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THE RELATIONSHIP BETWEEN ENVIRONMENTAL RESPONSIBILITY AND THE FINANCIAL PERFORMANCE OF POLISH LISTED COMPANIES

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ABSTRACT: The aim of the paper is to examine how the degree of achieving environmentally sustainable revenues and incurring environmentally sustainable expenditures impacts the profitability of Polish listed companies. The research method used is multiple regression analysis. The research results do not confirm the hypothesised positive impact of environmental responsibility on the financial results of companies. The greater the percentage of operating expenditures allocated to environmentally sustainable economic activities, the lower the profitability of companies measured by return on assets, return on equity and return on sales. Moreover, the percentage of revenues obtained from products or services related to environmentally sustainable economic activities is irrelevant to the level of profitability of companies. This study adds to the literature on the linkage between corporate environmental performance and financial performance, and its novelty lies in measuring the level of commitment to environmental responsibility using financial metrics based on the recently implemented EU Taxonomy Regulation.

KEYWORDS: environmental performance, corporate financial performance, EU Taxonomy

Introduction

The impact of enterprises on the natural environment is, most often, negative, consisting of its degradation as a result of the exploitation of resources and waste disposal, but also positive, manifested by undertaking environmental protection projects. The increasing involvement of enterprises in environmental responsibility is the result of constantly growing legal requirements, the increase in ecological awareness of societies and pressure from investors and financial institutions. The environmental activities of enterprises generate certain costs and, at the same time, bring certain benefits to business entities, including those that are financially measurable.

Being environmentally responsible usually involves incurring capital expenditure on pro-ecological projects and various types of operating expenditure, related, e.g. to the operation of protective devices, environmental fees, purchase of emission allowances, waste disposal services, the use of environmentally friendly raw materials and energy sources. The benefits of environmental protection activities can come in the form of revenues and savings. Examples of revenues from environmental activities include revenues from increased sales of products thanks to the image of an environmentally friendly company, sales of by-products from the operation of protective equipment, sales of surplus emission allowances or subsidies. Environmental practices may also bring savings to firms in the form of, e.g. reducing raw material and energy consumption, reducing environmental fees, lower insurance rates and lower cost of capital thanks to reduced environmental risk and avoided compensation for civil liability in environmental protection (Dyduch, 2013). The question of whether the benefits for companies resulting from environmental responsibility outweigh its costs or vice versa, i.e. whether environmental performance improves or worsens financial performance, remains without an unambiguous answer so far (Gao & Wan, 2023; Ghosh et al., 2023; Ooi et al., 2024). Numerous empirical studies conducted hitherto argue in favour of both a positive impact of environmental responsibility on corporate financial situation and a negative impact, or its absence.

The aim of the paper is to examine how the degree of achieving environmentally sustainable revenues and incurring environmentally sustainable expenditures impacts the profitability of Polish listed companies. This study adds to the literature on the linkage between corporate environmental performance and financial performance, and its novelty lies in measuring the level of commitment to environmental responsibility using financial metrics based on the recently implemented EU Taxonomy Regulation (Regulation, 2020). The EU Taxonomy is a classification system that allows for the examination and disclosure of the extent to which companies' economic activities are environmentally sustainable. The purpose of this classification is, among others, reorienting investors' capital allocation towards sustainable projects and limiting greenwashing practices. The EU Taxonomy Regulation regarding non-financial undertakings applies to listed companies that are public interest entities. It requires these companies to report in their nonfinancial statements to what extent their business activities are consistent with the assumptions of the Taxonomy by indicating what percentage of turnover, operating expenditure and capital expenditure contributed to the implementation of the environmental objectives specified in the Taxonomy. Key regulatory frameworks directly linked to the EU Taxonomy Regulation are the Non-Financial Reporting Directive (Directive, 2014) and the Corporate Sustainability Reporting Directive (Directive, 2022). The EU Taxonomy Regulation, through its Article 8, explicitly requires companies covered by these directives to disclose the extent to which their economic activities comply with the Taxonomy's sustainability goals. The group of entities subject to the EU Taxonomy Regulation is to be gradually expanded in the coming years.

The analysis of the relationship between environmental responsibility and profitability in this study is based on a sample of 94 non-financial companies listed on the Warsaw Stock Exchange, selected according to specific criteria, including compliance with EU Taxonomy disclosure requirements and positive financial results. Multiple regression analysis is used to test the hypothesis that environmental responsibility has a positive impact on profitability.

The remainder of the paper is structured as follows. The following section provides the literature review on the linkage between corporate environmental performance and financial performance. The sample selection, data, and regression models are then presented. Next, the results of the regression analysis are shown and discussed. The final section indicates conclusions, research limitations and suggestions for further research.

An overview of the literature

The relationship between corporate environmental activity and the financial condition (financial results) of an enterprise is considered in the literature of economics in the context of various theories: trade-off hypothesis, Porter hypothesis, stakeholder theory, the theory of supply and demand (of and for environmentally friendly products) and the hypotheses of positive and negative synergy.

The trade-off hypothesis reflects the views of M. Friedman, who claimed that the only social responsibility of business is to increase its profits, and the environmental and social corporate activities are in contradiction with the maximisation of shareholder value (Friedman, 1970). This hypothesis assumes a negative impact of environmental activity on the financial situation of enterprises, because the costs of environmental protection exceed its economic benefits. Environmental protection may divert resources from a company's principal activities and thus create a relative disadvantage for it compared to competing firms that are environmentally unfriendly. This view applies in particular to investments in the so-called end-of-pipe projects that can be viewed as cost-only ones (Trumpp & Guenther, 2017).

Opposing views on the impact of environmental protection on the financial condition of enterprises were expressed by Porter and van der Linde (Porter, 1991; Porter & van der Linde, 1995), whose idea is currently known as the Porter hypothesis. According to this hypothesis, tightening environmental requirements may contribute to improving the competitiveness of enterprises, which will consequently result in an increase in their profits. The reason for this is that stricter environmental requirements should encourage enterprises to seek and implement broadly understood 'green' innovations, which include, for example, improved products and services, production technologies, and organisational and marketing solutions. Eco-innovations can achieve savings, increase productivity and create new market opportunities. Porter and van der Linde particularly point out the benefits that can be gained by companies that are the first on the market to implement innovative environmental solutions and sell them to other entities.

Various stakeholders (e.g. owners, creditors, employees, customers, suppliers, competitors, local community, non-governmental organisations) have certain expectations towards the company. Meeting them by the managers of – according to stakeholder theory – is in the interest not only of the people expressing these expectations, but also of the company itself, because it leads to an increase in its value, bringing it certain benefits, e.g. improving reputation, customer loyalty and reducing the risk of doing business. Some stakeholders demand that the company engage in environmental protection activities. Stakeholder theory suggests that positive results from pro-environmental projects improve the company's financial position by satisfying these stakeholders and creating a favourable reputation for the entity (Allouche & Laroche, 2005). It should be noted, however, that the expectations of different stakeholder groups may be contradictory, and it will not always be possible to reconcile them. The hypothesis of a positive impact of environmental activities on the company's financial results in the light of stakeholder theory therefore assumes that either (almost) all stakeholders expect the company to pursue an appropriate environmental policy, or that greater benefits for the company's financial situation result from meeting the needs of stakeholders with a strong pro-ecological attitude at the expense of expectations of stakeholders with non-environmental goals related to the company.

The theory of supply and demand (of and for environmentally friendly products), presented by McWilliams and Siegel (2001) with regard to corporate social responsibility activities, assumes the existence of an optimal level of environmental investments that maximises the company's profit. This level can be determined using a cost-benefit analysis, taking into account the demand for products characterised by high environmental friendliness and the cost of their production. Companies that engage in environmental protection incur higher costs, but at the same time earn higher revenues thanks to consumers willing to pay higher prices for their environmentally friendly products. Enterprises that do not invest in pro-ecological projects have lower production costs, but also lower prices for the products they offer, which do not have features that indicate their lower negative impact on the environment. Assuming that both types of enterprises make optimal choices and produce at a level that allows them to maximise their profits, the rate of profit achieved will be identical in all enterprises. The supply and demand theory, therefore, predicts a neutral relationship between corporate environmental performance and financial performance.

According to the positive and negative synergy hypotheses, corporate environmental and financial performance are synergistic: they reinforce or weaken each other, respectively. A good environmental performance contributes to improving the company's financial condition, which in turn leads to increased pro-ecological investments and improved environmental performance (positive synergy hypothesis). It is also possible that the mutual impact of both types of results is weakening: poor results of environmental activities worsen the financial results of the enterprise, which in turn results in a limitation of pro-ecological projects undertaken in the enterprise (negative synergy hypothesis) (Allouche & Laroche, 2005).

The linkage between environmental performance and financial performance has been so far examined in many empirical studies which argue in favor of a negative relationship (confirming the trade-off hypothesis), a positive relationship (supporting the Porter hypothesis or stakeholder theory), a neutral relationship (according to the theory of supply and demand of and for environmentally friendly products) or a bidirectional relationship (proving the hypotheses of positive and negative synergy). Moreover, research has also explored the influence of various determinants, such as industry type or ownership structure, while identifying more complex patterns, including U-shaped and inverted U-shaped relationships, reflecting the multifaceted and context-dependent nature of this linkage. Additionally, some studies suggest that the nature of this relationship may differ in the short term and the long term, further emphasising its dynamic character (cf. Table 1).

Table 1. Empirical studies on the impact of environmental performance on the financial performance of corporations

Studies	Research results	Theoretical framework
Abban & Hasan (2021), Brahmana & Kontesa (2021), Gallego-Álvarez et al. (2015), Gao & Wan (2023), Gull et al. (2022), Manrique & Martí-Ballester (2017), Partalidou et al. (2020), Sandberg et al. (2023), Zeng et al. (2024)	Positive impact of companies' environmental performance on their financial situation	Porter hypothesis Stakeholder theory
Clarkson et al. (2011), Liu (2020), Nakao et al. (2007)	Positive mutual relationship between companies' environmental performance and their financial situation	Positive synergy hypothesis
Brouwers et al. (2018), Busch et al. (2022), Duque-Grisales & Aguilera-Caracuel (2021), Linder et al. (2014), Robaina & Madaleno (2020), Rokhmawati et al. (2015), Wagner et al. (2002)	Negative impact of companies' environmental performance on their financial situation	Trade-off hypothesis
Baah et al. (2021), Doni & Fiameni (2024), Lewandowski (2017), Ooi et al. (2024), Xu & Zhu (2024).	Positive or negative impact of companies' environmental performance on their financial situation depending on various factors	Contextual factors framework
Horváthová (2012), Chomachaei & Golmohammadi (2024)	Negative impact of companies' environmental performance on their financial situation in the short term, positive in the long term	Time-dependent theoretical framework
Dragomir (2013), Dubravská et al. (2020), Link & Naveh (2006), Lucato et al. (2017), Pinteá et al. (2014), Szedmák & Szabó (2023)	No relationship between companies' environmental performance and their financial situation	Theory of supply and demand of and for environmentally friendly products
Fujii et al. (2013), Misani & Pogutz (2015), Tatsuo (2010)	Inverted U-shaped relationship between companies' environmental performance and their financial situation	Non-linear relationship framework
Ghosh et al. (2023), Trumpp & Guenther (2017)	U-shaped relationship between companies' environmental performance and their financial situation	

Gao and Wan (2023) claim, based on research on Chinese listed companies, that corporate environmental responsibility contributes to increasing operational efficiency and reducing the cost of debt, which in turn improves corporate financial performance. Gull et al. (2022) found that US listed companies that are best-in-class in environmental performance achieve better financial results (in terms of Tobin's q and return on assets) than their industry peers. The environmental performance

assessment included emission reduction, product innovation and resource reduction. According to the research of Zeng et al. (2024) on listed companies in highly polluting industries in China, higher levels of environmental irresponsibility contribute to lower financial performance. This positive linkage between environmental performance and financial performance is moderated by corporate philanthropy. The study by Kozubíková et al. (2023), based on responses from 1,398 small and medium-sized enterprises in the Visegrad countries, confirms a statistically significant positive impact of environmental responsibility on the perceived profitability of these enterprises.

Similarly, other research conducted by Gallego-Álvarez et al. (2015), Partalidou et al. (2020), Abban and Hasan (2021), Brahmana and Kontesa (2021), and Sandberg et al. (2023) also shows the positive impact of environmental practices on firms' financial results. In addition, the reciprocal positive bidirectional relationship between the results of environmental activities of enterprises and their financial situation was found in studies by Nakao et al. (2007), Clarkson et al. (2011) and Liu (2020), confirming the positive synergy hypothesis.

However, the trade-off hypothesis, assuming a negative effect of environmental activities on corporate financial performance, is also supported by some studies. Rokhmawati et al. (2015) examined Indonesian companies for the relationship between CO₂e intensity (measured as the ratio of a kilogram of CO₂e to cost of goods sold) and profitability (measured by return on assets) and concluded that companies with higher CO₂e emissions have a better financial position. Robaina and Madaleno (2020) claim that Portuguese firms perceive environmental protection as additional costs, and more pollution emitted by them is associated with higher financial results. According to Duque-Grisales and Aguilera-Caracuel (2021), multinational firms from Brazil, Chile, Colombia, Mexico and Peru with better environmental scores achieved poorer financial results. The deterioration of the financial position of companies as a result of pro-ecological activities is also confirmed by research by Wagner et al. (2002), Linder et al. (2014) and Brouwers et al. (2018).

Whether a commitment to environmental protection improves or worsens a company's financial position may depend on the ownership structure of the company. Ooi et al. (2024) observed a positive impact of carbon strategy on the financial performance of Malaysian listed companies with higher levels of foreign ownership and an adverse impact for companies with higher levels of government shareholdings. Similarly, Xu and Zhu (2024) pointed out that the ESG performance of non-state-owned enterprises in China plays a more visible role in improving financial performance as compared to state-owned enterprises.

The relationship between environmental performance and the financial position of companies may also be influenced by other factors, such as environmental performance level, the company's approach to environmental orientation, innovation level and the sector or country in which the company operates. The results of the research by Lewandowski (2017) suggest that reducing greenhouse gas emissions brings financial benefits for companies with excellent carbon records, but not for companies with poorer carbon records. According to Baah et al. (2021), green production practices that go beyond compliance with environmental regulations and include other voluntary practices that are not mandatory for manufacturing companies (proactive approach to environmental orientation), burden their financial capabilities and have a negative impact on their financial performance. However, a reactive approach to environmental orientation, i.e. striving only to meet environmental regulations, has a positive impact on the companies' financial performance. Doni and Fiameni (2024), examining companies included in the Euro Stoxx index, found a positive impact of environmental performance on the financial performance for high-innovation firms, a negative impact for low-innovation firms and no linkage between environmental performance and financial performance for medium-innovation firms. ESG performance turned out to be insignificant for the financial position of Chinese enterprises in highly polluting industries, while in the case of non-heavily polluting industries, ESG performance exerted a positive effect (Xu and Zhu, 2024). Manrique and Martí-Ballester (2017) analysed whether the adoption of environmental practices allows companies to improve their corporate financial performance, considering both developed and developing countries during the global financial crisis. Their study shows that the positive impact of environmental practices is more pronounced for companies located in developing countries than those located in developed countries.

Green business practices and investments may, in the short term, result in a deterioration of the financial condition of companies, and only after a longer period may they become profitable. The

explanation for this may be that stakeholders may have a delay in recognising and appreciating the company's improved eco-efficiency. Moreover, savings from regulatory compliance costs are difficult to achieve in the short term (Busch et al., 2022). Horváthová (2012) based on the sample of the Czech firms found a deterioration of financial performance in the case of environmental performance with a one-year lag and its improvement in the case of environmental performance with a two-year lag. Chomachaei and Golmohammadi (2024) reached similar conclusions regarding the negative impact of environmental activities on the companies' financial results in the short term and the positive impact in the long term when examining the linkage between the stringency of environmental policy and the financial performance of European automobile manufacturers. By contrast, the study by Busch et al. (2022) indicates a statistically significant negative impact of reducing carbon emissions on the financial performance not only in the short term (measured by return on assets), but also in the long term (measured by Tobin's q).

The results of some studies suggest that the financial condition of enterprises does not depend on the level of their commitment to environmental protection and environmental practices. Link and Naveh (2006) examined the financial implications of implementing the environmental management standard ISO 14001 for forty companies and concluded that achieving improved environmental performance neither worsened nor improved their business performance. This finding is consistent with Dragomir's (2013) study based on panel data of 77 European business groups, which confirms the indifference of financial performance to greenhouse gas emission levels and supports the theory of supply and demand (of and for environmentally friendly products). Pinteá et al. (2014) examined the relationship between environmental performance and the financial results of Romanian companies, revealing no significant association with profitability, costs, or revenues. In light of the research by Szedmák and Szabó (2023), focusing on environmental sustainability has no impact on profitability for Hungarian small and medium enterprises, neither in the short term nor in the long term. Similarly, Lucato et al. (2017) analysed the impact of eco-efficiency level on the financial condition of small and medium textile manufacturing companies in Brazil and found no statistically significant relationship between environmental performance and financial results. Additionally, the study by Dubravská et al. (2020) reveals that the implementation of an environmental management system does not affect the profitability of companies, as demonstrated by their research on the largest enterprises operating in various industries in Slovakia.

The relationships between environmental performance and financial performance may be more complex and have a non-linear form, in particular a U-shaped curve or an inverted U-shaped curve (Fujii et al., 2013; Trumpp & Guenther, 2017; Ghosh et al., 2023). The U-shaped curve of these relationships illustrates a situation in which firms can only achieve a surplus of benefits over costs from this activity after exceeding a certain level of involvement in environmental activities. As suggested by Fujii et al. (2013), the reason for this is a change in the environmental protection strategy. Initially, companies use a reactive strategy to comply with environmental standards, based on the use of end-of-pipe protective technologies, which are expensive. Then, thanks to employees gaining knowledge and experience related to reducing pollution, firms are ready to implement a preventive strategy based on the concept of cleaner production, which brings them more benefits than costs. The inverted U-shaped curve illustrates a situation in which increasing involvement in pro-ecological projects improves the financial situation of the company to a certain level, beyond which the marginal costs are higher than the marginal benefits of reducing pollution. The explanation for this may be the need for the company to use increasingly advanced environmental protection technologies with increasingly higher marginal costs of pollution reduction in order to further improve its environmental performance.

The study by Tatsuo (2010) reveals support for the inverted U-shaped relationship between eco-efficiency in terms of CO₂ emissions and financial performance for Japanese manufacturing firms. This result is consistent with the findings of Fujii et al. (2013), who also examined Japanese firms and found that efforts to reduce the aggregated toxic risk initially are accompanied by increasing profitability, but beyond a certain level, more efforts result in deterioration of profitability. Similarly, Misani and Pogutz (2015) investigated the impact of carbon emissions on Tobin's q for firms participating in the Carbon Disclosure Project and indicated an inverted U-shaped linkage between environmental performance and financial performance. On the other hand, the research by Trumpp and Guenther (2017) based on an international sample of firms found a negative impact of carbon performance and

waste intensity on profitability for the low level of environmental performance and a positive impact after exceeding a certain point of environmental performance. Also Ghosh et al. (2023) claim that a U-shaped relationship between environmental performance and Tobin's q is the case for non-financial Indian companies.

In summary, existing empirical research on the impact of environmental protection on the financial results of enterprises brings contradictory conclusions. The reason for this may be the use of different methodological approaches. Researchers use various measures of corporate financial performance such as return on assets (Rokhmawati et al., 2015; Gull et al., 2022; Galeazzo et al., 2024), return on equity (Sandberg et al., 2023; Ooi et al., 2024), Tobin's q (Misani & Pogutz, 2015; Busch et al., 2022; Ghosh et al., 2023), cost of capital (Gao & Wan, 2023), cash flow per share (Doni & Fiameni, 2024) or Altman's Z score (Wedari et al., 2023). There is even greater variation in the measurement of environmental performance which can be considered in terms of the company's environmental impact such as – especially – carbon emission (Brahmana & Kontesa, 2021; Brouwers et al., 2018; Busch et al., 2022; Dragomir, 2013; Gallego-Álvarez et al., 2015; Tatsuo, 2010) or eco-efficiency level (Lucato et al., 2017), waste spills (Brahmana & Kontesa, 2021), pollution level (Robaina & Madaleno, 2020), aggregated toxic risk (Fujii et al., 2013), and emission of toxic substances (Clarkson et al., 2011) or CO₂e (Rokhmawati et al., 2015) in relation to the cost of goods sold. Another way of measuring environmental performance takes into account actions to reduce the adverse impact of companies such as implementation of the environmental management standard ISO 14001 (Link and Naveh, 2006), environmental initiatives (Abban & Hasan, 2021), environmental production practices (Baah et al., 2021), efforts and investments in corporate environmental responsibility (Gao & Wan, 2023) and carbon strategy (Ooi et al., 2024). Other studies also use ratings provided by third parties (Linder et al., 2014; Sandberg et al., 2023) or corporate environmental disclosure (Ghosh et al., 2023; Galeazzo et al., 2024). The motivation of this research is to use the financial measures of corporate environmental performance (environmental responsibility), i.e. the share of environmentally sustainable revenues and the share of environmentally sustainable expenditures, which have not been taken into account in empirical research so far. In this study, the following hypothesis is tested:

H1. Environmental responsibility has a positive impact on the profitability of companies.

Research methods

The companies in the sample have been selected from among companies listed on the Warsaw Stock Exchange as of May 29, 2024 (cf. Table 2). The final sample consists of non-financial companies based in Poland, obliged to the EU Taxonomy disclosure in accordance with the Regulation (EU) 2020/852 (Regulation, 2020). Additional selection criteria included a positive value of the net financial result and equity and access to the annual report for the financial year ending December 31, 2023 (or exceptionally ending by June 30, 2024). Companies with negative profitability operate under special circumstances, such as restructurings, financial crises, or sector-specific issues. They may introduce distortions in the analysis because their sustainability decisions may not be typical (e.g. they may reduce expenditures on sustainability initiatives regardless of long-term strategies). The final sample includes 94 companies from various industries.

Table 2. Sample selection

Companies	Number
Companies listed at the Warsaw Stock Exchange as of 29 May 2024	411
Excluded companies based outside Poland	42
Excluded financial companies	48
Excluded non-financial companies not obliged to the EU Taxonomy disclosure	205
Excluded companies with negative net financial result and/or negative equity	21
Excluded companies with missing data	1
Final sample	94

The share of environmentally sustainable revenues and the share of environmentally sustainable operating expenditure, reported by the companies subject to the EU Taxonomy Regulation (2020), were used as a measure of corporate environmental responsibility in this study.

The EU Taxonomy Regulation (2020), adopted by the European Parliament in 2020, provides the criteria for determining whether an economic activity qualifies as environmentally sustainable. These criteria are as follows:

- economic activity contributes substantially to at least one of the following environmental objectives:
 - climate change mitigation,
 - climate change adaptation,
 - the sustainable use and protection of water and marine resources,
 - the transition to a circular economy,
 - pollution prevention and control, and,
 - the protection and restoration of biodiversity and ecosystems,
- economic activity does not significantly harm any of the above-mentioned environmental objectives,
- economic activity is carried out in compliance with the minimum safeguards (concerning the alignment with the OECD Guidelines for Multinational Enterprises and the UN Guiding Principles on Business and Human Rights),
- economic activity complies with technical screening criteria that have been established by the European Commission.

The EU Taxonomy Regulation requires non-financial companies specified in Article 8 to disclose three key performance indicators in their non-financial reports:

- the proportion of their turnover derived from products or services associated with economic activities qualified as environmentally sustainable,
- the proportion of their capital expenditure and the proportion of their operating expenditure related to assets or processes associated with economic activities qualified as environmentally sustainable.

In this study, two out of three key performance indicators were used (sustainable revenues and operating expenditure). The impact of sustainable capital expenditure on the financial results of enterprises may be spread over time, it requires a longer analysis period than one year.

The analysis covers data published in companies' annual reports for 2023, as this was the first year of reporting of the EU taxonomy, in which companies were obliged to take into account all six environmental objectives. Previously, reporting requirements only applied to activities contributing to climate change mitigation and adaptation.

This study examines the relationship between environmental responsibility and the financial performance of Polish listed companies using multiple regression analysis. The basic regression model used is as follows:

$$ROA = \beta_0 + \beta_1 \text{TURN} + \beta_2 \text{OPEX} + \beta_3 \text{LEV} + \beta_4 \text{CAPIN} + \beta_5 \text{SECT} + \varepsilon, \quad (1)$$

where:

ROA – return on assets,

TURN – the share of environmentally sustainable revenues in total revenues,

OPEX – the share of environmentally sustainable operating expenditures in total operating expenditures,

LEV – financial leverage, i.e. debt-to-equity ratio,

CAPIN – capital intensity, i.e. total assets to total revenues,

SECT – industry environmental sensitivity (dummy variable: value 1 if a company is from an industry with a negative impact on the environment, otherwise value 0),

$\beta_0, \beta_1, \dots, \beta_5$ – parameters,

ε – random component.

Additionally, in order to check the robustness of the results, two other models using ROE and ROS as measures of corporate profitability were employed:

$$ROE = \beta_0 + \beta_1 \text{TURN} + \beta_2 \text{OPEX} + \beta_3 \text{LEV} + \beta_4 \text{CAPIN} + \beta_5 \text{SECT} + \varepsilon, \quad (2)$$

$$\text{ROS} = \beta_0 + \beta_1 \text{TURN} + \beta_2 \text{OPEX} + \beta_3 \text{LEV} + \beta_4 \text{CAPIN} + \beta_5 \text{SECT} + \varepsilon, \quad (3)$$

where:

ROE – return on equity,

ROS – return on sales.

The dependent variables (return on assets, return on equity and return on sales) are commonly used measures of a company's profitability. ROA, ROE and ROS ratios were calculated based on the data from companies' financial statements. The values of independent variables (share of environmentally sustainable revenues in total revenues and share of environmentally sustainable operating expenditures in total operating expenses) were manually collected from the EU Taxonomy disclosure included in the non-financial statements of the analysed companies.

Three control variables are used in the regression models: financial leverage (Manrique & Martí-Ballester, 2017), capital intensity (Rokhmawati et al., 2015; Sandberg et al., 2023), and industry environmental sensitivity (Wedari et al., 2023; Galeazzo et al., 2024). Data for calculating financial leverage and capital intensity ratios were retrieved from companies' financial statements.

Companies from the following industries were classified as environmentally sensitive enterprises (with a substantial negative impact on the environment): chemical industry, mining, wood and paper industry, construction industry, energy industry, metallurgy, automotive industry, fuel and gas industries, electrical machinery industry, transport and logistics, and enterprise supply industry. Companies from the clothing and cosmetics industry, the food industry, biotechnology, the telecommunications industry, the IT industry, the trade industry, the game industry, the recreation industry, the new technologies industry, the medical industry, the pharmaceutical distribution industry, the drug production, the real estate industry, the media, and the home furnishings industry were considered environmentally insensitive. The names of the industries are consistent with the designations of the Warsaw Stock Exchange.

Results of the research and discussion

More than one-third of the companies analysed (36 out of 94) reported zero environmentally sustainable revenues (turnover) as well as zero operating and capital expenditures in 2023. These companies came from both environmentally sensitive industries (17 companies, e.g. from the metallurgical and construction industries) and environmentally insensitive industries (19 companies, e.g. from the IT, gaming and media industries). Positive values for all three key performance indicators were disclosed by 29 companies, the majority of which (26) were firms with a significant impact on the environment. Overall, 44 companies reported generating revenues from environmentally sustainable activities, 51 companies reported incurring capital expenditures (CapEx), and 33 companies disclosed incurring operating expenditures (OpEx) related to assets or processes associated with sustainable economic activities.

The vast majority of economic activities considered environmentally sustainable contributed to the achievement of one of the six objectives, i.e. climate change mitigation. This objective was reported by 79.6% of companies with non-zero sustainable turnover share values, by 88.2% of companies with non-zero sustainable CapEx share values and by 93.9% of companies with non-zero sustainable OpEx share values.

On average, about 11.0% of the revenues achieved by the analysed Polish firms came from activities recognised as environmentally sustainable. The share of operating expenditures and capital expenditures related to assets or processes associated with environmentally sustainable economic activities was, on average, 8.7% and 13.5%, respectively (cf. Figure 1).

According to the EY EU Taxonomy Barometer 2024 (EY, 2024), which presents an analysis of disclosures for 2023 based on a sample of 307 non-financial companies from the EU, the degree to which financial values are linked to environmentally sustainable economic activities varies across countries and industries. For example, the average share of sustainable OpEx ranged from 0% for firms from Malta and Slovakia to 46% for firms from the Czech Republic. However, it is important to note that the data for the Czech Republic is based on a sample of only three companies, two of which are financial undertakings, which may limit the generalizability of these results. The mean values of

the share of sustainable turnover, OpEx and CapEx for all companies included in the EY report (EY, 2024) were roughly similar to those for the sample of companies analysed in this study and amounted to 10%, 12% and 16%, respectively.

Polish listed companies operating in environmentally sensitive industries showed, on average, higher values of the share of sustainable revenues, OpEx and CapEx compared to companies operating in environmentally non-sensitive industries. The difference between the two groups was approximately 9.3 percentage points, 11.2 percentage points, and 8.6 percentage points, respectively (cf. Figure 1).

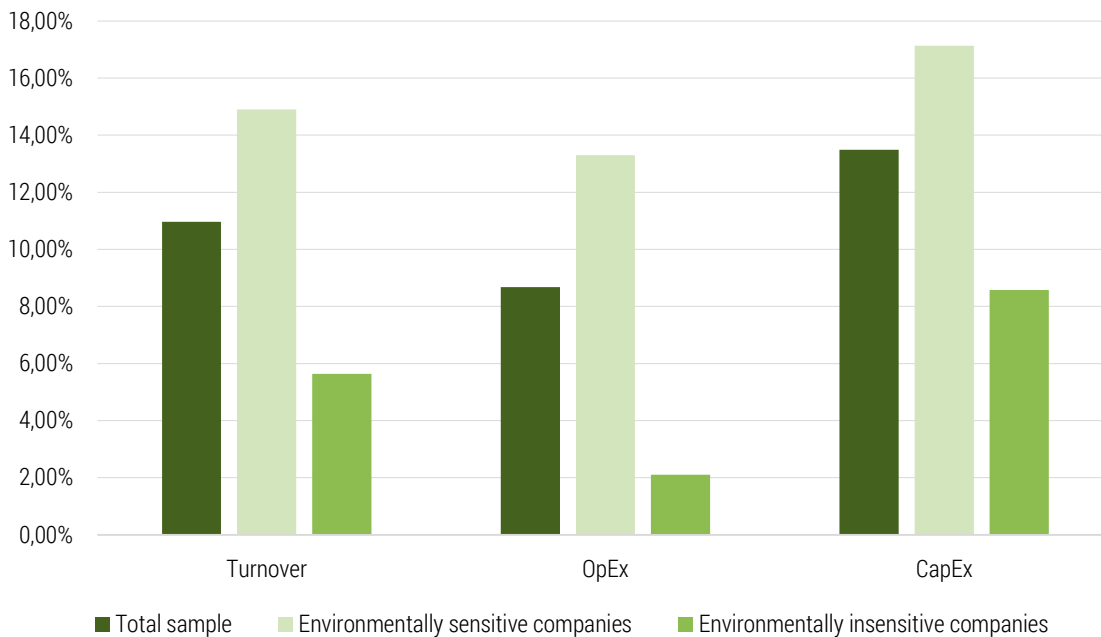


Figure 1. The average value of the proportion of sustainable turnover, operating expenditures, and capital expenditures for the analysed companies

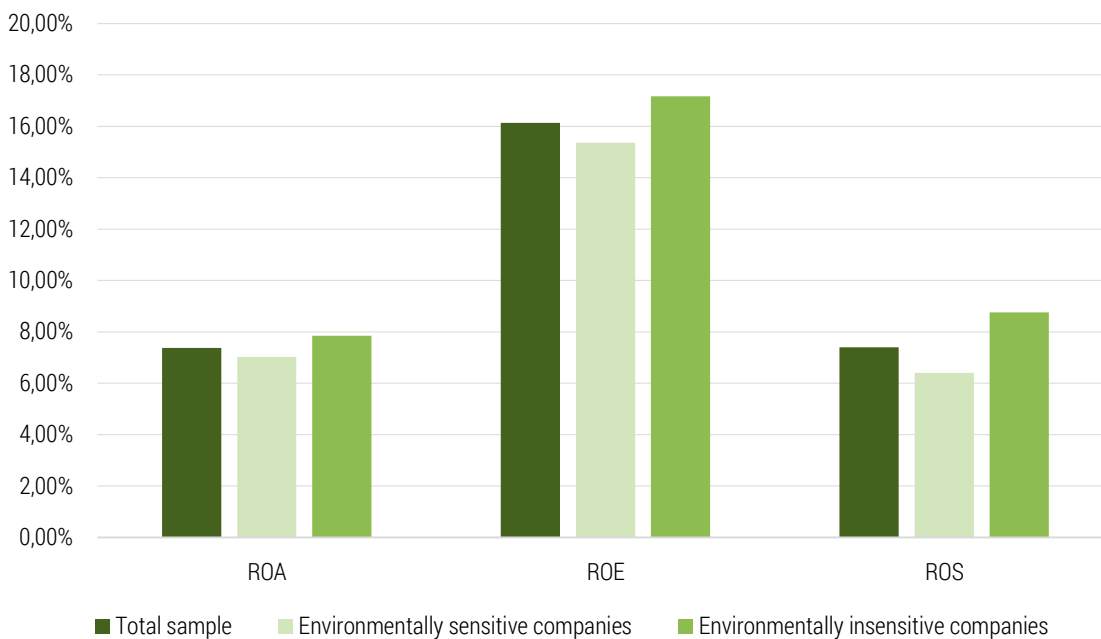


Figure 2. The average value of return on assets, return on equity and return on sales for the analysed companies

On the other hand, companies with a significant environmental impact achieved lower profitability measured by return on assets, return on equity and return on sales than companies with less environmental impact (cf. Figure 2).

Table 3 shows the descriptive statistics for the dependent, independent and control variables. The maximum level of the share of environmentally sustainable revenues in total revenues of 98% was achieved by a company from the IT industry (Sygnity). The maximum level of the share of environmentally sustainable operating expenditures in total operating expenditures of 83.9% was recorded in the company from the energy industry (Polenergia). Both variables are highly diversified (the coefficient of variation for TURN is 208% and for OPEX 223%).

Table 3. Descriptive statistics of variables

Variable	Mean	Median	Standard deviation	Minimum	Maximum
ROA	-2.8681	-2.7448	0.7835	-4.7817	-1.4831
ROE	-2.0880	-1.9801	0.7522	-4.1492	-0.1886
ROS	-2.9678	-2.8702	0.9166	-5.4127	-0.9389
TURN	0.1096	0.000	0.2287	0.0000	0.9800
OPEX	0.0868	0.000	0.1934	0.0000	0.8391
LEV	1.4256	0.9971	1.4937	0.0874	10.0920
CAPIN	0.9881	0.8722	0.5192	0.2205	3.7148
SECT	0.5745	1.000	0.4971	0.0000	1.0000

Note: ROA, ROE and ROS variables are logarithmized.

The values of variance inflation factors (1.530 for TURN, 1.627 for OPEX, 1.152 for SECT, 1.050 for LEV and 1.114 for CAPIN) indicate that the problem of multicollinearity does not occur in any of the three models used.

Table 4. Results of OLS regression analysis for model (1) (94 observations)

Variable	Coefficient	Standard deviation	t-statistics	p-value	Significance
Constant	-2.21652	0.191257	-11.59	<0.0001	***
TURN	0.601222	0.360158	1.669	0.0986	*
OPEX	-1.39876	0.488828	-2.861	0.0053	***
LEV	-0.196427	0.0354080	-5.548	<0.0001	***
CAPIN	-0.288049	0.144861	-1.988	0.0499	**
SECT	-0.0548351	0.146594	-0.3741	0.7093	-
Arithmetic mean of the dependent variable		-2.868141	Standard deviation of the dependent variable		0.783465
Sum of squared residuals		43.85221	Standard error of residuals		0.705918
R-squared		0.231809	Adjusted R-squared		0.188161
F(5, 88)		10.11261	P-value for F-test		0.0000
Log-likelihood		-97.54415	Akaike information criterion		207.0883
Schwarz Bayesian criterion		222.3481	Hannan-Quinn criterion		213.2521

*** significance level at 1%, ** significance level at 5%, * significance level at 10%

The basic model (1) presents the impact of environmental responsibility on the financial situation of companies measured by return on assets. The estimation results of multiple regression for this model using the ordinary least squares (OLS) method are shown in Table 4. The estimated model meets the assumptions of the OLS regression in terms of homoscedasticity (the results of the Breusch-Pagan test: LM statistic = 3.980782, p-value = 0.552186) and normality of the residuals (the

results of the Doornik-Hansen test: chi-square statistic = 1.95727, p-value = 0.375824). As shown by the estimation results, the share of environmentally sustainable operating expenditures, along with financial leverage and capital intensity, turned out to be significant variables (at the significance level of 0.05). All three variables have a negative impact on the ROA level. The share of environmentally sustainable revenues does not significantly influence return on assets, nor does industry environmental sensitivity.

Table 5 shows the estimation results for model (2) with return on equity as the dependent variable. The Breusch-Pagan test corroborates the homoscedasticity of the model (LM = 3.174979, p-value = 0.673030), and the Doornik-Hansen test confirms the normality of the residuals (chi-square statistic = 0.325731, p-value = 0.849705). According to the estimation results, only the share of environmentally sustainable operating expenditures and capital intensity significantly (and negatively) affect the profitability of companies.

Table 5. Results of OLS regression analysis for model (2) (94 observations)

Variable	Coefficient	Standard deviation	t-statistics	p-value	Significance
Constant	-1.77755	0.191995	-9.258	<0.0001	***
TURN	0.494087	0.294420	1.678	0.0969	*
OPEX	-1.22697	0.444598	-2.760	0.0070	***
LEV	0.0614502	0.0442916	1.387	0.1688	-
CAPIN	-0.306697	0.138927	-2.208	0.0299	**
SECT	-0.0742801	0.150839	-0.4924	0.6236	-
Arithmetic mean of the dependent variable		-2.087974	Standard deviation of the dependent variable		0.752210
Sum of squared residuals		44.54282	Standard error of residuals		0.711455
R-squared		0.153521	Adjusted R-squared		0.105425
F(5, 88)		4.068521	P-value for F-test		0.002276
Log-likelihood		-98.27856	Akaike information criterion		208.5571
Schwarz Bayesian criterion		223.8169	Hannan-Quinn criterion		214.7210

*** significance level at 1%, ** significance level at 5%, * significance level at 10%

Table 6. Results of OLS regression analysis for model (3) (94 observations)

Variable	Coefficient	Standard deviation	t-statistics	p-value	Significance
Constant	-3.18144	0.258974	-12.28	<0.0001	***
TURN	0.676468	0.381274	1.774	0.0795	*
OPEX	-1.40834	0.521559	-2.700	0.0083	***
LEV	-0.235885	0.0465427	-5.068	<0.0001	***
CAPIN	0.583749	0.217218	2.687	0.0086	***
SECT	0.0369403	0.156945	0.2354	0.8145	-
Arithmetic mean of the dependent variable		-2.967781	Standard deviation of the dependent variable		0.916574
Sum of squared residuals		50.912882	Standard error of residuals		0.760628
R-squared		0.348357	Adjusted R-squared		0.311332
F(5, 88)		12.83146	P-value for F-test		2.26e-09
Log-likelihood		-104.5608	Akaike information criterion		221.1216
Schwarz Bayesian criterion		236.3814	Hannan-Quinn criterion		227.2855

*** significance level at 1%, * significance level at 10%

The estimation results for model (3) with return on sales as the dependent variable are presented in Table 6. The model satisfies the assumptions regarding homoscedasticity (the results of the Breusch-Pagan test: LM statistic = 6.151758, p-value = 0.291731) and normality of the residuals (the results of the Doornik-Hansen test: chi-square statistic = 1.67477, p-value = 0.432841). The share of environmentally sustainable revenues and industry environmental sensitivity proved to be insignificant variables. On the other hand, the share of environmentally sustainable operating expenditures, financial leverage and capital intensity are statistically significant determinants of return on sales. However, the first two have a negative impact on profitability, and the third has a positive impact.

To sum up, the estimation results of both the basic model and the two additional models indicate a significant and negative impact of the proportion of operating expenditures related to assets or processes associated with environmentally sustainable business activities on companies' profitability. This finding is in line with the results of the studies by Rokhmawati et al. (2015), Brouwers et al. (2018) and Duque-Grisales and Aguilera-Caracuel (2021), who argue that environmental commitment leads to lower financial performance. Moreover, financial performance in terms of ROA, ROE and ROS was found to be indifferent to the percentage of revenues derived from products or services related to environmentally sustainable business activities. Similar research results confirming the insignificance of environmental practices for the financial condition of enterprises were obtained, among others, by Dragomir (2013) and Lucato et al. (2017). Generally, the results of this study are in contradiction with research by, among others, Gallego-Álvarez et al. (2015), Partalidou et al. (2020) and Gao and Wan (2023), who support the view that greater environmental responsibility improves the financial results of companies.

The results of the research allow for the rejection of the hypothesis that environmental responsibility has a positive impact on the profitability of companies.

Conclusions

Engaging in environmental protection activities becomes a common business practice in the era of increasingly strict legal regulations and growing pressure from environmentally conscious consumers and investors. Such actions obviously have financial consequences for companies. This study examines whether the degree of achieving environmentally sustainable revenues and incurring environmentally sustainable expenditures affects the profitability of Polish listed companies. The research results do not confirm the positive impact of environmental responsibility on the financial results of companies. The greater the percentage of operating expenditures allocated to environmentally sustainable economic activities, the lower the profitability of companies measured by return on assets, return on equity and return on sales. This conclusion argues in favour of the trade-off hypothesis. The reason for the lower profitability of companies that allocate a larger share of operating expenditures to sustainable activities is that, in the short term, the higher costs of implementing these initiatives may not be fully offset by external factors such as subsidies, tax incentives, and market competition. Moreover, the percentage of revenues derived from products or services associated with environmentally sustainable economic activities is irrelevant to the level of profitability of companies. The explanation for this may be that stakeholders of Polish firms have not yet noticed and appreciated those companies that achieve revenues in a more environmentally responsible way.

Although the study focused exclusively on companies listed in Poland, it can be assumed that the results may be partially representative of other countries in Central and Eastern Europe, which share similar levels of economic development, capital market structures, and regulatory challenges related to sustainable development. However, differences in stakeholder environmental awareness, availability of funds for environmental projects, and the intensity of regulatory actions may influence the results in individual countries within the region.

The main limitation of the present study is the use of data for only one reporting year (due to hitherto the short duration of the EU Taxonomy disclosure obligation for the full range of environmental objectives). Taking into account a multi-year analysis period in future research, as well as the share of environmentally sustainable capital expenditures, would allow for examining the linkage between environmental performance and financial performance in the long run. Another limitation of the study is the analysis of companies operating in one country. Examining the impact of environ-

mental responsibility on the financial performance of companies from different backgrounds in terms of social, cultural and political conditions, and the level of economic development could provide insight into the determinants affecting the profitability of environmental protection activities.

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ZWIĄZEK ODPOWIEDZIALNOŚCI ŚRODOWISKOWEJ I WYNIKÓW FINANSOWYCH POLSKICH SPÓŁEK GIEŁDOWYCH

STRESZCZENIE: Celem artykułu jest zbadanie, jak stopień osiągnięcia przychodów zrównoważonych środowiskowo oraz ponoszenia wydatków zrównoważonych środowiskowo wpływa na rentowność polskich spółek giełdowych. Zastosowaną metodą badawczą jest analiza regresji wielorakiej. Wyniki badań nie potwierdzają założonego pozytywnego wpływu odpowiedzialności środowiskowej na wyniki finansowe przedsiębiorstw. Im większy odsetek wydatków operacyjnych przeznaczanych na działalność gospodarczą zrównoważoną środowiskowo, tym niższa rentowność przedsiębiorstw mierzona stopą zwrotu z aktywów, stopą zwrotu z kapitału własnego i stopą rentownością sprzedaży. Ponadto odsetek przychodów uzyskanych z produktów lub usług związanych z działalnością gospodarczą zrównoważoną środowiskowo nie ma znaczenia dla poziomu rentowności przedsiębiorstw. Niniejsze badanie stanowi uzupełnienie literatury na temat powiązania między efektywnością środowiskową przedsiębiorstw a wynikami finansowymi, a jego nowość polega na pomiarze poziomu zaangażowania przedsiębiorstw w odpowiedzialność środowiskową za pomocą wskaźników finansowych w oparciu o niedawno wdrożone rozporządzenie UE w sprawie taksonomii.

SŁOWA KLUCZOWE: efektywność środowiskowa, wyniki finansowe przedsiębiorstw, taksonomia UE