the hypotheses developed in Section 2 and specifies the relationships tested in the empirical analysis. Specifically, the model includes two exogenous latent constructs—EU Taxonomy alignment and ESG sustainability profile—predicting the endogenous construct financial performance while controlling for firm size and leverage. The model is subsequently estimated using PLS-SEM as described below.

3.3 | Data Sources: EU Taxonomy Alignment Methodology

The operationalisation of the latent constructs is summarised in Table 1. Indicators were sourced from the Refinitiv Eikon (London Stock Exchange Group [LSEG]) database, widely recognised in the academic literature for its scoreised sustainability metrics. Firm performance was assessed using accounting- and market-based measures: ROA, ROE, ROS and Tobin's Q. Taxonomy alignment was captured through the percentage of aligned revenues, CapEx and OpEx; ESG sustainability profile through emissions intensity, renewable energy use and ESG pillar scores; while control variables included log-transformed measures of revenues, assets and employees (Size), and the debt-to-equity ratio (Leverage).

The indicators for EU Taxonomy alignment used in this study (percentage of aligned revenues, capital expenditures and operating expenditures) were obtained from the Refinitiv Eikon (LSEG) database. These metrics are constructed following the official methodology developed by the LSEG, which integrates both as-reported and derived data (London Stock Exchange Group 2024a, 2024b). In particular, aligned CapEx captures the portion of capital expenditures associated with assets and processes linked to taxonomy-aligned activities and can therefore be

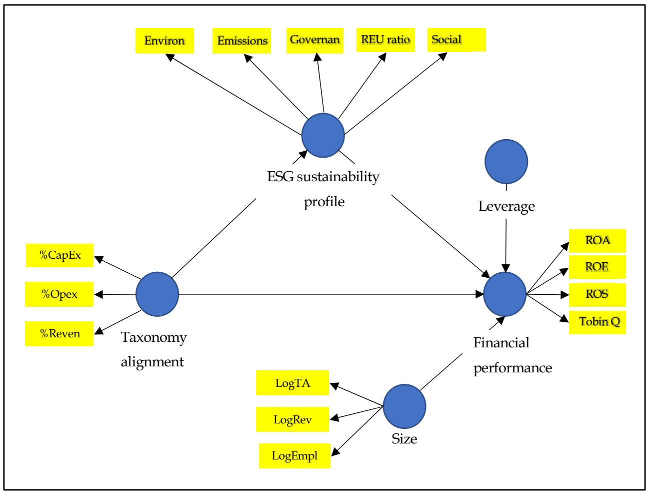

FIGURE 1 | Theoretical model of EU Taxonomy alignment.

TABLE 1 | Latent variables, indicators and definitions.

Latent variables	Indicators	Definitions
Taxonomy alignment	% of aligned Revenues	Percentage of revenue that a company generates from activities that are classified as environmentally sustainable under the EU Taxonomy
	% of aligned CapEx	Percentage of capital expenditure that the company invested in activities that are classified as environmentally sustainable under the EU Taxonomy
	% of aligned OpEx	Percentage of operating expenditure that the company invested in activities that are classified as environmentally sustainable under the EU Taxonomy
ESG sustainability profile	Emissions intensity	Total estimated greenhouse gas emissions across Scope 1 (direct), Scope 2 (purchased energy) and Scope 3 (value chain), expressed in tonnes of CO_2-equivalent, scaled by firm activity and computed as total estimated Scopes 1–3 emissions divided by net sales/revenue (USD million). This metric provides a size-normalised proxy of a firm's carbon footprint and facilitates cross-firm comparability. When emissions are not fully disclosed, Refinitiv/Eikon provides estimated values based on available disclosures and modelling.
	REU ratio	Renewable energy use ratio Total energy purchased from primary renewable energy sources divided by total energy use
	Environmental score	Environmental pillar score The environmental pillar measures a company's impact on living and nonliving natural systems, including the air, land and water, as well as complete ecosystems. It reflects how well a company uses best management practices to avoid environmental risks and capitalise on environmental opportunities in order to generate long-term shareholder value.
	Social score	Social pillar score The social pillar measures a company's capacity to generate trust and loyalty with its workforce, customers and society, through its use of best management practices. It is a reflection of the company's reputation and the health of its license to operate, which are key factors in determining its ability to generate long-term shareholder value.
	Governance score	Governance pillar score The corporate governance pillar measures a company's systems and processes, which ensure that its board members and executives act in the best interests of its long-term shareholders. It reflects a company's capacity, through its use of best management practices, to direct and control its rights and responsibilities through the creation of incentives, as well as checks and balances to generate long-term shareholder value.
Financial performance	ROA	Return on assets Return on average total assets—% (income before discontinued operations and extraordinary items), represents income before discontinued operations and extraordinary items/total assets * 100. Denominator should be positive.
	ROE	Return on equity Represents income available to common excluding extraordinary items/shareholders equity—common * 100. Denominator should be positive. If numerator and denominator are both zero, this will return a value of zero.
	ROS	Return on sales Income after tax margin—% [RIATM] represents the ratio of net income after tax [TR.F.NetIncAfterTax] divided by the value of revenue from business activities—Total [TR.F.TotRevenue], multiplied by 100. Denominator should be positive.
	Tobin Q	Company market capitalisation divided by total assets

(Continues)

TABLE 1 | (Continued)

Latent variables	Indicators	Definitions
Size	Log Revenue	Logarithm of total revenues
	Log employees	Logarithm of number of employees
	LogTotal assets	Logarithm of total assets
Leverage	Leverage	Total debt percentage of total equity represents the ratio of debt—total divided by the value of total shareholders' equity—including minority interest and hybrid debt, multiplied by 100. Denominator should be positive.

Source: LSGE Refinitiv.

interpreted as a standardised proxy for firms' transition-oriented investment in environmentally sustainable (i.e., 'green') technologies and infrastructure within the Taxonomy framework.

The EU Taxonomy alignment indicators (aligned revenues, CapEx and OpEx) are obtained from Refinitiv Eikon (LSEG) and follow the EU disclosure templates when firms report them. However, because disclosure is still uneven across firms and jurisdictions, LSEG complements as-reported values with derived estimates based on standardised business classification and mapped activity data. We summarise this methodology to clarify the provenance, comparability and potential measurement frictions of the Taxonomy KPIs used in our empirical model—an aspect that is particularly relevant when interpreting early-stage evidence on the financial effects of Taxonomy alignment. A detailed description of the LSEG methodology is provided in Appendix A.

We conceptualise the ESG construct as an ESG sustainability profile and operationalise it as a latent variable measured with the indicators reported in Table 1, namely, the Environmental score, Social score and Governance score, complemented by Emissions intensity and the Renewable energy use ratio. The inclusion of the three-pillar measures follows the established ESG literature and provides broad coverage of sustainability-related managerial practices and governance arrangements. Importantly, we additionally incorporate Emissions intensity and Renewable energy use ratio because our research is explicitly grounded in the logic of the EU Taxonomy, which focuses on environmentally sustainable economic activity and climate-related transition efforts; these two indicators capture climate-relevant dimensions that are not always fully reflected by aggregate ESG scores alone, particularly in a sector where decarbonisation and energy sourcing are central operational levers. Consistent with PLS-SEM practice, this construct is not treated as a fixed vendor 'score'; rather, it is empirically calibrated through the measurement-model assessment. Indicators are retained or removed based on their reliability and validity contributions to the latent construct (e.g., loadings/construct reliability and convergent validity), ensuring that the final ESG sustainability profile reflects the subset of indicators that is both theoretically meaningful and statistically robust within the model.

3.4 | Sample and Data Collection

The sample comprises pharmaceutical firms reporting to the Eikon database. Data collection was restricted to the most recent fiscal year available (2024) to ensure comparability across firms. After applying data quality checks (Hair et al. 2019), the final dataset included 217 firms worldwide with complete observations.

The final sample spans a wide range of firm sizes, consistent with the heterogeneity of the global pharmaceutical industry. Based on the log-transformed fundamentals reported in Table 2, firms' revenues range from 7.14 to 10.95 (median 9.11), total assets from 7.02 to 11.36 (median 9.43) and employees from 1.62 to 5.14 (median 3.60), indicating that the dataset includes both smaller specialised firms and large multinational incumbents.

The initial population consisted of 308 firms that disclosed data for the ESG sustainability profile construct at least once in 2024. This construct is discriminating in our analysis, yet it is not consistently reported across all firms. Following PLS-SEM guidance on missing indicators, we retained observations only when missing values per indicator were below 5% (Hair et al. 2019). Applying this rule—together with standard data-quality screens—yielded a final analytical sample of 217 firms. To determine the minimum sample size needed, we follow Faul et al. (2009). The results of applying a significance level of 0.05 with an effect size f^2 of 0.15 using G*Power software were satisfactory. A required size of 89 observations with statistical power of 0.95 was indicated, while we validated 217 observations.

The final sample comprises 217 pharmaceutical firms worldwide. To document sample composition, we classify firms by headquarters location and summarise the geographic distribution in Table A1 (countries) and Table A2 (regions). The sample is predominantly headquartered in Asia-Pacific and the Middle East ($n=124$; 57.1%), followed by North America ($n=51$; 23.5%) and Europe ($n=40$; 18.4%), with a small representation from Africa ($n=2$; 0.9%). At the country level, the largest shares come from China ($n=87$) and the United States ($n=46$), followed by Japan ($n=12$) and India ($n=10$). This distribution reflects broad international coverage while highlighting that the sample is concentrated in major global pharmaceutical hubs.

3.5 | Evaluation of the Measurement Model

Indicator reliability was assessed through outer loadings, with the threshold set at 0.707. Indicators with insufficient reliability were excluded to preserve construct validity. As a result, the model retained % of aligned CapEx as the sole proxy for

TABLE 2 | Descriptive statistics.

Name	Missing	Median	Min	Max	St dev
ROE	0	−0.01	−9.34	2.54	0.83
ROA	0	0.03	−1.07	0.27	0.14
ROS	0	−0.01	−9.32	0.59	0.71
Tobin's Q	0	1.93	0.02	15.95	2.08
Environmental score	0	49.46	0.99	93.39	25.15
Social score	0	54.80	9.42	97.14	24.64
Governance score	0	51.87	4.84	96.39	22.05
% of aligned revenue	0	0.51	0.00	83.11	5.84
% of aligned CapEx	0	11.46	0.00	100	26.68
% of aligned OpEx	0	0.75	0.00	97.38	7.25
Emissions intensity	0	305.12	21.82	1089.63	204.49
REU ratio	0	0.08	0.00	0.93	0.17
Log revenue	0	9.11	7.14	10.95	0.78
Log employees	0	3.60	1.62	5.14	0.72
Leverage	0	0.73	0.00	19.96	2.04
LogTotal assets	0	9.43	7.02	11.36	0.74

Taxonomy alignment, while the emissions intensity indicator was removed from the ESG sustainability profile, and Tobin's Q from financial performance. Internal consistency was verified with Cronbach's alpha and composite reliability (> 0.7), and convergent validity with AVE (> 0.5). Discriminant validity was confirmed using the HTMT ratio and Fornell–Larcker criterion (Henseler et al. 2015).

3.6 | Evaluation of the Structural Model

The structural model was evaluated after validating the measurement model. Multicollinearity was assessed via VIF (< 3.3). Path significance was tested using a bootstrapping procedure with 10,000 resamples, generating t-values, p-values and confidence intervals for hypothesis testing. The model's explanatory power was measured with R^2 for firm performance and effect sizes (f^2).

We specify the structural model equations as follows:

$$\text{Mediator equation: } ESGP = \alpha_1 TaxAl + v \tag{1}$$

$$\text{Outcome equation: } FP = \beta_1 TaxAl + \beta_2 ESGP + \beta_3 Size + \beta_4 Lev + \varepsilon \tag{2}$$

The indirect (mediated) effect of Taxonomy alignment on financial performance through ESG sustainability profile is given by $\alpha 1 \times \beta 2$ and is assessed using bootstrapping.

Where FP denotes firms' performance (ROA, ROE, ROS and Tobin's Q); TaxAl is Taxonomy alignment (% of aligned Revenue, CapEx and OpEx); ESGP is the ESG sustainability profile (emissions intensity, REU ratio and ESG scores); Size is firm size (revenue, employees and total assets); and Lev is leverage.

4 | Results

This section reports the results of the PLS-SEM analysis, estimated with bootstrapped standard errors. We evaluate the hypotheses developed in Section 2 using a bootstrapped PLS algorithm to obtain inference for the structural paths. Figure 2 displays the resulting path diagram (nomogram) with the hypothesised relationships. Consistent with expectations, financial performance is positively and significantly influenced by the ESG sustainability profile, whereas the direct effect of EU Taxonomy alignment on firm performance is not statistically significant. These findings support the idea that, at this stage of data maturity and adoption, the ESG sustainability profile is one of the key factors driving financial performance in the pharmaceutical sector.

4.1 | Descriptive Statistics

Table 2 summarises the main descriptive statistics of the indicators included in the model. Regarding firm performance, the average ROE (−0.01) and ROS (−0.01) reveal considerable heterogeneity across pharmaceutical firms, with extreme negative values (−9.3) reflecting the presence of loss-making companies, while the medians (0.08 for ROE and 0.09 for ROS) suggest that most firms operate close to break-even or with modest profitability. ROA shows a slightly positive mean (0.03), with less dispersion than ROE and ROS, indicating that asset profitability is more stable across the sample.

By contrast, Tobin's Q exhibits the highest variability, ranging from 0.02 to 15.95, with a mean of 1.93, consistent with market-based measures capturing strong valuation gaps within the industry.

Overall, descriptive results underline both the diversity of financial performance within the pharmaceutical sector and the importance of integrating ESG dimensions when assessing firms' strategic positioning.

4.2 | Measurement Model Assessment

The reliability and validity of constructs were evaluated following standard PLS-SEM criteria. Several indicators with low loadings were excluded to improve construct validity: % aligned revenues and % aligned OpEx from the Taxonomy alignment construct, emissions intensity from ESG sustainability profile and Tobin's Q from financial performance. As a result, the final model retained % aligned CapEx as the single proxy for EU Taxonomy alignment, renewable energy ratio and ESG pillar scores for ESG sustainability profile, and ROA, ROE and ROS as measures of financial performance (see Figure 2). All constructs met the thresholds for indicator reliability, internal consistency (Cronbach's alpha > 0.7), convergent validity (AVE > 0.5) and discriminant validity (HTMT < 0.85).

The results presented in the reliability and validity tables confirm that the measurement model meets the standard quality criteria for PLS-SEM. Specifically, Cronbach's alpha and composite reliability values exceed the recommended threshold of 0.70, indicating strong internal consistency among the retained indicators. Average Variance Extracted (AVE) values are above 0.50, which supports convergent validity and shows that each construct explains a sufficient proportion of the variance of its indicators (see Table 3). Furthermore, the HTMT ratios remain well below the conservative cut-off of 0.85 (see Table 4), while the Fornell–Larcker criterion confirms that the square root of AVE for each construct is greater than its correlations with other constructs (see Table 5). Together, these results provide robust evidence of both convergent and discriminant validity, ensuring that the latent variables included in the model are conceptually distinct and reliably measured.

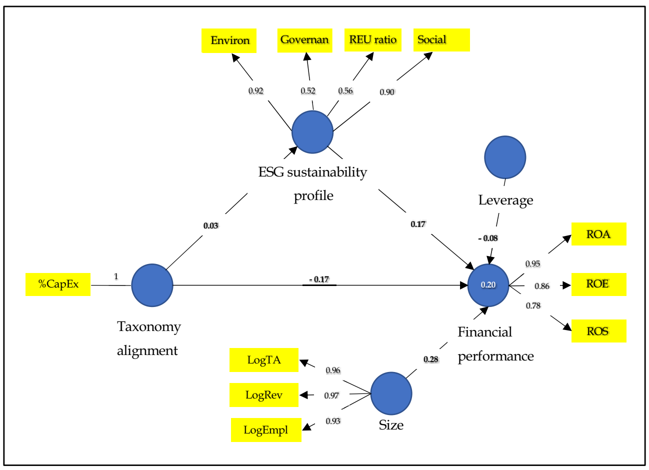

FIGURE 2 | Results of the whole model.

4.3 | Structural Model Results

Table 6 and Figure 2 report the structural model results. Multicollinearity among latent variables was not a concern: inner VIF values were below the conservative 3.3 threshold. The structural model was estimated using PLS with 10,000 bootstrap resamples, yielding path coefficients along with *t*-statistics and *p*-values. The bootstrap procedure was used to assess the statistical significance of each hypothesised relationship and to draw inferences about the structural paths.

The direct effect of EU Taxonomy alignment on firm performance was negative ($\beta = -0.17$), which supports H1. Using our global sample of pharmaceutical firms for fiscal year 2024, higher investment in green activities—as proxied by alignment metrics—does not translate into stronger contemporaneous financial performance. Although the point estimate is negative, the effect is indistinguishable from zero at conventional levels ($p > 0.05$). This result is consistent with recent evidence showing little or no association between Taxonomy alignment and standard operating or valuation metrics during the initial years of mandatory disclosure (e.g., Cheema-Fox et al. 2025). Related work also documents muted or mixed investor responses to moderate/positive taxonomy signals (Chrzan and Pott 2024) and settings where taxonomy constraints appear redundant alongside existing policy instruments (Lygnerud et al. 2025), helping to explain the absence of short-run performance effects in our context.

By contrast, ESG sustainability profile exhibited a positive and significant effect ($\beta = +0.17$, $p = 0.02$), supporting H2. In our global sample, firms with stronger ESG practices—including environmental management (e.g., renewable energy use), social policies and governance systems—exhibit better contemporaneous outcomes.

TABLE 3 | Reliability and construct validity.

	Cronbach's alpha	Dijkstra–Henseler's index	Jöreskog's composite reliability	Average variance extracted (AVE)
ESG sustainability profile	0.74	0.91	0.83	0.56
Financial performance	0.83	0.87	0.90	0.75
Size	0.95	0.96	0.97	0.91

TABLE 4 | Discriminant validity HTMT ratio.

	ESG sustainability profile	Firm performance	Leverage	Size
Firm performance	0.39			
Leverage	0.12	0.10		
Size	0.72	0.41	0.19	
Taxonomy alignment	0.07	0.18	0.13	0.06

TABLE 5 | Discriminant validity Fornell and Larcker criterion.

	ESG sustainability profile	Firm performance	Leverage	Size
ESG sustainability profile	0.75			
Financial performance	0.35	0.87		
Leverage	0.08	−0.04	1	
Size	0.67	0.37	0.19	0.95
Taxonomy alignment	0.03	−0.16	0.13	0.06

TABLE 6 | Results of the whole model.

Direct effects	Path	*t*-Student	*p*	Hypothesis	Conclusion
Taxonomy alignment ≥ financial performance	−0.17	1.64	0.10	H1	Supported
ESG sustainability profile ≥ financial performance	0.17	2.33	0.02	H2	Supported
Mediation effect					
Taxonomy alignment ≥ ESG sustainability profile ≥ financial performance	0.00	0.30	0.76	H3	Not supported
Control variables effects					
Leverage ≥ financial performance	−0.08	0.58	0.56	N/A	No
Size ≥ financial performance	0.28	3.33	0.00	N/A	Yes

Finally, we tested whether EU Taxonomy alignment affects financial performance indirectly through ESG sustainability profile (H3). The bootstrapped indirect effect Taxonomy alignment → ESG sustainability profile → Financial performance was not significant ($\beta = 0.00$, $p = 0.76$), and thus, H3 is rejected. Together with the nonsignificant direct path from Taxonomy alignment to firm performance ($\beta = -0.17$, $p = 0.10$), this indicates that Taxonomy alignment does not explain contemporaneous performance (neither directly nor indirectly) in our global 2024 pharma sample.

Regarding the control variables, firm size captures scale economies as expected in the pharmaceutical industry and shows a positive, significant association with performance, reflecting operating leverage and market power. Size showed a significant positive association with performance ($\beta = +0.28$, $p < 0.01$), while leverage was negative but nonsignificant ($\beta = -0.08$, $p = 0.56$), suggesting that capital structure heterogeneity does not drive outcomes in our model.

The endogenous construct, financial performance, reached an R^2 of 0.20, indicating a moderate explanatory power. Effect sizes (f^2) were in the low range (0.01–0.08) according to the thresholds proposed by Cohen (1988). In line with the methodological framework of the PLS-SEM approach, which emphasises both prediction and causal explanation (Wold 1982), the Q^2 value (Stone–Geisser) was also evaluated using the blindfolding procedure, yielding positive values for the endogenous construct. These results, with Q^2 greater than zero, corroborate the predictive ability of the model, demonstrating that it reconstructs omitted data better than mere means and showing that higher Q^2 indicates superior performance in terms of predicting new cases (Hair et al. 2019; Sarstedt et al. 2021). This triad—R^2 for explanatory power, f^2 for effect size, and Q^2 for predictive relevance—provides robust methodological justification for the estimation strategy employed and ensures that the reported results are relevant for both causal interpretation and practical predictive utility of the model.

5 | Discussion

The endogenous construct, firm performance, achieved an R^2 value of 0.20, indicating that the model explains 20% of the variance in firm performance. This level of explanatory power is considered moderate and is consistent with prior exploratory research in sustainability contexts and complex industries, where firm performance is influenced by multiple interrelated factors (Falk and Miller 1992).

The findings show that EU Taxonomy alignment does not have a significant impact on financial performance (H1). Although the estimated association is negative, it is not statistically significant. In contrast, better performance across the three pillars of the ESG framework, as well as the adoption of renewable energy practices, is positively associated with financial performance (H2). Importantly, when referring to 'green investments' in this context, we mean the investment component embedded in Taxonomy alignment—particularly aligned CapEx, which reflects the share of capital expenditures linked to taxonomy-aligned activities. In this regard, prior research suggests that certain ESG-related activities can influence financial outcomes and reinforce the link between corporate financial results and ESG disclosure (Amaraveni and Chandana 2024). This finding is consistent with the broader literature: meta-analytic evidence reports that the ESG–corporate financial performance relation is predominantly non-negative and frequently positive (Friede et al. 2015); firms that invest in financially material sustainability issues outperform peers (Khan et al. 2016); and organisations with embedded sustainability practices show superior long-run results (Eccles et al. 2014). Mechanistically, ESG can also enhance performance by reducing risk, which theory and evidence link to higher firm value (Albuquerque et al. 2019).

On the other hand, it is necessary to highlight that, in line with these conclusions, some multinational pharmaceutical companies continue to direct their investments towards sustainability (Lopez-Toro et al. 2021). Thus, with regard to H3, it should be confirmed that in this investigation the EU Taxonomy does not produce either direct or indirect effects on performance. In this regard, a concise interpretation is timing: Taxonomy indicators are still in an early adoption phase (and partly derived), whereas ESG profiles capture more mature, embedded practices; any influence of alignment on performance is therefore likely to emerge with a lag via subsequent changes in ESG practices rather than within the same fiscal year.

A key implication is that high ESG ratings and near-zero EU Taxonomy alignment can legitimately coexist. ESG ratings predominantly assess risk management, governance, disclosure quality and policy frameworks at the firm level, whereas the EU Taxonomy quantifies the share of economic activities meeting technical screening criteria, DNSH and minimum safeguards in revenues/CapEx/OpEx. Consequently, companies—particularly in high-emitting industries—may score strongly on ESG while showing minimal taxonomy-aligned activity if their core business has not (yet) migrated to technologies that satisfy the taxonomy's thresholds. This divergence helps reduce greenwashing by tying sustainability claims to auditable, activity-based KPIs. Recent evidence documents weak correlations between alignment metrics and conventional environmental ratings/emissions in the first disclosure year (Cheema-Fox et al. 2025) and highlights early reporting frictions that can slow the translation of policies into aligned activity shares (Hummel and Bauernhofer 2024).

Overall, the results suggest a clear guideline for managers and stakeholders: in the short term, ESG functions as an operational lever and a more mature market signal, while the taxonomy will likely gain relevance as coverage, verification and conversion from eligible to aligned (especially in CapEx) improve. Therefore, companies should consolidate ESG practices that impact performance and, in parallel, strengthen their reporting and activity mapping systems to capture the effects of the Taxonomy as its adoption progresses and the time lag between policies and aligned activity is reduced.

6 | Conclusions

Sustainability has become a central concern for contemporary society, requiring organisations to evaluate the economic implications of their activities and also their broader impact on performance and long-term resilience. In that sense, this study analyses these relationships over the period 2024 by employing a PLS-SEM approach. The model incorporates different key variables such as Taxonomy alignment (measured by the percentage of aligned revenues, capital expenditures and operating expenditures), ESG performance (captured through greenhouse gas emissions, renewable energy use ratio and environmental, social and governance scores), firm performance (assessed via ROA, ROE, ROS and Tobin's Q), as well as size (logarithm of revenues, employees and total assets) and leverage. The findings contribute to a deeper understanding of how sustainability-related factors interact with financial and organisational outcomes, providing valuable insights for both academics and business practitioners.

First, the validation of H1 indicates that alignment with the EU Taxonomy is indeed a relevant factor; however, its direct effect on firm performance appears to be limited. In contrast, H2 demonstrates that ESG performance exerts a clear and significant influence on firm performance, underscoring the growing international recognition of ESG factors and the increasing awareness of their relevance within organisations.

Furthermore, the results related to H3 reveal that ESG performance does not mediate the relationship between EU Taxonomy alignment and firm performance. This may suggest that, while the EU Taxonomy provides a structured regulatory framework, its influence has not yet been fully integrated into firms' strategic or operational practices in a way that translates directly into financial outcomes. By contrast, ESG metrics are more widely adopted, standardised and understood at the global level, which may explain their stronger and more immediate impact on firm performance.

To sum up, these results highlight the need for greater diffusion and practical adoption of the EU Taxonomy in order to strengthen its role in shaping organisational outcomes, while also reaffirming the strategic importance of ESG factors in bridging sustainability and financial performance. ESG currently emerges as the more actionable lever for managers and stakeholders seeking near-term performance gains, whereas the financial salience of Taxonomy alignment is likely to materialise with a lag as disclosure coverage improves, verification deepens and eligible to aligned transitions become visible—especially through CapEx mapping to taxonomy-compliant activities. We therefore encourage firms to (i) consolidate ESG practices that demonstrably affect outcomes, and (ii) strengthen internal reporting systems to track, validate and scale Taxonomy-aligned activities.

7 | Implications

This research is particularly relevant within the current context of the international market. Our results indicate that ESG performance functions as an immediate, actionable lever for corporate outcomes in pharmaceuticals, whereas EU Taxonomy alignment has not yet translated into contemporaneous performance effects. Practically, this means executives should concentrate on embedding environmental management (including renewable energy use), product responsibility and safety, human capital practices and governance controls into day-to-day operations and performance dashboards. In parallel, firms should develop internal capabilities to measure and verify alignment at the level of activities and investment projects so they can demonstrate, through auditable evidence, that future CapEx is directed towards converting currently eligible activities into fully taxonomy-aligned ones as reporting standards mature.

For investors and analysts, the findings argue for using two complementary lenses. ESG scores signal risk management quality and organisational discipline, which matter now, while Taxonomy indicators provide activity-level credibility about where value will be created later. Emphasis should be placed on the trajectory of aligned CapEx and on clear mapping between business segments and technical screening criteria, DNSH and minimum safeguards, in order to distinguish robust transitions from purely narrative claims and to mitigate greenwashing risk.

For policymakers and standard setters, the evidence highlights data-maturity frictions in an intangible-, R&D-intensive sector. Clarifying criteria application along pharma value chains, strengthening verification and encouraging disclosure of forward CapEx road maps can accelerate the point at which alignment becomes financially salient. In short, managers should harvest the operational gains of ESG today while laying the foundations for credible, auditable Taxonomy alignment that markets can price as the regime consolidates.

8 | Future Research Lines

It is essential to issue a call to future researchers and academics to continue examining topics related to the environment. Sustainability, both in the medium and long term, must be regarded as a shared responsibility. For this reason, it is necessary to take into account the policies established by governmental bodies, the manner in which such policies affect organisations, the adaptation and integration periods they require and the outcomes or objectives achieved through their implementation and monitoring.

In this sense, conducting detailed analyses of specific territories or business sectors will prove valuable, as it will enable comparisons across countries, internal policies and forms of governmental support or incentives. Thus, analysing the economy from this perspective becomes particularly relevant, as it allows for a deeper understanding of the interconnections between environmental sustainability, regulatory frameworks and organisational performance. Such an approach highlights the economic implications of environmental policies and also provides a basis for evaluating the efficiency and resilience of organisations within an increasingly demanding international context.

9 | Limitations

This study is not without limitations. In this regard, it is necessary to consider the specific dataset analysed. The data were sourced exclusively from Refinitiv, so results depend on its coverage and methodology. This research focuses on the pharmaceutical industry; in that sense, findings may not directly apply to other sectors. Future studies should use updated data and consider broader industry coverage. Accordingly, it is essential to incorporate additional time periods in future research in order to enable a more comprehensive comparison of the results obtained. It must also be acknowledged that this investigation focuses particularly on the EU and the taxonomy it has established in relation to sustainability.

Author Contributions

Alicia Ramírez-Orellana: conceptualization, data curation, formal analysis, methodology, supervision, writing – original draft, writing – review and editing. **Cristina Blanco González-Tejero:** conceptualization, data curation, formal analysis, methodology, supervision, writing – original draft, writing – review and editing. **Silvia Giralt Escobar:** conceptualization, data curation, formal analysis, methodology, supervision, writing – original draft, writing – review and editing. **Antonio Garcia-Amate:** conceptualization, data curation, formal analysis, methodology, supervision, writing – original draft, writing – review and editing.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Appendix A

Construction of EU Taxonomy KPIs in LSEG/Refinitiv

On the one hand, starting from January 2023, firms falling under the scope of the Nonfinancial Reporting Directive (NFRD)—and subsequently the Corporate Sustainability Reporting Directive (CSRD)—have been required to disclose the share of their revenues, CapEx and OpEx that are eligible and aligned with the EU Taxonomy. These figures constitute the as-reported data, which follow the disclosure template set by the EU Taxonomy Delegated Act.

On the other hand, given that not all companies report such information consistently, LSEG complements disclosures with its own derived estimates. This methodology combines several proprietary datasets:

- FTSE Russell Green Revenues (GRCS) classifies company revenues across 133 green microsectors and maps them against the six environmental objectives of the EU Taxonomy.
- LSEG Business Classification (TRBC) provides a detailed classification of business activities, mapped to NACE codes, enabling consistency with EU regulation.
- LSEG Fundamentals includes revenues, CapEx and OpEx data, which serve as a basis for calculating alignment ratios.
- LSEG ESG indicators: more than 600 environmental, social and governance measures used to evaluate the Substantial Contribution (SC), Do No Significant Harm (DNSH) and Minimum Social Safeguards (MSS) requirements.

The derivation process follows a five-step procedure (London Stock Exchange Group 2024b):

1. Selection of data sources (Green Revenues, TRBC and Fundamentals).
2. Classification of business segments into eligible and noneligible activities.
3. Application of the EU Taxonomy Technical Screening Criteria (TSC) to test for substantial contribution.
4. Testing of DNSH and MSS requirements through mapped ESG indicators.
5. Calculation of final percentages of aligned revenues, CapEx and OpEx by combining as-reported and derived data.

This hybrid methodology allows for broader coverage and international comparability, while ensuring transparency and auditability of the alignment metrics. As such, the EU Taxonomy indicators used in this research represent standardised and reliable measures of firms' environmental alignment within the pharmaceutical sector.

TABLE A1 | Country of headquarters and number of firms (final sample, $N=217$).

Country of headquarters	Number of firms
China	87
United States of America	46
Japan	12
India	10
Switzerland	6
Hong Kong	6
United Kingdom	5
Germany	4
Spain	4
Canada	4
Ireland	4
France	3
Denmark	3
Sweden	3
Italy	2
Australia	2
Turkey	2
Malaysia	2
South Africa	2
Finland	2
Thailand	1
Slovenia	1
Indonesia	1
Israel	1
Belgium	1
Hungary	1
Mexico	1
Poland	1
Total	**217**

TABLE A2 | Regional distribution of the sample (final sample, $N=217$).

Region	Number of firms	Share of sample (%)
Asia-Pacific and Middle East	124	57.1
North America	51	23.5
Europe	40	18.4
Africa	2	0.9
Total	**217**	**100.00**