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SCHOOL OF ECONOMICS AND BUSINESS

MASTER THESIS

**SUSTAINABILITY AND STOCK PERFORMANCE: HOW ESG
SCORES AFFECT VALUATIONS OF PHARMACEUTICALS'
STOCKS**

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AUTHORSHIP STATEMENT

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LIST OF ABBREVIATIONS

AI – Artificial Intelligence
CDP – Carbon Disclosure Project
CDSB – Climate Disclosure Standards Board
CSA – Corporate Sustainability Assessment
CSR – Corporate Social Responsibility
CSRD - Corporate Sustainability Reporting Directive
CSV – Creating Shared Value
ESG – Environmental, Social, Governance
ETF – Exchange-Traded Fund
EU – European Union
FFE – Firm Fixed Effect
GDP – Gross Domestic Product
GRI – Global Reporting Initiative
IFRS – International Financial Reporting Standards
ISO – International Organization for Standardization
MSCI – Morgan Stanley Capital International
ROA – Return on Asset
ROE – Return on Equity
SASB – Sustainability Accounting Standards Board
S&P – Standard & Poor's
TCFD – Task Force on Climate-related Financial Disclosures
WDI – Workforce Disclosure Initiative
WGI – World Governance Indicators
WHO – World Health Organization

1 INTRODUCTION

In recent years, ESG and impact investing have experienced exponential growth, driven by compelling evidence that focusing on key ESG factors leads to superior management practices and enhances financial performance. An extensive review of more than 1,000 research papers published between 2015 and 2020 examined the link between ESG practices and financial outcomes in corporate settings. The findings indicated that 58% of the studies assessing key operational indicators such as ROE, ROA, and stock performance identified a favorable correlation between ESG initiatives and financial success. The analysis found that 13% of the research indicated no significant effect of ESG on financial performance, while 21% presented mixed outcomes. Only 8% of the studies reported an unfavorable correlation. Researchers also determined that the financial benefits of ESG practices tend to become more apparent over extended periods. Furthermore, ESG-focused investments seem to help mitigate risks, particularly during a social or economic crisis (Whelan et al., 2021). When companies embed sustainability into their workflows and decision-making; they can reap numerous advantages over time. These include improved financial performance, reduced exposure to risks, lower operational costs, increased stock value, enhanced public perception, and a stronger brand presence in the market. Emphasizing sustainability can also lead to long-term resilience and competitiveness in an evolving economic landscape (Jucá et al., 2024). The global shift towards sustainability has made ESG factors crucial for evaluating a company's long-term viability and ethical standards. In financial markets, ESG scores are key indicators for investors balancing financial returns with responsible investing (Friede et al., 2015).

The pharmaceutical industry is a massive global market, valued at over 1.6 trillion U.S. dollars. It is also forecasted to rise at a yearly growth rate of 6.12% from 2025 to 2030. The market trends are guided by growing burden of chronic diseases, older generation growth and growing health investments (9 trillion U.S. dollars, what is 10% of global GDP). In 2023, the United States maintained its position as the world's leading pharmaceutical market, generating nearly half of global industry revenues. The sector experienced notable growth, with U.S. market revenues rising by approximately 12% from the previous year, while the European Union saw an increase of nearly 10%. Emerging markets have gained significant traction, expanding from 13% of the industry's total market value in 2006 to 22% in 2023. Countries like China are undergoing substantial healthcare reforms, leading to increased pharmaceutical industry revenues—reaching around 112 billion U.S. dollars in 2023. Several major corporations dominate the global pharmaceutical landscape. Among the most prominent in the United States are Pfizer, Merck, and Johnson & Johnson, while Europe is home to major players such as Novartis, Roche, and Sanofi. Ongoing strategic alliances and research investments enhance product growth and industry positioning. This sector invests heavily in research and development, with spending exceeding \$80 billion annually in the U.S. alone (Statista, 2025).

The pharmaceutical industry with its important role in public health and complex regulations, presents a unique case for examining the influence of ESG factors. Companies in this sector face strict ethical standards and significant pressure to demonstrate their commitment to sustainability, both in terms of environmental and social responsibility. Despite this, there is lack of empirical research on how ESG scores affect the stock valuations of pharmaceutical companies. There are published some research about the influence of sustainability factors of pharmaceutical companies on financial performance however the analyses show mixed results (Liu & Yang, 2023; López-Toro et al., 2021).

The main purpose of this research is to fill this gap with evaluating the impact of environmental, social and governance performance of world's leading pharmaceutical companies on company's economic performance. The economic performance is aimed to be assess through share price and some other financial indicators. Based on literature overview, we set the main research hypotheses which are:

- Hypothesis 1 (H1): The overall ESG scores of pharmaceutical companies influence on the companies' share prices.
- Hypothesis 2 (H2): All three factors jointly in Environmental, Social and Governance framework have a positive impact on the companies' share prices.
- Hypothesis 3 (H3): All three factors separately in Environmental, Social and Governance framework have positive impact on return on equity of pharmaceutical companies.
- Hypothesis 4 (H4): The environmental factor has the biggest impact on the pharmaceutical companies' share prices among all factors in Environmental, Social and Governance framework.

With this research we would like to provide the answers on questions if investors need to care about company's ESG performance when investing in shares of pharmaceutical companies and if companies need to invest more in the activities connected with ESG performance. The research's findings offer a meaningful contribution to the broader understanding of how sustainability issues are reshaping investment strategies and behavior. This research employs a quantitative approach to assess how ESG performance influences financial results in the pharmaceutical sector, drawing on both financial metrics and ESG evaluations. Data from 2015–2022 is sourced from LSEG Data&Analytics, renowned for its comprehensive ESG database. The sample of pharmaceutical companies is selected based on market capitalization. Data analysis includes descriptive statistics, a correlation matrix to examine variable relationships, and multiple linear regressions to assess connections between dependent variables (price-to-book ratio, ROE) and independent variables related to ESG scores, reflecting environmental, social and governance performance.

2 THE ROLE AND IMPACT OF ESG

2.1 Introduction of sustainability

Sustainability involves ensuring that processes and systems can be maintained over the long term without exhausting essential resources. In business and economic policy, the focus is on preserving natural and physical assets to guarantee their availability for future generations. The concept is founded on three key dimensions: economic stability, social responsibility, and environmental protection—often summarized as profits, people, and the planet. To operate sustainably, businesses must consider financial viability alongside ethical practices, social equity, and environmental stewardship (Mollenkamp, 2023).

In today's business landscape, corporate sustainability is built on three fundamental pillars: financial stability, social responsibility, and environmental stewardship. When these elements are integrated effectively, companies can drive profitability by fostering long-term expansion, enhancing efficiency, and maximizing value for shareholders. Among the widely recognized approaches businesses use to manage their social and environmental impact are the Environmental, Social, and Governance (ESG) framework, Corporate Social Responsibility (CSR), and the Creating Shared Value (CSV) model. These strategies help organizations align financial success with ethical and sustainable practices. ESG has gained traction among investors and analysts, serving as a key measure of a company's environmental, social, and governance performance. (Oprean-Stan et al., 2020). Corporate governance, environmental responsibility, and social impact play a significant role in shaping business performance. Global efforts to enhance visibility and support for sustainable practices have grown, with initiatives like the Global Compact and ISO26000 leading the way. The 2030 Agenda further emphasizes the link between corporate social responsibility and sustainable development. For businesses to remain competitive and financially strong, their sustainability contributions must be recognized and valued in financial markets (López-Toro et al., 2021).

ESG reporting involves transparently sharing a company's efforts and achievements in environmental sustainability, social responsibility, and corporate governance. Typically published annually, these reports outline key ESG performance indicators, incorporating both qualitative insights and quantitative measurements. They also highlight long-term strategic goals and provide updates on significant milestones, reflecting the company's commitment to responsible business practices. The practice of ESG reporting is already widespread among large companies. According to the research, in 2021, sustainability reports were published by 96% of S&P 500 firms and 81% of companies in the Russell 1000 Index, highlighting a widespread commitment to transparency in environmental, social, and governance practices. There are also starting regulatory requirements on disclosures of sustainability (e.g. in January 2023 European Union's Corporate Sustainability Reporting Directive (CSRD) was implemented) (GibbonsPaul, 2023). Klynveld Peat Marwick

Goerdeler (KPMG) sustainability report showed that the worldwide sample of 100 top companies by revenue have consistent growth of their reporting rates with every global survey. A decade ago, 64% of businesses disclosed their reports, rising to 79% in 2022. In Europe, reporting rates grew from 77% in 2020 to 82%, driven by increasing expectations from regulators, investors, ESG analysts, and consumers. When comparing regions, Western Europe had a reporting rate of 85%, while Eastern Europe stood at 72% (KPMG, 2022).

In 2023 the Corporate Sustainability Reporting Directive (CSRD) came into effect and substitute Non-Financial Reporting Directive, strengthens and expands the rules related to the companies' social and environmental reported data. The sustainability efforts must be disclosed by a wider range of major corporations, along with publicly traded small and medium-sized businesses. Non-EU companies earning over 150 million EUR in Europe must report under the CSRD, following ESRS guidelines. The directive also mandates verification of sustainability data and its inclusion in a digital taxonomy. The main goals of CSRD are to improve transparency, prevent greenwashing and help investors, consumers and stakeholders make informed decisions based on standardized sustainability data. In September 2024, the Commissioner outlined steps by the European Commission to implement corporate sustainability reporting fairly. The letter also urged Member States to ease the reporting burden on businesses (European Commission, n.d.). ESG reports allow stakeholders to assess a company's performance in key areas such as environmental consequences, social responsibility campaigns, and policy guidelines. Even more, ESG reporting facilitates companies also to identify areas for improvement and make data-driven decisions to drive progress. With the growing importance of ESG in the investment sector, companies that lead in ESG disclosures are more likely to attract investors and gain a competitive advantage (Varma, 2023b).

2.2 Major ESG reporting frameworks

Businesses utilize various frameworks to disclose sustainability and ethical performance. These structures help assess ESG risks and opportunities while ensuring transparency and accountability. Each framework has distinct reporting requirements and performance indicators, offering a systematic way to communicate ESG efforts to stakeholders. By following principles-based guidelines, businesses can illustrate their commitment to sustainable expansion. At the same time, sustainability standards set clear, comprehensive, and consistent guidelines for reporting on each subject (Paul, 2024). The most prominent ESG frameworks are:

– IFRS Sustainability Disclosure Standards. The International Sustainability Standards Board (ISSB), established in 2021 by the IFRS Foundation, has introduced new standards, which are based on the SASB Standards and replace the CDSB Framework, aiming to enhance sustainability reporting. ISSB issued two standards. IFRS S1 (General Requirements for Disclosure of Sustainability related Financial Information), which serve

as the foundation for reporting key sustainability-related risks and opportunities throughout an organization value stream. The second is the IFRS S2 (Climate-related Disclosures), which is the initial thematic standard for entities to report information about climate-related risks and opportunities (Paul, 2024; PwC, 2023).

– SASB Standards. In 2018 the Sustainability Accounting Standards Board created and published SASB standards. The framework categorizes key ESG issues for various industries, also the information technology sector. In 2021, SASB merged into the Value Reporting Foundation, which was later integrated into the IFRS Foundation in 2022. While SASB Standards are still accessible, the IFRS Foundation plans to phase them out in favor of its updated standards (IFRS Foundation, n.d.; Paul, 2024).

– CDSB Framework. The Climate Disclosure Standards Board (CDSB) developed this framework promotes ESG reporting in corporate disclosures like annual reports. Initially introduced in 2010 with a focus on climate change, it was expanded in 2015 to cover broader environmental aspects and, by 2022, included social factors. It remains unchanged since the CDSB merged into the IFRS Foundation in 2022 (Climate Disclosure, 2022; Paul, 2024).

– GRI (Global Reporting Initiative) Standards. These standards form a flexible framework comprising universal, sector-specific, and topic-based sustainability reporting guidelines. These standards help organizations of all sizes, both private and public, assess and communicate their economic, environmental, and social impact in a consistent and reliable manner. GRI states that these standards apply not only to reporting companies but also to investors, government officials, and other key stakeholders. By enhancing transparency, they highlight contributions to sustainable development. In 2000 they were firstly introduced as the GRI Guidelines and then several updates were introduced (Global Reporting Initiative, n.d.; Paul, 2024).

– CDP (Carbon Disclosure Project). Established in 2000, CDP runs an environmental reporting system that helps companies disclose risks and opportunities linked with climate shift, reliable water supply, and forest loss. Businesses submit separate questionnaires on these issues, and CDP assigns them letter-grade scores, accessible to stakeholders for evaluation (Paul, 2024).

– TCFD (Task Force on Climate-related Financial Disclosures). They were created to provide guidance on the financial risks companies should disclose regarding climate change, helping investors, lenders, and insurance providers make informed decisions. These recommendations focus on four fundamental components: management, tactic, assessment and climate-focused measures and objectives (Paul, 2024).

– United Nations Global Compact. Founded in 2000, this initiative is based on ten core principles that address human rights, labor regulations, environmental sustainability, and

anti-corruption efforts. Businesses can also report their contributions to the U.N.'s Sustainable Development Goals via a dedicated platform that integrates the Global Compact's principles with the GRI Standards. (Paul, 2024).

– WDI (Workforce Disclosure Initiative). Created in 2016, it provides a system for reporting workforce policies and managerial practices. Businesses complete an online questionnaire and receive a "disclosure scorecard," which helps them compare their performance with industry peers (Henisz et al., 2019; Paul, 2024).

– European Sustainability Reporting Standards (ESRS). Companies covered by the CSRD must report under ESRS standards (Table 1), developed by EFRAG, formerly an independent stakeholder body. ESRS adopt a “double materiality” approach. Companies are required to report their influence on individuals and the environment (impact materiality) along with the financial risks and benefits linked to social and environmental aspects (financial materiality). ESRS aligns with global standards GRI, ISSB and IFRS to ensure consistency. The ESRS consists of 12 reporting standards: two broad standards all companies must include in their reporting (ESRS 1 and 2) and 10 thematic standards determined by the results of a materiality evaluation (Mays & Daphne, 2024; United Nations Environment Finance Initiative, n.d.).

ESRS 1 (General Requirements) establishes overarching principles for reporting under ESRS without defining specific disclosure obligations. They cover key areas such as standard categories, qualitative information, double materiality, due diligence, value chain, time horizons, sustainability data presentation, reporting structure, corporate reporting integration, and transitional provisions (United Nations Environment Finance Initiative, n.d.). ESRS 2 (General Disclosures) outlines key reporting elements across all sustainability topics. They cover governance (oversight of impacts, risks, and opportunities), strategy (how business models address material ESG factors), impact, risk, and opportunity management (methods for identifying and managing ESG aspects), and metrics and targets (performance measurement and progress tracking). All other standards and disclosures depend on a materiality assessment(United Nations Environment Finance Initiative, n.d.).

Table 1: Overview of sustainability reporting standards in Europe.

Standard	Description of standard
ESRS 1	General requirements: define reporting areas, required disclosures, due diligence role, and time horizons.
ESRS 2	General disclosures: describes the four-pillar reporting method—governance, strategy, impact and risk management, and metrics—required for companies.

to be continued

Table 1: Overview of sustainability reporting standards in Europe. (cont.)

Standard	Description of standard
Environmental standards	
ESRS E1	Climate change (development of climate transition plan)
ESRS E2	Pollution
ESRS E3	Resources of water (consumption and impact on it)
ESRS E4	Biodiversity and ecosystems
ESRS E5	Resource use and circular economy
Society standards	
ESRS S1	Workforce (worker engagement, salaries, social protection, quality of life)
ESRS S2	Value chain workers (regulations, procedures, oversight practices)
ESRS S3	Impacted communities (economic, cultural, and political rights)
ESRS S4	Consumers and users (engagement, privacy, expression, safety, inclusion)
Governance standards	
ESRS G1	Ethical business practices (company culture, conduct policies, supplier relationship management)

Source: Mays & Daphne, (2024); United Nations Environment Finance Initiative, (n.d.)

2.3 ESG rating agencies

ESG Rating Agencies evaluate companies' sustainability and ethical performance using publicly available data, including corporate reports, regulatory disclosures, management interviews, and additional accessible information. They assess various aspects of business operations, policies, and practices to determine overall ESG alignment. Companies receive

ESG scores, either numerical or letter-based, which serve as benchmarks for investors and stakeholders seeking transparency and accountability in business practices. However, ESG ratings are not without flaws. The presence of multiple agencies with different evaluation methods can result in inconsistent ratings for the same company, potentially eroding investor confidence. Discrepancies in ESG assessments can shape investor perceptions and impact stock performance. The research indicates that discrepancies in ESG ratings can reduce excess stock returns (Wang et al., 2024). However, elements like investor sentiment, potential for ESG improvements, and the transparency of information can help mitigate this effect. Among ESG components, social rating discrepancies exert the strongest influence on superior returns, then come environmental and governance aspects (Hannay, 2023; Paul, 2024).

Well-known providers of ESG ratings, that have gained significant influence on the market are (Hannay, 2023; Paul, 2024):

- Bloomberg ESG Ratings: This service assesses ESG performance for over 10,000 publicly traded companies worldwide, primary with mid-to-large cap businesses. It conducts annual evaluations using publicly available data from sustainability reports, corporate disclosures, websites, and other sources. The collected information is standardized across 120 indicators, and companies that fail to disclose relevant data face penalties. ESG ratings range from 0 to 100, incorporating third-party assessments and historical comparisons with industry peers (IRIS Carbon, 2023).

- MSCI (Morgan Stanley Capital International) ESG Ratings: It is among the largest independent ESG rating firms, offering assessments that span from AAA to CCC, with updates issued on a weekly basis. Assessing 37 key ESG issues across three pillars and ten themes, the service conducts thorough company reviews at least once a year. Firms can verify data before their ESG Rating is published (IRIS Carbon, 2023).

- ISS (Institutional Shareholder Services) ESG Ratings & Rankings: It provides ESG solutions to help institutional investors implement responsible investment strategies. Following its acquisition of Climate Natural Investments, it also offers climate-related analytics. The ISS Quality Score evaluates governance for over 5,600 public companies, using a 1st to 10th decile scale—lower deciles indicate stronger governance, while higher ones suggest increased risk. The methodology assesses over 200 factors across four key areas: board organization, top management salary, shareholder rights, and audit/risk oversight, with weights adjusted based on regional governance standards and ISS voting policies (IRIS Carbon, 2023).

- Refinitiv ESG: Refinitiv's ESG scoring system offers an impartial evaluation of a company's sustainability performance, commitment, and impact, using over 630 ESG metrics categorized into 10 groups within three pillars. The score accounts for industry

relevance and company size biases, ensuring a balanced assessment. Businesses can review and provide input on their ESG data, with analysts determining whether updates to the score are justified (IRIS Carbon, 2023).

– S&P Global ESG: The scoring system evaluates companies based on quantitative metrics, management practices, and policies, with scores ranging from 0 to 100. Higher scores indicate stronger ESG performance. ESG data is evaluated based on its accessibility, accuracy, and significance, with points assigned accordingly. The yearly S&P Global Corporate Sustainability Assessment (CSA) gathers company submissions through an online portal, assessing their latest financial-year reporting. Monthly updates reflect new findings from ongoing research. The CSA analyzes ESG-corporate risks, opportunities, and stakeholder influence across different timeframes, considering both general and industry-specific factors. Each criterion examines companies' understanding of ESG relevance, risk impact, possible advantages, and strategic actions taken to address sustainability challenges (IRIS Carbon, 2023).

2.4 Key areas of importance for pharmaceutical companies

Pharmaceutical companies have long played a vital role in society's well-being. The country, with the highest pharmaceutical spending in 2023 was United States of America (16.5% of GDP) as prices are driven by market competition, following by Germany, Switzerland and Canada, where prices of medicines are regulated by government (Statista, 2025b). Pharmaceutical companies produce essential medicines and have the ability to research and create treatments for serious and rare diseases. Their contributions have significantly increased life expectancy worldwide. Lichtenberg's research on pharmaceutical innovation and life expectancy found that, between 2006 and 2016, the average age at death in 26 high-income nations rose by 1.23 years, with pharmaceutical advancements being the key factor behind this increase. The effect was even larger in people with more education (Lichtenberg, 2022). However, the pharmaceutical industry harms the surroundings shaped by energy-demanding systems, improper waste disposal, and high greenhouse gas emissions. The pharmaceutical and life sciences sector contributes around 4.5% of global greenhouse gas emissions, along with comparable levels of toxic air pollutants, making it one of the most environmentally demanding industries in the developed world (Willis Towers Watson, 2021). Production processes release chemicals, including antibiotics, which can lead to antibiotic resistance. Communities near manufacturing sites are especially vulnerable, as their water sources can be contaminated with chemical waste. WHO reported that approximately 15% of the overall waste production by health-care services is considered toxic, which included pharmaceutical waste (Oren, 2022; World Health Organization, 2024).

Through ESG initiatives, pharmaceutical firms can emphasize their dedication to improving healthcare outcomes and protecting lives. By emphasizing health equity, the industry's commitment to ESG can help address health disparities and support general welfare. This

aligns with the wider goals of the industry. However, despite having numerous ESG-related initiatives, the pharmaceutical sector often struggles to effectively communicate these efforts to the public. Such examples are marketing campaigns which often highlight environmental initiatives, but overall impact of pharmaceutical operations on the environment remains significant (Pfizer, n.d.). Many patients in low- and middle-income countries have limited access to clinical trials, restricting their opportunity for new treatments. Despite representing nearly 80% of the global population, only 43% of trials analyzed in the 2024 Index took place in these regions. Market access tends to follow trial locations, leaving much of the world underserved. While some pharmaceutical companies are working to close the gap, challenges remain. In recent years, five companies have introduced inclusive business models to improve access for neglected populations (Access to Medicine Foundation, 2024a; Access to Medicine Foundation, 2024b). A GlobalData survey of 312 pharmaceutical executives reveals a growing gap between sustainability rhetoric and action. In 2021, lack of management support and disengaged company culture were cited as key obstacles by 13% and 22% of respondents, dropping to 9% and 11% in 2022—suggesting greater leadership backing. However, the biggest challenge in 2022 was insufficient investment in expertise and technology, reported by 37%, up from 25% in 2021 (Controlant, 2023). Recently, the pharmaceutical industry has been under intense scrutiny due to its substantial impact on global health, the environment, and economic stability. This scrutiny has spurred a growing interest in the role of ESG factors in shaping the performance and reputation of pharmaceutical companies. ESG considerations are increasingly recognized as critical components in assessing the long-term viability and ethical standing of companies within this sector. For pharmaceutical companies, which operate in a highly regulated and competitive market, the integration of robust sustainability practices can result in significant benefits, including enhanced innovation, operational efficiencies, and access to capital (Eccles et al., 2014; Friede et al., 2015).

The main benefits of ESG for pharmaceutical companies, discussed in the literature, are (Oren, 2022):

- enabling the business to support to cleaner surroundings, optimize energy use, and benefit the society;
- enhancing business reputation and financial opportunities, attracting potential investors;
- reducing operational costs and increasing profitability through sustainable strategies;
- increasing credibility with customers, investors, and stakeholders and
- helping business leaders to improve efficiency, making the business eco-friendly, profitable, and sustainable.

2.4.1 Impacts on environment

Pharmaceutical corporations play a substantial role in environmental impact, underscoring the need for stronger sustainability efforts. A GlobalData survey of industry experts found that 70% believe the sector is falling short in advancing environmental responsibility. The

study also revealed that ecological concerns are a top priority for pharmaceutical firms, with 52% identifying climate change as the most urgent issue and 32% highlighting pollution as a key challenge (Datwyler, 2022).

According to a recent study, the industry is among the top carbon emitters globally. The healthcare sector is responsible for 4.4% of global carbon emissions, with around 71% originating from supply chain activities such as pharmaceutical manufacturing and medical device transportation (Dehipawala et al., 2023). However, pharmaceutical sustainability leaders are taking proactive steps to reduce their carbon footprint and embrace renewable energy sources. Pharmaceutical companies are using advanced AI tools and strategic partnerships to improve their operations and cut down on emissions. They are working closely with suppliers, distributors, and manufacturers who care about the environment to reduce carbon emissions at every stage of the supply chain. By genuinely aligning their environmental goals with their business values and brand, these companies are showing their commitment to sustainability and avoiding being accused of pretending to be eco-friendly (Varma, 2023b). The pharmaceutical sector requires significant energy for its operations, with annual energy expenditures in the U.S. reaching nearly \$1 billion (Lawrence et al., 2008). Tracking and evaluating energy usage is essential. Improving energy efficiency not only lowers operational expenses but also reduces environmental strain, helping businesses minimize their ecological footprint. The industry generates significant chemical and plastic waste. Research indicates that producing one kilogram of an active pharmaceutical ingredient results in 25 to 100 kilograms of waste, with the exact amount varying based on the complexity of the synthesis method. A single-use bioreactor system in biopharmaceutical manufacturing generates approximately 500 to 1,000 kilograms of plastic waste per batch, depending on the scale and type of production. Much plastic waste, though recyclable, often ends up in landfills due to sorting challenges. Effective recycling requires cooperation between the medical sector and waste management authorities, with a focus on designing recycling-friendly medical plastics. While plastic is essential in medicine, research can provide better alternatives. Chemical waste also harms the environment, contaminating food and water sources. Improved waste disposal practices in the pharmaceutical industry are crucial for environmental sustainability (Mordor Intelligence, 2025; Oren, 2022). A GlobalData review of 757 pharmaceutical company filings revealed a 114% rise in mentions of environmental sustainability in the first quarter of 2023 compared to the final quarter of 2022 (Controlant, 2023).

2.4.2 Impacts on society

The social aspect of ESG in pharmaceuticals focuses on three key areas: employee management (workforce diversity, satisfaction, and pay transparency), health and safety (regulatory compliance and proactive safety measures), and reputational risk (litigation and ethical pricing concerns) (Poonton Solutions, n.d.). The industry's primary mission is to enhance and prolong life, making the social pillar a central priority. Pharmaceutical

companies recognized the importance of reporting on their social impact and have made notable strides in this area. By focusing on diseases with high unmet needs in low-income and middle-income countries, they ensure their products reach the most vulnerable populations. Seventeen of the 20 largest pharmaceutical firms have launched initiatives to expand medication access in low- and middle-income nations, more than doubling from just eight in 2010. They are also working to improve access to medicine at every stage, from pricing to donations. Additionally, the leading pharmaceutical companies are enhancing healthcare systems and building capacity through community engagement and training at the local level. They have also initiated and joined health awareness programs. By documenting these initiatives and creating new social impact categories, they are leading the way and showing their dedication to societal improvement (Controlant, 2023; Datwyler, 2022; Oren, 2024; Varma, 2023b).

2.4.3 Impacts on governance

Governance in the pharmaceutical sector requires clear ESG communication with employees, investors, and the public. Success depends on transparency and avoiding superficial marketing. Growing skepticism toward unmet ESG promises underscores the need for accountability and accurate reporting. Research shows 68% of pharmaceutical employees are unaware of their company's ESG strategy, highlighting the importance of data-driven actions and measurable impact (Poonton Solutions, n.d.). Pharmaceutical companies should address inequality, uphold business ethics, and ensure fair decision-making and legal compliance. Following ethical principles is essential to maintaining user trust and community concerns. Avoiding tax irregularities and unethical behavior is crucial to preventing serious consequence (Oren, 2022).

Regulations for the pharmaceutical industry are stringent, and because of that, it is essential that companies go beyond compliance and embed governance practices into their organizational structures. Many leading pharmaceutical companies have appointed chief sustainability officers who report directly to the chief executive officer, signaling top-level prioritization of sustainability goals. These companies are also considering the establishment of internal task forces to focus on ESG requirements and enhance disclosures. By adopting a comprehensive governance framework, pharmaceutical companies can ensure that their ecological and social targets are fulfilled, ensuring compliance with future policies (Varma, 2023b).

2.5 ESG controversies score

The ESG controversies score evaluates sustainability-related disputes, including unethical, damaging, or unlawful actions, as well as corporate scandals linked to such misconduct. ESG controversies emerge from company actions or business practices that may harm their reputation due to negative environmental, social, or governance impacts. These issues often

stem from product-related concerns or operational missteps that pose sustainability risks (Jucá et al., 2024). Even firms with strong ESG ratings can still face reputational risks from scandals tied to inadequate social or governance standards, as well as environmental crises (Liu, 2024).

The study including 625 publicly owned companies from 29 countries found out that ESG controversies weaken financial outcomes of companies operating in environmental sensitive industries and companies operating in developed countries. A one-point rise in the ESG controversies score leads to a 0.04% drop in return on equity for companies. In environmentally sensitive sectors, the impact is greater, with a 0.07% decline in *ROE* per point increase in the ESG controversies score. But it has no influence in companies in non-environmentally sensitive industries. The influence of increase of ESG controversies was also notice in developed countries (*ROE* decreases for 0.05 percent for every one-point increase of ESG controversies) (Jucá et al., 2024).

2.6 ESG rating and financial performance

2.6.1 Link between ESG and financial performance

Since 1970, over 2,000 studies have explored the impact of ESG factors on corporate financial performance. However, ESG assessment faces two major challenges: insufficient detailed data on companies' ESG strategies and risk exposure, and the absence of a dependable ESG rating system. The study from Friede et al. (2015), which combines insights from approximately 2200 separate studies and it is one of the most exhaustive overviews of academic analyses related to this area, concludes that roughly 90% of studies found a nonnegative relationship between ESG and corporate financial performance. More importantly the majority of studies (62%) reported positive findings. Positive ESG effect on corporate financial performance appeared stable over time. Studies highlight that rational investors should prioritize long-term responsible investing to uphold fiduciary duties and align with societal objectives. A deeper understanding of ESG integration in investment processes is crucial to unlocking value. Future research should focus on the interplay of ESG criteria and their impact on financial metrics (Friede et al., 2015).

ESG performance discussions have evolved from a purely financial focus to broader socio-economic impacts. Increased ESG disclosure enhances transparency in governance, environmental, and social practices, encouraging managers, investors, and key players to make more informed decisions and assessments (Cek & Eyupoglu, 2020). Pharmaceutical companies integrate sustainability into their strategies, but a universal standard for corporate sustainability reports in global health is lacking. While areas like environmental impact and labor relations are well-developed, sensitive issues like citizen rights remain under addressed. Companies refine their reporting strategies to add value and meet stakeholder expectations. Public concerns include high drug prices and unethical practices like animal

testing. Though vital for human, animal, and plant health, the industry significantly impacts the environment, driving the adoption of sustainability principles (López-Toro et al., 2021).

2.6.2 General overview of mechanisms of ESG impact

ESG impacts cash flow through five key channels. They offer a systematic approach to thinking about ESG, rather than guaranteeing that each will apply universally or to the same extent in every case. Despite a business approach or geographical location, all five aspects should be considered due to their significant potential for value creation. Overlooking any of these dimensions may result in missed opportunities for enhancing business performance and sustainability (Henisz et al., 2019).

a) Improved reputation and brand value

Strong ESG performance boosts a company's reputation, fostering customer loyalty, increasing sales, and enabling premium pricing. A well-developed ESG strategy opens doors to new markets and strengthens positions in existing ones. Companies with earned trust from regulatory bodies are more likely to receive approvals, licenses, and growth opportunities. Strong ESG engagement also improves access to resources through positive community and government relationships. Additionally, ESG influences consumer preferences, with over 70% of surveyed buyers across industries willing to pay 5% more for a sustainable product that matches the quality of conventional alternatives (Henisz et al., 2019; Khan et al., 2024).

b) Employee productivity uplift

Companies with strong ESG practices often attract and retain employees who are motivated by ethical and sustainable practices, leading to improved productivity and lower turnover rates. Higher employee satisfaction is linked to stronger shareholder returns (Bhattacharjee et al., 2017; Henisz et al., 2019).

c) Investment and asset optimization

A strong ESG proposition enhances investment returns by channeling capital to sustainable opportunities and avoiding stranded investments. Ignoring ESG principles can lead to declining value, especially in energy-intensive operations. While updating infrastructure may be costly, delaying can be more expensive as regulatory landscapes evolve, particularly regarding emissions and material restrictions. Proactively repurposing assets, like converting underutilized spaces, helps companies stay ahead of regulatory and market changes. Firms with strong ESG performance also may benefit from better access to capital markets and lower borrowing costs due to lower perceived risk by investors and lenders (Henisz et al., 2019).

d) Operation efficacy and innovation

Implementing ESG initiatives can enhance efficiency and foster innovation, minimizing waste and energy usage. These improvements help lower costs and boost overall

profitability. ESG strategies effectively can lead to significant cost savings. One key benefit is mitigating escalating operational expenses, such as raw material prices and the real costs of resources like water and carbon. These factors can impact operating profits by up to 60% (Henisz et al., 2019; McWilliams & Siegel, 2000).

e) Reducing regulatory and legal risks

Companies that proactively manage ESG risks are often better prepared for regulatory changes and environmental challenges, which can lead to lower costs related to fines, lawsuits, and compliance issues. A robust external-value proposition allows companies more strategic flexibility while reducing regulatory constraints. Strong ESG performance lowers the likelihood of negative government intervention and can foster regulatory backing (Henisz et al., 2019).

Table 2 illustrates the potential impacts of a company's ESG positioning across various critical business areas. A strong ESG proposition can drive positive outcomes such as enhanced reputation, increased employee motivation, and improved operational efficiency. In contrast, a weak ESG stance may lead to negative consequences including loss of resources, reduced talent pool, and regulatory penalties (Henisz et al., 2019).

Table 2: Examples of ESG impact on company's overall performance.

	Strong ESG preposition	Weak ESG preposition
Company's reputation and brand value	Attract consumers with eco-friendly offerings Secure improved resource availability through enhanced ties with local communities and government entities	Lose consumer trust over environmental and ethical shortcomings, affecting brand reputation and sales, face resource limitations caused by strained community and workforce relationships
Workforce efficiency	Enhance staff engagement Enhance recruitment by emphasizing social responsibility	Struggle with recruitment due to negative societal perceptions, limiting their talent pool
Regulatory and legal risks	Gain more operational flexibility by reducing regulatory constraints Obtain public funding and policy incentives	Face limitations on marketing and sales channels Face financial sanctions and legal consequences

to be continued

Table 3: Examples of ESG impact on company's overall performance. (cont.)

	Strong ESG preposition	Weak ESG preposition
Investment and asset optimization	Improve investment outcomes by strategically directing capital toward long-term assets Minimize financial risks by avoiding assets vulnerable to long-term ecological concerns	Experience asset devaluation due to early financial adjustments Lag behind rivals who have prioritized energy efficiency improvements
Operation efficacy and innovation	Lower energy consumption Minimize water consumption	Produce excess waste, leading to increased disposal expenses Increase packaging expenditures

Source: Henisz et al. (2019)

All factors do not have the same impact on sustainability and on company's borrowing capacity (business and financial risk). ESG considerations can be divided in various categories related to environmental, social and governance factors and different level of impact (Table 4) (Scope Ratings GmbH, 2022).

Table 4: ESG considerations in pharmaceutical industry based on company's credit profile.

Sustainability impact	<i>High</i>	Resource management	Product innovation	Regulatory & Reputational
	<i>Medium</i>	Clarity/ Transparency	Clients and supply chain Company control	Stakeholder management
	<i>Low</i>		Health & Safety Corporate culture	
		<i>Low</i>	<i>Medium</i>	<i>High</i>
	Business and financial impact			

Source: Tölke et al. (2022)

2.6.3 Empirical evidence

2.6.3.1 *Empirical evidence general*

Currently 50% of the total value of assets held by financial institutions worldwide (assets managed by banks, insurance companies, pension funds, mutual funds, other financial entities) are managed by Principles for Responsible Investment. This movement highlights the growing commitment of financial markets to incorporating environmental, social, and governance (ESG) factors into investment approaches. However, the widespread adoption of sustainable investment practices among mainstream investors continues to progress slowly. To accelerate this shift, it is essential to embrace a long-term perspective on sustainable investment, ensuring ESG data becomes more reliable and transparent (Busch et al., 2015; Friede et al., 2015).

UN Secretary General and UN Global Compact in collaboration with the Swiss government, supported by 23 financial institutions firstly mentioned ESG in modern context and encourage all business stakeholders to embrace ESG long-term. They established principles and suggestions to enhance the incorporation of environmental, social, and corporate governance (ESG) considerations in asset management, securities trading, and related research activities. Effective management of these factors contributes to a company's overall leadership quality, which is essential for maintaining a competitive edge. Businesses that excel in addressing ESG concerns can enhance shareholder value while strengthening their brand reputation—an increasingly significant component of corporate worth (United Nations, 2004).

Organizations should enhance ESG practices to boost stock valuation and investor perception. Proactive ESG engagement helps managing overvaluation and optimize capital structures. Transparent ESG communication fosters positive investor views and sustained stock performance, while integrating ESG into financial planning enables informed decision-making. A strong commitment to environmental, social, and governance (ESG) principles is closely linked to improved investment efficiency. Companies that excel in environmental, social, and governance (ESG) practices experience fewer gaps in information transparency, face fewer financial limitations, enjoy higher cash flow levels, and benefit from greater stability in cash flow patterns (Bilyay-Erdogan et al., 2024; Khan et al., 2024).

Neglecting ESG considerations poses significant long-term risks for companies. Financially, they may encounter higher operational costs due to inefficient resource use, penalties for regulatory non-compliance, and reduced access to capital as investors prioritize sustainability. Operational risks include supply chain disruptions caused by environmental factors or labor disputes. Additionally, failing to address ESG challenges can damage a company's reputation, leading to loss of customer trust, decreased investor confidence, declining market share, and reduced stock value (Varma, 2023a). The impact of integrating

environmental, social, and governance (ESG) factors into investment strategies remains a widely debated issue. Research (Table 5) indicates that businesses with strong ESG performance tend to benefit from reduced capital costs, lower market volatility, and fewer cases of unethical practices such as bribery, fraud, and corruption. On the other hand, companies with weaker ESG scores often face higher capital expenses and increased financial instability due to controversies, regulatory breaches, and operational disruptions like labor strikes, environmental incidents, and governance failures. Recent research by academics and investors has shown that portfolios incorporating key environmental, social, and governance (ESG) factors alongside thorough financial analysis have historically demonstrated reduced risk and, in many cases, superior performance over the medium to long term. The study by MSCI group evaluate how ESG characteristics have led to financially significant effects. Research indicates that ESG factors significantly influence company valuation and performance. Firms with high ESG ratings tend to be more competitive, achieving greater profitability, stronger returns, and higher dividend payouts. They also face fewer major risk events and lower systematic volatility, resulting in reduced capital costs. In contrast, companies with lower ESG scores are more vulnerable to financial instability and unexpected disruptions (MSCI, n.d.). Despite there are many positive examples of ESG and financial performance indicators, researches often claim that results are ambiguous, inconclusive or contradictory. The influence of the financial sector on both the environment and society remains a topic of ongoing discussion. Experts continue to examine its broader impact, weighing its role in sustainability, ethical investment, and economic responsibility. According to the research by Eccles et al. (2014) it was found that high sustainability companies are more likely to have established processes for stakeholders' engagement, to be more long-term oriented and to exhibit higher measurement and disclosure of non-financial information. Companies with strong sustainability practices consistently achieve superior long-term results, excelling in both stock market performance and financial metrics. Furthermore, the analysis of manufacturing companies by Chen et al. indicated that factors related to human rights, social impact, and product responsibility show a strong and positive relationship with return on equity (Chen et al., 2015; Eccles et al., 2014).

Most studies indicate that companies with strong ESG ratings tend to achieve higher excess returns. This aligns with the notion that investors regard ESG factors as a dependable measure of financial resilience and long-term stability (Liu & Yang, 2023). Also, according to Eurosif, sustainable and responsible investment involves combining traditional financial analysis with the evaluation of ESG factors. This approach is used in the research, analysis, and selection of securities within an investment portfolio. The goal is to achieve better long-term returns for investors and positively influence company behavior for the benefit of society (Torre et al., 2020).

Cek et al. (2020) analysed the economic performance of S&P 500 companies and found a strong correlation between their overall ESG model and key financial metrics, including

ROA, ROE, and earnings per share. Their findings indicate that a one-unit rise in the ESG score corresponds to a 0.15% increase in ROA. Additionally, social and governance factors consistently influenced economic performance across all regression models, whereas environmental performance did not demonstrate a significant impact (Cek & Eyupoglu, 2020). Whelan et al. conducted a meta-analysis of over 1,000 studies, revealing that 58% of corporate research found a positive correlation between ESG factors and financial performance, including return on equity (ROE), return on assets (ROA), and stock price. Additionally, 13% of studies showed a neutral impact, 21% reported mixed results—where findings varied between positive, neutral, or negative—and only 8% identified a negative relationship (Whelan et al., 2021).

The COVID-19 crisis highlighted the significance of strong ESG performance in financial stability. Research by Zhou et al. (2022) found that companies with high ESG ratings experienced less stock price volatility compared to those with lower ESG scores. While the pandemic increased market fluctuations, firms with strong ESG practices saw only a minor rise in volatility. The study concluded that good ESG performance enhances resilience and helps stabilize stock prices during economic shocks. Using a 10-day window—five trading days before and after the base date—the analysis revealed that stock price volatility in high ESG-rated companies was 0.046 lower than that of those with average ESG performance (Zhou & Zhou, 2022).

Demers et al. (2021) provided strong evidence that, after controlling for industry affiliation, risk measures, financial position, and intangible asset investments, ESG did not significantly influence stock returns during the COVID-19 crisis. Their analysis found ESG factors were not a meaningful predictor of returns in regression models for both Q1 2020 and the full year. High ESG-rated firms saw a modest abnormal return of 0.5% and a slight reduction in stock volatility by 0.3% during the crisis. The study concluded that ESG did not shield stocks from the pandemic's financial impact, whereas investments in intangible assets played a key role. Companies with substantial intangible assets experienced a 1.2% increase in stock returns and a 0.4% decline in volatility (Demers et al., 2021).

Interestingly study by Ichev (2021), which investigated the influence of appointment of Chief Health Officer before or during COVID-19 on stock returns found out that there was a positive impact. Cumulative abnormal return among those companies was +6.29% and was higher than in companies without Chief Health Officer. Appointment of Chief Health Officer can be connected with company's sustainable practices especially social parameter (Ichev, 2021). Fu et al. (2023) conducted one of the first studies exploring the link between ESG performance and financial outcomes in developing countries, also pioneering the use of digital transformation as a moderating factor in this relationship. Their regression analysis confirmed a positive impact of ESG on return on assets (ROA), with effects persisting from the initial year through the second and third years ($\alpha = 0.894$, $p < 0.01$). Additionally, they identified a strong correlation between ESG and digital transformation ($\beta = 2.518$, $p < 0.01$).

The influence of ESG on financial performance varied depending on company ownership structure, geographic region, and environmental impact. The study suggests that non-state-owned firms may have stronger incentives to enhance ESG practices and transparency due to heightened investor scrutiny and competitive pressures (Fu & Li, 2023). The study which examined ESG news and its impact on long-term U.S. stock returns, found out that market reactions were short-lived, often reversing within a month. On the event day, positive ESG news yielded a 0.31% abnormal return, while negative news led to -0.75%. Companies facing negative ESG events saw a slight 0.1% drop in market value. Environmental news had minimal influence, whereas social and governance-related news triggered stronger but temporary effects, with benefits fading within three to six months (Vu et al., 2024). The findings of study, which examined the influence of ESG performance across different stages of company's life cycle, indicate that ESG initiatives positively impact corporate financial metrics, such as return on assets (ROA), return on equity (ROE), and earnings per share, across all life cycle phases, with the strongest effects observed during the growth stage. Specifically, a one-unit rise in ESG score corresponds to a 0.20% increase in ROA during this stage. The study also highlights that financial risk plays a mediating role in the relationship between ESG performance and corporate success, particularly in growth and maturity phases (Gao et al., 2023).

A study analyzing 468 healthcare companies across both developed and developing countries suggests that ESG scores do not have a universally consistent effect on financial performance. Findings indicate that ESG initiatives contribute positively to firm performance in developed economies, leading to a 0.18% increase in return on assets (ROA). However, in developing economies, the impact appears weaker or even negligible, with only a 0.05% ROA increase. (Kalia & Aggarwal, 2023). With a rising global population and advancements in healthcare, the demand for pharmaceutical products continues to grow. As a result, the industry is increasingly focused on integrating sustainable practices while expanding its product offerings. This heightened awareness has drawn significant attention to the pharmaceutical sector's environmental and social impact, emphasizing the need for responsible development (Milanesi et al., 2020).

2.6.3.2 Empirical evidence among pharmaceutical companies

Due to the pharmaceutical industry's high investment requirements, significant risks, extended development cycles, and potential for substantial returns, investors tend to approach funding decisions with greater caution. Typically, pharmaceutical companies receive lower scores for environmental risks, higher ratings for governance-related concerns, and the highest scores in social risk, reflecting their strong connection to healthcare services and medicinal products (Liu & Yang, 2023). A survey of pharmaceutical professionals, including industry representatives, revealed strong agreement that corporate sustainability reporting enhances financial performance and should be considered a long-term investment. It should be adopted universally, regardless of company location, as it strengthens

stakeholder engagement—including customers, government entities, investors, and advocacy groups. By fostering positive relationships, sustainability reporting contributes to improved corporate reputation and profitability (Min et al., 2017). The study by Liu et al. (2023) investigated the relationship between ESG scores and stock performance in the U.S. pharmaceutical industry, analyzing data from 251 companies, including three major enterprises. Their regression analysis revealed that strong ESG performance does not universally lead to higher stock returns, though results varied across company size and industry-wide trends. Large pharmaceutical firms showed positive effects from higher ESG scores, whereas smaller companies sometimes experienced negative impacts. The authors suggested that ESG performance may have a delayed effect on financial indicators, as Bloomberg ESG ratings are typically released at the end of the year, meaning stock returns might not immediately reflect ESG changes. Additionally, they noted that greater systematic risk could contribute to lower stock returns. (Liu & Yang, 2023). The study by Lopez-Toro et al. (2021) found a positive correlation between environmental, social, and governance (ESG) factors and key financial metrics, including return on equity (ROE), return on assets (ROA), and Tobin's Q. However, the study was based on a relatively small sample of 25 international pharmaceutical companies and covered only a two-year period, which may limit the generalizability of the findings (López-Toro et al., 2021).

Mihaiu et al. (2021) conducted a global exploratory study on the impact of mergers, acquisitions, and sustainability in the pharmaceutical sector, analyzing 100 top pharmaceutical companies ranked by market capitalization. Their findings revealed a direct positive link between ESG scores and company performance, suggesting that higher ESG ratings contribute to financial success. To assess the financial dimension, they applied ratio analysis using financial statements and ESG scores from the 2011-2020 period, sourced from the Refinitiv database. Notably, this was the first study without regional restrictions that considered both mergers and acquisitions along with non-financial performance factors (Mihaiu et al., 2021).

The pharmaceutical industry, as part of environmentally sensitive sectors, encounters significant exposure to environmental risks, intense competition, public scrutiny, and political uncertainties due to its production and commercial operations. These challenges make it difficult for companies to build a reputation for sustainable and responsible practices among stakeholders. Research indicates that a higher controversy score leads to lower individual ESG ratings for firms in such industries, negatively affecting financial performance. Specifically, for each one-point rise in controversy score, return on equity declines by 0.07% (Jucá et al., 2024).

The summary of key research studies on ESG and financial performance is presented in Table 5.

Table 5: Summary of key research studies on ESG and financial performance.

Author (year)	Methodology	Variables	Key findings
Khan et al. (2024)	Descriptive statistics (pooled fixed effect model)	<u>Dependent:</u> misevaluation value (ratio of market price/true company value), capital structure <u>Independent:</u> ESG score <u>Control:</u> earnings per share, leverage ratio, company total size, market-to-book ratio, capital expenditures	Enhancing ESG profiles leads to a rise in market prices beyond their intrinsic value. ESG performance amplifies the overvaluation of already overvalued stocks while helping undervalued stocks return to their fair market value.
Cek et al. (2020)	Structural equation modelling, linear multiple regression analysis	<u>Dependent:</u> ROA, ROE, earnings per share <u>Independent:</u> ESG, E, S, G score	A one-unit increase in the overall ESG score is associated with a 0.15% increase in ROA. A one-unit increase in social performance leads to a 0.12% increase in ROE. A one-unit increase in governance performance results in a 0.10% increase in earnings per share. There is no significant relationship between environmental performance and economic performance.

to be continued

Table 4: Summary of key research studies on ESG and financial performance. (cont.)

Author, year	Methodology	Variables	Key findings
Fu et al. (2023)	Descriptive statistics, regression analysis	<u>Dependent:</u> ROA <u>Independent:</u> ESG score, property rights, pollution nature, regional nature <u>Control:</u> operating leverage, firm size, debt level, firm age, equity restriction ratio, wage, cash flow, GDP, executive compensation <u>Moderator:</u> level of digitalization	ESG performance has a significant and positive effect on ROA ($\alpha = 0.894, p < 0.01$). Digital transformation significantly enhances corporate ESG performance ($\beta = 2.518, p < 0.01$). Digital transformation plays a key role in strengthening the link between ESG practices and financial success, acting as a positive moderating factor in this relationship. ($\beta = 0.001, p < 0.05$).

to be continued

Table 4: Summary of key research studies on ESG and financial performance. (cont.)

Author, year	Methodology	Variables	Key findings
Demers et al. (2021)	Multiple regression analysis	<u>Dependent</u>: stock returns, stock volatility (standard deviation) <u>Independent</u>: ESG, E, S, G score <u>Control</u>: firm size, leverage ratio, market-to-book ration	High ESG-rated firms experienced an average abnormal return of 0.5% and a reduction in stock volatility by 0.3% during the crisis. Firms with high social scores saw an average abnormal return of 0.6%.
Vu et al. (2024)	Rolling-portfolio approach	<u>Dependent</u>: stock returns, stock volatility <u>Independent</u>: ESG news <u>Control</u>: firm size, industry classification, market condition	ESG news leads to an immediate market reaction (an average abnormal return 0.31% for positive ESG news and -0.75% for negative news), but this effect diminishes within a month (firms facing negative ESG events experience a drop in their market value of 0.1% on average). Market responses are stronger for social and governance-related news, whereas environmental topics show minimal impact. Over a 12-month period, ESG news does not have a lasting effect on stock returns.

to be continued

Table 4: Summary of key research studies on ESG and financial performance. (cont.)

Author, year	Methodology	Variables	Key findings
Gao et al. (2023)	Multiple regression analysis	<u>Dependent</u>: ROA, ROE, earnings per share <u>Independent</u>: ESG, E, S, G, score <u>Control</u>: firm size, leverage ratio, market-to-book ratio, firm age	ESG performance significantly improves corporate performance in the growth stage of a firm's life cycle. A one-unit increase in ESG score is associated with a 0.20% increase in ROA during the growth stage. ESG performance continues to positively impact 0.10 % increase of <i>ROE</i> in the maturity stage. The impact of ESG performance on corporate performance (0.10 increase in earnings per share) is less pronounced in the decline stage, with environmental uncertainty playing a significant role.
Kalia et al. (2023)	Correlation and multivariate regression analysis	<u>Dependent</u>: ROA <u>Independent</u>: ESG score	The impact of ESG scores on financial performance varies across different contexts and cannot be universally applied. Engaging in ESG initiatives enhances corporate performance in developed markets (0.18% ROA increase). In developing economies, ESG activities have little to no meaningful impact on firm performance, with effects often proving negligible or even negative (0.05% ROA increase).

to be continued

Table 4: Summary of key research studies on ESG and financial performance. (cont.)

Author, year	Methodology	Variables	Key findings
Lopez-Toro et al. (2021)	Structural equation modelling	<u>Dependent:</u> ROA, ROE, Tobin's Q <u>Independent:</u> ESG, E, S, G, ESG controversies	ESG indicators are positively correlated with financial performance metrics such as return on assets (ROA), return on equity (ROE), and Tobin's Q. The controversy indicator is positively correlated with Tobin's Q, indicating that pharmaceutical multinationals strategically invest in ESG initiatives while managing controversies to enhance their visibility and ultimately increase their market value.
Mihaiu et al. (2021)	Multiple regression analysis	<u>Independent:</u> ESG, mergers and acquisitions (M&A); <u>Dependent:</u> ROA, ROE, Tobin's Q; <u>Control:</u> company size, leverage ratio, market to book ratio	Companies involved in M&A processes tend to register a performance improvement, with an average increase in ROA by 0.25% and ROE by 0.20%. The ESG score has a positive and direct impact on company performance.
Juca et al. (2024)	Multilevel regression model	<u>Dependent:</u> ROE; <u>Independent:</u> ESG controversies; <u>Control</u> variables: size, leverage, liquidity, systemic risk, WGI	ESG controversies have a negative effect on corporate financial performance, especially for businesses in environmentally sensitive sectors and developed economies. ESG controversies tend to have a greater adverse effect on financial performance in developed nations than in emerging markets.

Source: Own work based on research review.

2.6.4 ESG and investor behavior

ESG has become a major focus in finance, shaping how businesses and individuals approach sustainability. As investors increasingly prioritize ESG principles, investment firms have responded by directing funds toward projects and companies that align with these values. By the end of 2022, ESG investments had reached \$2.5 trillion. However, concerns about greenwashing persist, as some large firms market initiatives as ESG-friendly despite having minimal or even negative environmental impact (Humbolt, 2023).

Investors and financial markets rely on ESG as a key assessment tool for sustainable and socially responsible investing, as well as corporate behavior. ESG evaluations, whether through scores or ratings, help gauge a company's future performance. By comparing ESG metrics with industry benchmarks and competitors, investors gain insights into management strategies, board effectiveness, governance standards, and sustainable investment approaches, aiding informed decision-making (Kell, 2013). Investors use ESG ratings in several ways. Some apply them as a screening tool to select well-performing companies and exclude weaker ones, aligning investments with personal values ("ESG integration"). Others use them to identify firms at financial or reputational risk due to poor ESG performance ("ESG exclusion"), minimizing portfolio risk. ESG ratings also help spot companies likely to outperform over time, as strong environmental, labor, and governance practices often lead to long-term success. This process drives impact by pushing companies to disclose their ESG strategies, enhancing transparency and accountability (IRIS Carbon, 2023).

Global awareness of ESG issues continues to grow, pushing investment strategies beyond profit maximization and risk reduction. This shift has led to substantial capital inflows into ESG funds, solidifying their role in the financial industry. Europe remains the primary hub for sustainable investments, holding the largest share of ESG-focused assets. By 2023, investor priorities centered on influencing social and environmental outcomes, with 37% of respondents emphasizing the importance of integrating ESG goals with financial objectives. ESG prioritization varied across regions, with North America showing the lowest commitment, Asia-Pacific ranking second at 22%, and Europe leading at 31%. The assets allocated to ESG-oriented ETF funds surged from \$5 billion in 2006 to \$391 billion in 2021, highlighting the growing prominence of sustainability-driven investments (Statista, 2024a, 2024b, 2025a).

3 RESEARCH METHODOLOGY

3.1 Research hypothesis

The main aim of this research is to assess the impact of environmental, social and governance performance of world's leading pharmaceutical companies on company's economic performance. The economic performance is aimed to be assessed through share price and some other financial indicators. With this research we would like to provide the answers on

questions if investors need to care about company's ESG performance when investing in shares of pharmaceutical companies and if companies need to invest more in the activities connected with ESG performance.

Based on literature overview, which is summarized in Table 5 we set the main research hypotheses which are:

- Hypothesis 1 (H1): The overall ESG scores of pharmaceutical companies influence on the companies' share prices.
- Hypothesis 2 (H2): All three factors jointly in Environmental, Social and Governance framework have a positive impact on the companies' share prices.
- Hypothesis 3 (H3): All three factors separately in Environmental, Social and Governance framework have positive impact on return on equity of pharmaceutical companies.
- Hypothesis 4 (H4): The environmental factor has the biggest impact on the pharmaceutical companies' share prices among all factors in Environmental, Social and Governance framework.

3.2 Data collection

The research adopts a quantitative research design to evaluate the influence of ESG performance on the pharmaceutical financial performance. The theoretical framework is based on financial performance analysis and ESG impact analysis. Data about ESG and financial parameters of pharmaceutical companies are collected from LSEG Data&Analytics platform. The LSEG Data&Analytics ESG database is considered as one of the most comprehensive databases in the industry. It provides extensive coverage of environmental, social, and governance data, which is crucial for investors and companies aiming to make informed decisions based on sustainability and ethical considerations.

LSEG Data & Analytics constructs ESG scores through a three-step process. First, content research analysts gather ESG data from publicly accessible sources. Next, category scores are aggregated to generate pillar scores for environmental, social, and governance factors, as well as an overall ESG rating. Lastly, an ESG Combined Score is calculated, incorporating global media-reported controversies for a more complete assessment of a company's ESG performance. This Combined Score offers a balanced perspective by merging proactive ESG initiatives with responses to controversies, integrating both the ESG Score—based on publicly disclosed data—and the ESG Controversies Score, which evaluates a firm's exposure to and management of ESG-related issues (Darolles et al., 2024). The data collection consists of companies' data from 2015 to including 2022 (if reported). The sample of pharmaceutical companies is based on the company's market capitalization. Primary it was planned to analysis the data of 50 world's leading pharmaceutical companies and Slovenian pharmaceutical company Krka, d. d., Novo mesto, however due to inconsistencies and lack of certain data the final analysis includes data of 45 companies (Appendix 2).

3.3 Definition of variables

3.3.1 Dependent variables

Independent, dependent and control variables are presented in Table 6 together with their short description and abbreviation.

Table 6: Description of variables.

Variable	Abbreviation	Description
Consecutive year	Y	The year for which dependent variables are given
Price-to-Book ratio (dependent variable)	$P/B_{(t)}$	The price-to-book ratio measures a company's market valuation by comparing its current stock price per share to its book value per share. It indicates how the market values the company relative to its net assets.
Total Environmental, Social and Governance combined score (independent variable)	$ESG_{(t-1)}$	Objective evaluation of company with respect to environmental, social, and governance issues in one year before consecutive year.
Environmental score (independent variable)	$E_{(t-1)}$	Objective evaluation of company with respect to environmental issues in one year before consecutive year.
Social score (independent variable)	$S_{(t-1)}$	Objective evaluation of company with respect to social issues in one year before consecutive year.
Governance score (independent variable)	$G_{(t-1)}$	Objective evaluation of company with respect to governance issues in one year before consecutive year.
Return on equity (independent and control variable)	$ROE_{(t)}$	Company's return on equity in consecutive year.
Total Debt to Total Equity (control variable)	$D/E_{(t-1)}$	It evaluates a company's financial structure by comparing total liabilities to shareholder equity, providing insight into how much the business depends on debt for funding.
Dividend Payout Ratio (control variable)	$DPR_{(t-1)}$	The amount of dividends paid to shareholders in relation to the total amount of net income the company generates.

to be continued

Table 5: Description of variables. (cont.)

Variable	Abbreviation	Description
Firm Fixed Effect (control variable)	<i>FFE</i>	Control for unobserved variables that are constant over time within each firm but vary between firms.

Source: Own work.

The response variables in the regression analysis are the Price-to-Book ratio and Return on equity.

a) Price to book ratio (P/B) is a financial metric used to compare a company's market value with its book value. The price-to-book (P/B) ratio is determined by dividing a company's current stock price by its book value per share, offering insight into how the market values its equity relative to its net assets. Investors often use this ratio to identify undervalued stocks, anticipating that their price will eventually align with intrinsic value. Some view the P/B ratio as a forward-looking measure, reflecting a company's potential future cash flows. A P/B ratio below 1.0 suggests undervaluation, where the stock is priced lower than its book value, while a ratio above 1 indicates possible overvaluation, with the market price exceeding the company's net asset worth. Share price fluctuations not only represent a company's present valuation and earnings but also reflect investor expectations regarding its future growth and performance (Tarver, 2024). The price to book ratio of company is considered as a dependent variable in regression analysis as it is influenced by a variety of factors and does not change in isolation. In calculation of price to book ratio of single company it is used price of share at the end of consecutive year in standardized currency.

b) Return on equity (ROE) is financial ratio that shows how well a company is managing the capital that shareholders have invested in. It measures a company's profitability in relation to shareholder's equity. It is often evaluated with price to book ratio. Significant gaps between the price-to-book ratio and return on equity can signal potential concerns for investors. Using return on equity as independent variable help to quantify the financial benefits of good ESG practices and it provides clear picture of how ESG factors contribute to company's profitability and overall financial health.

3.3.2 Independent variables

Independent variables in regression analysis are various parameters, that can affect the share prices. These are all parameters connected with ESG scores, representing company's environmental, social and governance performance (Total ESG score, Environmental score, Social score, Governance score). The values for independent variables are taken form one year before consecutive years as these values can influence on share price in the next consecutive year. As the LSEG Data&Analytics database provides the values of ESG score

in descriptive scores, they are transferred to numerical scores to enable statistical analysis (Table 7).

Table 7: Transformation of descriptive ESG scores to numerical ESG scores.

Descriptive score	Corresponding numerical score
A+	4.25
A	4.00
A-	3.75
B+	3.25
B	3.00
B-	2.75
C+	2.25
C	2.00
C-	1.75
D+	1.25
D	1.00
D-	0.75

Source: Own work.

3.3.3 Control variables

In linear regression, control variables help adjust for external factors that might distort the relationship between the independent and dependent variables. Their inclusion in the model allows for a more precise measurement of the impact of the key independent variable(s) on the dependent outcome. As control variables in linear regression are used Total Debt to Total Equity Ratio, Dividend Payout Ratio, Return on Equity and Firm Fixed Effect.

a) Total Debt to Total Equity Ratio (D/E) measures a company's financial leverage and indicates how much debt is used to finance the company's assets relative to equity. High leverage can affect a company's risk profile and valuation, impacting P/B ratio. Investors often consider this ratio to assess the financial risk and stability of a company. Companies with high debt levels might be perceived as riskier, potentially lowering their P/B ratio. Inclusion in multiple regression minimize the effect of company's financial leverage and risk profile.

b) Dividend Payout Ratio (DPR) shows the proportion of earnings distributed to shareholders as dividends. It reflects the company's dividend policy and its ability to generate cash flows. A higher DPR can attract income-focused investor, potentially increasing the demand for the stock and affecting its market price, thereby influencing the P/B ratio.

c) Return on equity measures how effectively a company is using shareholder's equity to generate profits. Higher ROE indicates better management efficiency and profitability. Companies with high ROE are seen as more capable of generating value for shareholders,

what can positively impact their market valuation and consequently *P/B* ratio. In multiple regression it also minimizes the factor of different sizes of companies.

d) Firm Fixed Effect (FEE) is used as control for unobserved variables (e.g. management quality, company culture) that are constant over time within each firm but vary between firms. This method helps isolate the impact of the independent variables on the dependent variable by accounting for firm-specific characteristics that do not change over time. *FEE* is a special variable that helps us understand the unique, consistent impact that each firm's characteristics have on the outcome we're studying. By controlling firm-specific characteristics, fixed effects reduce the bias that might result from omitted variable bias. This makes the estimates of independent variables more reliable. The estimates of the relationship between dependent variable and independent variable are also more accurate by accounting for unobserved heterogeneity.

For modelling the relationship between dependent variable and independent variables the multiple linear regression is used as this statistical technique. The dependent variable is the outcome we aim to predict, while independent or explanatory variables are the factors used to estimate its value. Some of independent variables are defined as control variables. These are variables that are not of interest to the research's objectives, but is controlled because it could influence on dependent variable.

3.4 Description of statistical methods

Data analysis is performed using Microsoft Office Excell with add-on application XLSTAT by Lumivero. Data analysis consists of basic descriptive statistics to summarize the data and provide general understanding of datasets. The descriptive statistics of scores is presented tabularly and graphically with boxplot and scatterplot.

First quick overview of relatedness of variables we perform with correlation matrix, which helps us identify the strength and direction of linear relationships between variables. After that various multiple linear regressions are performed to find out the connection between dependent and independent variables. Based on regression analyses the correlations in following ways are obtained:

$$P/B_{(t)} = \alpha_0 + \alpha_1 * ESG_{(t-1)} + \alpha_2 * ROE_{(t-1)} + \alpha_3 * D/E_{(t-1)} + \alpha_4 * DPR_{(t-1)} \quad (1)$$

$$P/B_{(t)} = \alpha_0 + \alpha_1 * E_{(t-1)} + \alpha_2 * S_{(t-1)} + \alpha_3 * G_{(t-1)} + \alpha_4 * ROE_{(t-1)} + \alpha_5 * D/E_{(t-1)} + \alpha_6 * DPR_{(t-1)} \quad (2)$$

$$P/B_{(t)} = \alpha_0 + \alpha_1 * E_{(t-1)} + \alpha_2 * ROE_{(t-1)} + \alpha_3 * D/E_{(t-1)} + \alpha_4 * DPR_{(t-1)} \quad (3)$$

$$P/B_{(t)} = \alpha_0 + \alpha_1 * S_{(t-1)} + \alpha_2 * ROE_{(t-1)} + \alpha_3 * D/E_{(t-1)} + \alpha_4 * DPR_{(t-1)} \quad (4)$$

$$P/B_{(t)} = \alpha_0 + \alpha_1 * G_{(t-1)} + \alpha_2 * ROE_{(t-1)} + \alpha_3 * D/E_{(t-1)} + \alpha_4 * DPR_{(t-1)} \quad (5)$$

α_0 – intercept; constant term in the regression equation. It represents the expected value of the *P/B* ratio when all independent variables are zero.

$\alpha_1, \alpha_2, \alpha_3, \alpha_4$ - coefficients that show the change in the *P/B* ratio for a one-unit increase in the one independent variable from the previous period, holding all other variables constant. All other independent and dependent variables are explained in Table 6.

We also perform regression analysis to find out correlation between the independent variables and return on equity. The aim is to see how total ESG combined score and also separate ESG scores influence on return on equity and which score has the biggest influence. Also, these analyses are performed with inclusion of firm fixed effect and without it.

$$ROE_{(t)} = \alpha_0 - \alpha_1 * ESG_{(t-1)} + \alpha_4 * D/E_{(t-1)} - \alpha_5 * DPR_{(t-1)} \quad (6)$$

$$ROE_{(t)} = \alpha_0 - \alpha_1 * E_{(t-1)} + \alpha_2 * S_{(t-1)} - \alpha_3 * G_{(t-1)} + \alpha_4 * D/E_{(t-1)} - \alpha_5 * DPR_{(t-1)} \quad (7)$$

α_0 – intercept; constant term in the regression equation. It represents the expected value of the *ROE* when all independent variables are zero.

$\alpha_1, \alpha_2, \alpha_3, \alpha_4$ - coefficients that show the change in the *ROE* for a one-unit increase in the one independent variable from the previous period, holding all other variables constant.

All other independent and dependent variables are explained in Table 6.

When analyzing the relationship between ESG scores and *P/B* and *ROE*, we take these metrics in different, but consecutive years. Measuring in consecutive years, rather than in the same year, is generally a more robust approach for analyzing their relationship. The reasons for that are the lagged effect of ESG on financial performance, avoiding reverse causality and empirical consistency. The lagged effect is observed as the effects of ESG performance on financial performances often take time to materialize. With taking consecutive years, we allow time for the potential benefits of ESG initiatives to be reflected in the financial metrics. There is also empirical evidence that this approach aligns with best practices in financial research and helps to provide cleared insights into how ESG initiatives affect profitability over time.

4 RESULTS OF QUANTITATIVE ANALYSIS

4.1 Descriptive statistics

The descriptive statistics includes 353 data for all four scores (Table 8). The highest mean value among analyzed pharmaceutical companies is for social score with value 3.437 and it has also the lowest variance. Also, the values for 1st and 3rd quartile are the highest for social score.

Table 8: Descriptive statistics of Total ESG combined score, Environmental score, Social score and Governance score.

Statistical parameter	$ESG_{(t-1)}$	$E_{(t-1)}$	$S_{(t-1)}$	$G_{(t-1)}$
Number of observations	353	353	353	353
Minimum	1.000	0.750	1.000	0.750
Maximum	4.250	4.250	4.250	4.250
1 st Quartile	2.250	2.250	3.000	2.250
Median	3.000	3.250	3.750	3.250
3 rd Quartile	3.250	3.750	4.000	4.000
Mean	2.903	3.001	3.437	3.069
Variance $_{(n-1)}$	0.523	0.943	0.685	0.758
Standard deviation $_{(n-1)}$	0.723	0.971	0.828	0.871

Source: Own work.

4.2 Correlation analysis

This correlation table (Table 9) provides insights into the relationships between ESG-related variables (environmental, social, governance scores) and financial metrics such as *ROE*, *D/E*, *DPR* and *P/B*. It highlights the strength and direction of linear associations.

Table 9: Correlation matrix of all tested variables.

	$ESG_{(t-1)}$	$E_{(t-1)}$	$S_{(t-1)}$	$G_{(t-1)}$	$ROE_{(t-1)}$	$D/E_{(t-1)}$	$DPR_{(t-1)}$	$P/B_{(t)}$
$ESG_{(t-1)}$	1,000							
$E_{(t-1)}$	0,607	1,000						
$S_{(t-1)}$	0,623	0,748	1,000					
$G_{(t-1)}$	0,552	0,420	0,457	1,000				
$ROE_{(t-1)}$	0,179	0,119	0,230	-0,049	1,000			
$D/E_{(t-1)}$	-0,075	0,003	0,063	-0,087	0,454	1,000		
$DPR_{(t-1)}$	-0,034	0,135	0,124	0,162	-0,084	0,055	1,000	
$P/B_{(t)}$	-0,007	-0,024	0,082	-0,146	0,573	0,343	-0,026	1,000

Source: Own work.

Based on correlation analysis there is a positive correlation between *ESG* and *E*, *S* and *G* meaning that when *ESG* increases, *E*, *S* and *G* also increase. *ESG* weakly positively correlates with *ROE* and weakly negatively with *D/E*, *DPR* and *P/B*. *ROE* weakly positively correlates with total *ESG*, environmental and social scores from previous period. Among them the social score has the biggest positive correlation. The correlation between *ROE* and governance score is very weakly negative, practically with no correlation. Among all correlations between *ROE* and independent variables, the correlations with *D/E* and *P/B* ratio from the previous period are the highest, nevertheless weakly positive. *P/B* ratio very weakly negatively correlates with *ESG* score from previous period. There is almost no relationship between *ESG* score from previous period and *P/B* ratio in the current period. The same situation is also with the correlation between *P/B* and environmental score. The correlation between *P/B* and social score suggest slight positive relationship and slight negative relationship with governance score. Among other independent variables the highest

correlations appear between P/B ratio and ROE (moderate positive) and D/E (weak positive). We can conclude that all other, previously mentioned correlations with P/B are very weak, indicating minimal relationships.

4.3 Regression analysis

4.3.1 Analysis of the influence of Total ESG combined score in previous period on Price-to-Book ratio in current period.

This regression analysis evaluates the impact of Total ESG performance and other financial metrics on the dependent variable $P/B_{(t)}$. The dataset comprises 323 observations, indicating its robustness. The R^2 value of the first model is 0.34, suggesting that approximately 34.4% of the variance in the dependent variable is explained by the model, while the adjusted R^2 is slightly lower. The analysis (Table 10) highlights ROE (0.188; $p < 0.001$) as the dominant predictor of the dependent variable, indicating that financial efficiency, as measured by ROE , is a key driver of market valuation (P/B). ESG performance indicators show no meaningful direct influence on P/B (-0.087; insignificant p). Similarly, both control variables demonstrate negligible and statistically insignificant relationships with P/B .

Table 10: Analyzing the relationship between Total ESG combined score and Price-to-Book ratio: Regression output without inclusion of Firm fixed effect.

Number of observations = 323							
$R^2 = 0.344$							
Adjusted $R^2 = 0.335$							
Source	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	2.062	1.633	1.263	0.207	-1.150	5.275	/
$ESG_{(t-1)}$	-0.087	0.534	-0.163	0.870	-1.139	0.964	/
$ROE_{(t-1)}$	0.188	0.019	10.027	<0.0001	0.151	0.225	***
$D/E_{(t-1)}$	0.006	0.004	1.323	0.187	-0.003	0.014	/
$DPR_{(t-1)}$	0.000	0.001	0.333	0.740	-0.002	0.003	/
Signification codes: $0 < *** < 0.001 < ** < 0.01 < * < 0.05 < 0.1$							

Source: Own work.

Equation of the regression model without inclusion of Firm fixed effect:

$$P/B_{(t)} = 2.062 - 0.087 ESG_{(t-1)} + 0.188*ROE_{(t-1)} + 0.006*D/E_{(t-1)} + 0*DPR_{(t-1)}$$

Table 11 summarizes the results of the regression analysis, which evaluates the impact of Total ESG performance and other financial metrics on the dependent variable $P/B_{(t)}$, including the effect of firm fixed characteristics. Regression coefficients R^2 (0.832) and adjusted R^2 (0.804) suggest a strong model fit, with over 80% of the variance in the

dependent variable explained by the independent variables. Regression coefficients for firm fixed effects ($R^2 = 0.568$ and adjusted $R^2 = 0.507$) highlight the influence of firm-specific characteristics, accounting for 50–57% of the variance. This highlights the significant influence of firm-specific characteristics on the relationships observed. The intercept ($\alpha_0 = 4.711$) shows statistically significant relevance in the model ($p = 0.030$). The $ESG_{(t-1)}$ coefficient (-1.070) demonstrates a negative impact with statistical significance ($p = 0.042$), suggesting that ESG performance may negatively affect the dependent variable in the short term. $ROE_{(t-1)}$ shows no discernible influence. Among the control variables, $D/E_{(t-1)}$ indicates a strong positive and highly significant relationship ($p < 0.0001$) with the dependent variable, while $DPR_{(t-1)}$ shows minimal or no effect with no statistical significance.

Table 11: Analyzing the relationship between Total ESG combined score and Price-to-Book ratio: Regression output with inclusion of Firm fixed effect.

Number of observations = 323 $R^2 = 0.832$ Adjusted $R^2 = 0.804$ R^2 (firm fixed effect) = 0.568 Adjusted R^2 (firm fixed effect) = 0.507							
Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	4.711	2.161	2.180	0.030	0,457	8,965	*
$ESG_{(t-1)}$	-1.070	0.524	-2.042	0.042	-2,101	-0,038	*
$ROE_{(t-1)}$	0.000	0.014	0.002	0.998	-0,027	0,027	/
$D/E_{(t-1)}$	0.045	0.005	9.997	<0.0001	0,036	0,054	***
$DPR_{(t-1)}$	-0.001	0.001	-1.059	0.290	-0,003	0,001	/
$FFE1$	YES						
Signification codes: $0 < *** < 0.001 < ** < 0.01 < * < 0.05$							

Source: Own work.

Equation of the regression model with inclusion of Firm fixed effect:

$$P/B_{(t)} = 4.711 - 1.070 * ESG_{(t-1)} + 0.0 * ROE_{(t-1)} + 0.045 * D/E_{(t-1)} - 0.001 * DPR_{(t-1)}$$

The inclusion of firm fixed effects (*FFE*) in the regression model resulted in significant changes to the coefficients, highlighting the important role of firm-specific factors in shaping the relationship between the independent variables and the *P/B* ratio. The second model offers a more comprehensive explanation of the variance in the dependent variable, supported by its higher R^2 values and the incorporation of firm fixed effects. Notably, it reveals a shift in the significance and roles of the independent variables, with $ESG_{(t-1)}$ and $D/E_{(t-1)}$ emerging as key factors, unlike in the previous model.

Based on this analysis, hypothesis H1, which states that the overall ESG scores of pharmaceutical companies influence their share prices, is confirmed. A negative correlation is already evident in the correlation matrix (Table 9), though the effect is very weak, with a correlation coefficient of -0.007. The linear regression model, including firm fixed effects (*FFE*), demonstrates that the Total ESG combined score from the previous period negatively correlates with the *P/B* ratio in the current period, and this influence is statistically significant ($p < 0.05$). The Total ESG combined score emerges as an important predictor of the *P/B* ratio. Specifically, a one-unit increase in the Total ESG combined score results in a 1.07 decrease in the *P/B* ratio, indicating that the share price declines while the book value remains constant.

4.3.2 Analysis of the influence of each factor in ESG score in previous period on Price-to-Book ratio in current period

a) Environmental, Social and Governance scores jointly

The regression analysis (Table 12) consists of 323 observations, indicating a robust dataset. The model explains 35.5% of the variance in the dependent variable ($R^2 = 0.355$; adjusted $R^2 = 0.342$), with the adjusted R^2 being slightly lower due to model complexity. The overall explanatory power is moderate. $ROE_{(t-1)}$ is the most significant predictor in this model (0.178; $p < 0.0001$), emphasizing the importance of financial efficiency in determining market valuation. $G_{(t-1)}$ shows a statistically significant negative relationship (-1.001; $p < 0.05$), suggesting that governance performance has a negative short-term influence on the *P/B*. Other variables, including environmental and social scores ($E_{(t-1)}$, $S_{(t-1)}$), as well as $D/E_{(t-1)}$ and $DPR_{(t-1)}$, do not exhibit statistically significant relationships.

Table 12: Analyzing the relationship between Environmental, Social and Governance scores jointly and Price-to-Book ratio: Regression output without inclusion of Firm fixed effect.

Number of observations = 323							
$R^2 = 0.355$							
Adjusted $R^2 = 0.342$							
Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	2.138	1.831	1.167	0.244	-1.465	5.741	/

to be continued

Table 13: Analyzing the relationship between Environmental, Social and Governance scores jointly and Price-to-Book ratio: Regression output without inclusion of Firm fixed effect. (cont.)

Variable	Coefficient value	Standard	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values significant values
$E_{(t-1)}$	-0.426	0.593	-0.718	0.473	-1.593	0.741	/
$S_{(t-1)}$	1.221	0.745	1.638	0.102	-0.246	2.687	/
$G_{(t-1)}$	-1.001	0.505	-1.982	0.048	-1.995	-0.007	*
$ROE_{(t-1)}$	0.178	0.019	9.248	<0.001	0.140	0.216	***
$D/E_{(t-1)}$	0.005	0.004	1.306	0.192	-0.003	0.014	/
$DPR_{(t-1)}$	0.001	0.001	0.474	0.636	-0.002	0.004	/
Signification codes: $0 < *** < 0.001 < ** < 0.01 < * < 0.05$							

Source: Own work.

Equation of the regression model without inclusion of Firm fixed effect:

$$P/B_{(t)} = 2.138 - 0.426 * E_{(t-1)} + 1,221 * S_{(t-1)} - 1.001 * G_{(t-1)} + 0.178 * ROE_{(t-1)} + 0.005 * D/E_{(t-1)} + 0.001 * DPR_{(t-1)}$$

Table 14 presents the results of a regression analysis that evaluates the relationship between the independent variables ($E_{(t-1)}$, $S_{(t-1)}$, $G_{(t-1)}$, $ROE_{(t-1)}$, $D/E_{(t-1)}$, $DPR_{(t-1)}$) and the dependent variable (P/B), with firm fixed effects (FFE) included in the model. The analysis demonstrates strong explanatory power, with over 80% of the variance in the dependent variable explained by the independent variables ($R^2 = 0.834$, adjusted $R^2 = 0.804$). The R^2 (Firm Fixed Effect) value of 0.568 and the adjusted R^2 of 0.507 underscore the significance of firm-specific characteristics, which account for 50–57% of the variance.

This analysis highlights the critical role of firm-specific factors and capital structure, represented by $D/E_{(t-1)}$, in shaping market valuation. $D/E_{(t-1)}$ emerges as the strongest predictor (0.045; $p < 0.0001$), positively influencing the P/B . $G_{(t-1)}$ demonstrates a statistically significant negative effect (-0.940; $p < 0.1$), suggesting that governance scores have a detrimental short-term impact on the P/B . All other variables exhibit minimal or no statistically significant influence on the P/B . ESG components, overall, do not show strong

direct effects, indicating potential indirect or longer-term impacts that merit further exploration.

Table 14: Analyzing the relationship between Environmental, Social and Governance scores jointly and Price-to-Book ratio: Regression output with inclusion of Firm fixed effect.

Number of observations = 323							
$R^2 = 0.834$							
Adjusted $R^2 = 0.804$							
R^2 (firm fixed effect) = 0.568							
Adjusted R^2 (firm fixed effect) = 0.507							
Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	6.108	2.435	2.508	0.013	1.313	10.902	*
$E_{(t-1)}$	0.455	0.579	0.787	0.432	-0.684	1.595	/
$S_{(t-1)}$	-1.045	0.677	-1.543	0.124	-2.378	0.289	/
$G_{(t-1)}$	-0.940	0.530	-1.774	0.077	-1.983	0.103	.
$ROE_{(t-1)}$	0.001	0.014	0.092	0.927	-0.027	0.029	/
$D/E_{(t-1)}$	0.045	0.005	10.044	<0.0001	0.036	0.054	***
$DPR_{(t-1)}$	0.000	0.001	-0.535	0.593	-0.002	0.001	/
$FFE1$	YES						
<i>Signification codes: $0 < *** < 0.001 < ** < 0.01 < * < 0.05 < . < 0.1$</i>							

Source: Own work.

Equation of the regression model with inclusion of Firm fixed effect:

$$P/B_{(t)} = 6.108 + 0.455 * E_{(t-1)} - 1.045 * S_{(t-1)} - 0.940 * G_{(t-1)} + 0.001 * ROE_{(t-1)} + 0.045 * D/E_{(t-1)} + 0.000 * DPR_{(t-1)}$$

The inclusion of firm fixed effects in the second model significantly enhances explanatory power, highlighting the critical role of firm-specific characteristics in shaping market valuation. This adjustment shifts the focus from ESG components and financial efficiency metrics to firm-specific characteristics. Among the predictors, capital structure, represented by $D/E_{(t-1)}$, emerges as a pivotal factor, showing a strong and highly significant positive relationship with the P/B . Governance score consistently demonstrates a negative relationship with the dependent variable, suggesting potential short-term challenges associated with governance performance. Across both models, ESG components show limited direct influence on market valuation, pointing to the need for further exploration of indirect or longer-term impacts.

Based on this analysis, hypothesis H2, which states that all three factors within the Environmental, Social, and Governance (ESG) framework jointly have a positive impact on

companies' share prices, is not confirmed. As observed in the correlation matrix (Table 9), the negative correlation coefficients outweigh the positive ones. This finding is further supported by the regression model with *FFE* inclusion, which found out that governance and social scores have negative impact and only the governance one is significant (Table 14).

Based on this analysis, also the hypothesis H4, which posits that the environmental factor has the greatest impact on pharmaceutical companies' share prices among all factors within the Environmental, Social, and Governance (ESG) framework, is not confirmed. The environmental factor is not even statistically significant ($p = 0.432$).

b) Environmental score

This regression analysis (Table 15) examines the relationship between independent variables ($E_{(t-1)}$, $ROE_{(t-1)}$, $D/E_{(t-1)}$, $DPR_{(t-1)}$) and the dependent variable (P/B ratio). The regression model with R^2 0.344 and adjusted R^2 0.335 explained approximately 34% of the variance in the dependent variable is explained by the independent variables. The adjusted R^2 slightly reduces the explanatory power, but overall, it suggests moderate model performance.

$ROE_{(t-1)}$ stands out as the most significant variable, demonstrating a statistically significant ($p < 0.001$) positive relationship (0.188) with the P/B . This highlights the critical role of financial efficiency in determining market valuation. In contrast, environmental and other variables show no significant relationship with the dependent variable, indicating limited direct influence on share prices in the analyzed context. Additionally, the intercept, while positive, is not statistically significant in this model.

Table 15: Analyzing the relationship between Environmental score and Price-to-Book ratio: Regression output without inclusion of Firm fixed effect.

Number of observations = 323							
$R^2 = 0.344$							
Adjusted $R^2 = 0.335$							
Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	1.993	1.276	1.561	0.119	-0.518	4.504	/
$E_{(t-1)}$	-0.063	0.400	-0.157	0.875	-0.849	0.723	/
$ROE_{(t-1)}$	0.188	0.019	10.104	<0.0001	0.151	0.224	***
$D/E_{(t-1)}$	0.006	0.004	1.347	0.179	-0.003	0.014	/
$DPR_{(t-1)}$	0.001	0.001	0.354	0.724	-0.002	0.003	/
Signification codes: $0 < *** < 0.001$							

Source: Own work.

Equation of the regression model without inclusion of Firm fixed effect:

$$P/B_{(t)} = 1.993 - 0.063 * E_{(t-1)} + 0.188 * ROE_{(t-1)} + 0.006 * D/E_{(t-1)} + 0.001 * DPR_{(t-1)}$$

Table 16 summarizes the results of the regression analysis with the inclusion of firm fixed effects. The model demonstrates strong explanatory power, with over 80% of the variance in the dependent variable explained by the independent variables ($R^2 = 0.830$; adjusted $R^2 = 0.801$). The correlation coefficients for the firm fixed effects highlight the influence of firm-specific characteristics, which account for 50–57% of the variance.

$D/E_{(t-1)}$ stands out as the strongest predictor, exhibiting a highly significant positive relationship (0.046; $p < 0.0001$), emphasizing the crucial role of capital structure in determining market valuation. The Environmental Factor, $ROE_{(t-1)}$, and $DPR_{(t-1)}$ do not demonstrate statistically significant relationships with the P/B , suggesting limited or no direct influence in the analyzed context. Additionally, the intercept is not statistically significant.

Table 16: Analyzing the relationship between Environmental score and Price-to-Book ratio: Regression output with inclusion of Firm fixed effect.

Number of observations = 323							
$R^2 = 0.830$							
Adjusted $R^2 = 0.801$							
R^2 (firm fixed effect) = 0.568							
Adjusted R^2 (firm fixed effect) = 0.507							
Source	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	2.404	1.924	1.249	0.213	-1.384	6.191	/
$E_{(t-1)}$	-0.327	0.461	-0.709	0.479	-1.234	0.580	/
$ROE_{(t-1)}$	-0.003	0.014	-0.235	0.815	-0.031	0.024	/
$D/E_{(t-1)}$	0.046	0.005	10.277	<0.0001	0.038	0.055	***
$DPR_{(t-1)}$	0.000	0.001	-0.470	0.639	-0.002	0.001	/
$FFE1$	YES						
<i>Signification codes: 0 < *** < 0.001</i>							

Source: Own work.

Equation of the regression model with inclusion of Firm fixed effect:

$$P/B_{(t)} = 2.404 - 0.327 * E_{(t-1)} - 0.003 * ROE_{(t-1)} + 0.046 * D/E_{(t-1)} + 0.000 * DPR_{(t-1)}$$

The second regression analysis, with firm fixed effects included, provides a more comprehensive understanding of the relationships between variables. It emphasizes $D/E_{(t-1)}$ as the most critical factor influencing market valuation, while $ROE_{(t-1)}$ loses its significance compared to the first model. Environmental factors and other variables exhibit limited direct

impact across both analyses. Firm-specific characteristics play a substantial role in the second model, as evidenced by the strong explanatory power and R^2 (FFE) values.

c) Social score

The regression analysis (Table 17) examines the relationship between the independent variables ($S_{(t-1)}$, $ROE_{(t-1)}$, $D/E_{(t-1)}$, $DPR_{(t-1)}$) and the dependent variable (P/B). The model accounts for approximately 34.5% of the variance in the dependent variable, reflecting moderate explanatory power ($R^2 = 0.345$, Adjusted $R^2 = 0.336$).

$ROE_{(t-1)}$ stands out as the most significant predictor, demonstrating a statistically significant ($p < 0.001$) and positive relationship (0.183) with the P/B , emphasizing the importance of financial efficiency in shaping market valuation. In contrast, the social score, $D/E_{(t-1)}$, and $DPR_{(t-1)}$ do not exhibit statistically significant relationships with the dependent variable, indicating limited direct influence in this context.

*Table 17: Analyzing the relationship between Social score and Price-to-Book ratio:
Regression output without inclusion of Firm fixed effect.*

Number of observations = 323							
$R^2 = 0.345$							
Adjusted $R^2 = 0.336$							
Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	0.721	1.688	0.427	0.669	-2.599	4.041	/
$S_{(t-1)}$	0.332	0.490	0.678	0.498	-0.632	1.296	/
$ROE_{(t-1)}$	0.183	0.019	9.557	<0.0001	0.146	0.221	***
$D/E_{(t-1)}$	0.006	0.004	1.449	0.148	-0.002	0.014	/
$DPR_{(t-1)}$	0.000	0.001	0.215	0.830	-0.003	0.003	/
Signification codes: $0 < *** < 0.001$							

Source: Own work.

Equation of the regression model without inclusion of Firm fixed effect:

$$P/B_{(t)} = 0.721 + 0.332*S_{(t-1)} + 0.183*ROE_{(t-1)} + 0.006*D/E_{(t-1)} + 0.000*DPR_{(t-1)}$$

The regression model (Table 18), which includes firm fixed effects, demonstrates strong explanatory power, with over 80% of the variance in the dependent variable explained by the independent variables ($R^2 = 0.832$, Adjusted $R^2 = 0.803$). The R^2 values for firm fixed effects (0.568) and Adjusted R^2 values (0.507) highlight the significant influence of firm-specific traits, accounting for 50–57% of the variance.

$D/E_{(t-1)}$ emerges as the strongest and most significant predictor (0.046; $p < 0.001$), emphasizing the importance of capital structure in shaping market valuation. The social score shows a marginally significant negative effect (-0.993; $p < 0.1$). The intercept is statistically significant, indicating a meaningful baseline effect. Other independent variables do not exhibit statistically significant relationships with the P/B , indicating limited direct influence.

*Table 18: Analyzing the relationship between Social score and Price-to-Book ratio:
Regression output with inclusion of Firm fixed effect.*

Number of observations = 323

$R^2 = 0.832$

Adjusted $R^2 = 0.803$

R^2 (firm fixed effect) = 0.568

Adjusted R^2 (firm fixed effect) = 0.507

Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	4.676	2.278	2.053	0.041	0.192	9.160	*
$S_{(t-1)}$	-0.993	0.543	-1.830	0.068	-2.061	0.075	.
$ROE_{(t-1)}$	0.002	0.014	0.145	0.885	-0.026	0.030	/
$D/E_{(t-1)}$	0.046	0.004	10.199	<0.0001	0.037	0.055	***
$DPR_{(t-1)}$	0.000	0.001	-0.487	0.627	-0.002	0.001	/
$FFE1$	YES						

Signification codes: $0 < *** < 0.001 < ** < 0.01 < * < 0.05 < . < 0.1$

Source: Own work.

Equation of the regression model with inclusion of Firm fixed effect:

$$P/B_{(t)} = 4.676 - 0.993*S_{(t-1)} + 0.002*ROE_{(t-1)} + 0.046*D/E_{(t-1)} + 0.000*DPR_{(t-1)}$$

The inclusion of firm fixed effects in the second model significantly enhances its explanatory power and shifts the focus from financial efficiency ($ROE_{(t-1)}$) to capital structure ($D/E_{(t-1)}$) as the most critical factor. Firm-specific characteristics play a substantial role in shaping market valuation, while the first model is more limited in its scope and explanatory power. In the second model, the shows a marginally significant negative effect (-0.993; $p < 0.1$), suggesting a weak negative relationship with the P/B . In the first model, the social score is not statistically significant (0.332; $p = 0.498$), indicating minimal influence on market valuation.

d) Governance score

The regression analysis (Table 19) examines the relationships between the independent variables ($G_{(t-1)}$, $ROE_{(t-1)}$, $D/E_{(t-1)}$, $DPR_{(t-1)}$) and the dependent variable (P/B). The model

accounts for approximately 34.9% of the variance in the dependent variable, reflecting moderate explanatory power ($R^2 = 0.349$, Adjusted $R^2 = 0.340$). $ROE_{(t-1)}$ emerges as the most significant predictor, highlighting its critical role in shaping market valuation through its positive (0.188) and highly significant ($p < 0.001$) relationship with the P/B . Governance, $D/E_{(t-1)}$, and $DPR_{(t-1)}$ do not exhibit statistically significant relationships with the P/B , suggesting limited direct influence in the analyzed context. Additionally, the intercept is statistically significant, reflecting a meaningful baseline effect (3.929; $p < 0.01$).

*Table 19: Analyzing the relationship between Governance score and Price-to-Book ratio:
Regression output without inclusion of Firm fixed effect.*

Number of observations = 323							
$R^2 = 0.349$							
Adjusted $R^2 = 0.340$							
Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	3.929	1.468	2.676	0.008	1.040	6.818	**
$G_{(t-1)}$	-0.687	0.446	-1.541	0.124	-1.564	0.190	/
$ROE_{(t-1)}$	0.188	0.018	10.312	<0.0001	0.153	0.224	***
$D/E_{(t-1)}$	0.005	0.004	1.173	0.242	-0.003	0.013	/
$DPR_{(t-1)}$	0.001	0.001	0.600	0.549	-0.002	0.004	/
Signification codes: $0 < *** < 0.001 < ** < 0.01$							

Source: Own work.

Equation of the regression model without inclusion of Firm fixed effect:

$$P/B_{(t)} = 3.929 - 0.687 * G_{(t-1)} + 0.188 * ROE_{(t-1)} + 0.005 * D/E_{(t-1)} + 0.001 * DPR_{(t-1)}$$

The second model (Table 20) of the regression analysis, which incorporates firm fixed effects to account for firm-specific characteristics, demonstrates strong explanatory power, explaining over 80% of the variance in the dependent variable ($R^2 = 0.833$, Adjusted $R^2 = 0.804$). The regression coefficients for firm fixed effects highlight the substantial influence of firm-specific traits, accounting for 50–57% of the variance.

$D/E_{(t-1)}$ remains the most influential predictor, demonstrating a strong positive relationship (0.046; $p < 0.001$) with the P/B , emphasizing the importance of capital structure. Governance ($G_{(t-1)}$) exhibits a statistically significant negative relationship (-1.047; $p < 0.05$), indicating that higher governance scores may have a short-term adverse effect on market valuation. The intercept is also statistically significant, reflecting a meaningful baseline effect (4.271; $p < 0.05$). Other independent variables do not show statistically significant relationships, suggesting limited direct influence in this analysis.

Table 20: Analyzing the relationship between Governance score and Price-to-Book ratio:
Regression output with inclusion of Firm fixed effect.

Number of observations = 323 $R^2 = 0.833$ Adjusted $R^2 = 0.804$ R^2 (firm fixed effect) = 0.568 Adjusted R^2 (firm fixed effect) = 0.507							
Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	4.271	1.997	2.139	0.033	0.341	8.202	*
$G_{(t-1)}$	-1.047	0.503	-2.083	0.038	-2.036	-0.057	*
$ROE_{(t-1)}$	-0.004	0.014	-0.279	0.781	-0.031	0.023	/
$D/E_{(t-1)}$	0.046	0.004	10.151	<0.0001	0.037	0.055	***
$DPR_{(t-1)}$	0.000	0.001	-0.498	0.619	-0.002	0.001	/
$FFE1$	YES						
$Signification\ codes:\ 0 < *** < 0.001 < ** < 0.01 < * < 0.05$							

Source: Own work.

Equation of the regression model with inclusion of Firm fixed effect:

$$P/B_{(t)} = 4.271 - 1.047 * G_{(t-1)} - 0.004 * ROE_{(t-1)} + 0.046 * D/E_{(t-1)} + 0.000 * DPR_{(t-1)}$$

The first model highlights $ROE_{(t-1)}$ as the most critical factor, while the second model shifts the focus to $D/E_{(t-1)}$ as the strongest predictor, with governance playing a notable negative role. The inclusion of firm fixed effects in the second model significantly enhances its explanatory power and captures the substantial role of firm-specific characteristics in market valuation.

Based on separate analyses of the influence of each score within the ESG framework, the hypotheses H2 and H4 are not confirmed. In all three regression models that include firm fixed effects (*FFE*), the coefficients for the tested independent variables are negative. The governance score exhibits the highest statistically significant influence ($p < 0.05$), followed by the social score ($p < 0.1$), while the environmental score shows no statistically significant influence on the P/B . The same sequence is observed for the absolute values of all three variables.

4.3.3 Other analyses

4.3.3.1 Analysis of the influence of total ESG combined score in previous period on Return on equity in current period

The regression analysis (Table 21) examines the relationships between the independent variables ($ESG_{(t-1)}$, $D/E_{(t-1)}$, $DPR_{(t-1)}$) and the dependent variable (ROE). The dataset is reliable and robust ($n = 324$), and the regression model accounts for approximately 35.2% of the variance in ROE , reflecting moderate explanatory power.

$ESG_{(t-1)}$ and $D/E_{(t-1)}$ emerge as the most critical predictors, showing strong positive relationships with ROE and highlighting their roles in improving financial performance (5.704; $p < 0.001$ for ESG ; 0.136; $p < 0.001$ for D/E). $DPR_{(t-1)}$ shows a statistically significant but weak negative relationship, suggesting that its influence on ROE is minimal and possibly adverse in this context.

Table 21: Analyzing the relationship between Total ESG combined score and Return on equity: Regression output without inclusion of Firm fixed effect.

Number of observations = 324 $R^2 = 0.352$ Adjusted R ² = 0.346							
Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	-6.443	4.937	-1.305	0.193	-16.157	3.271	/
$ESG_{(t-1)}$	5.704	1.583	3.602	0.000	2.589	8.819	***
$D/E_{(t-1)}$	0.136	0.011	12.762	<0.0001	0.115	0.157	***
$DPR_{(t-1)}$	-0.011	0.004	-2.495	0.013	-0.019	-0.002	*
Signification codes: $0 < *** < 0.001 < ** < 0.01 < * < 0.05$							

Source: Own work.

Equation of the regression model without inclusion of Firm fixed effect:

$$ROE_{(t)} = -6.443 + 5.704 * ESG_{(t-1)} + 0.136 * D/E_{(t-1)} - 0.011 * DPR_{(t-1)}$$

The second regression analysis (Table 22) incorporates firm fixed effects, and the model demonstrates strong explanatory power, accounting for approximately 78.1% of the variance in the dependent variable ($R^2 = 0.781$, Adjusted $R^2 = 0.744$). $D/E_{(t-1)}$ emerges as the most critical predictor, showing a highly significant positive relationship (0.149; $p < 0.001$), emphasizing the importance of capital structure. $DPR_{(t-1)}$ exhibits a statistically significant negative relationship, although the effect is relatively weak (-0.008; $p < 0.01$). $ESG_{(t-1)}$ and

the intercept are not statistically significant, indicating limited direct influence from these factors.

Table 22: Analyzing the relationship between Total ESG combined score and Return on equity: Regression output with inclusion of Firm fixed effect.

Number of observations = 324

$R^2 = 0.781$

Adjusted $R^2 = 744$

R^2 (firm fixed effect) = 0.568

Adjusted R^2 (firm fixed effect) = 0.507

Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	11.396	7.463	1.527	0.128	-3.296	26.087	/
$ESG_{(t-1)}$	1.557	1.770	0.879	0.380	-1.928	5.042	/
$D/E_{(t-1)}$	0.149	0.015	9.786	<0.0001	0.119	0.179	***
$DPR_{(t-1)}$	-0.008	0.003	-2.655	0.008	-0.014	-0.002	**
$FFE1$	YES						

Signification codes: $0 < *** < 0.001 < ** < 0.01$

Source: Own work.

Equation of the regression model with inclusion of Firm fixed effect:

$$ROE_{(t)} = 11.396 + 1.557*ESG_{(t-1)} + 0.149*D/E_{(t-1)} - 0.008*DPR_{(t-1)}$$

In the first model, $ESG_{(t-1)}$ emerges as a strong positive predictor, while in the second model, $D/E_{(t-1)}$ is the most critical factor, showcasing a highly significant positive relationship. Both models show a negative impact of $DPR_{(t-1)}$, but with varying strength. The inclusion of firm fixed effects in the second model significantly enhances explanatory power, emphasizing firm-specific traits in shaping the dependent variable.

4.3.3.2 Analysis of the influence of each factor in ESG score in previous period on Return on equity in current period

The regression analysis examines the influence of selected factors within the ESG framework, along with $D/E_{(t-1)}$ and $DPR_{(t-1)}$, on ROE in the current period (Table 23). The model accounts for approximately 36.3% of the variance in ROE , reflecting moderate explanatory power ($R^2 = 0.363$, Adjusted $R^2 = 0.353$).

The social score (7.794; $p < 0.001$) emerges as a critical factor in enhancing ROE , highlighting the importance of social aspects within the ESG framework. $D/E_{(t-1)}$ (0.129; $p < 0.001$) continues to be a vital predictor of financial efficiency, emphasizing the significance of capital structure in shaping ROE . In contrast, both the environmental score

and governance score demonstrate limited influence, while the dividend payout ratio shows a minor but statistically significant adverse effect on *ROE*.

Table 23: Analyzing the relationship between each factor in ESG score jointly and Return on equity: Regression output without inclusion of Firm fixed effect.

Number of observations = 324							
$R^2 = 0.363$							
Adjusted $R^2 = 0.353$							
Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	-5.828	5.476	-1.064	0.288	-16.601	4.945	/
$E_{(t-1)}$	-1.495	1.786	-0.837	0.403	-5.008	2.019	/
$S_{(t-1)}$	7.794	2.154	3.618	0.000	3.556	12.033	***
$G_{(t-1)}$	-1.820	1.520	-1.197	0.232	-4.811	1.171	/
$D/E_{(t-1)}$	0.129	0.011	12.082	<0.0001	0.108	0.150	***
$DPR_{(t-1)}$	-0.012	0.004	-2.847	0.005	-0.021	-0.004	**
Signification codes: $0 < *** < 0.001 < ** < 0.01$							

Source: Own work.

Equation of the regression model without inclusion of Firm fixed effect:

$$ROE_{(t)} = -5.828 - 1.495 * E_{(t-1)} + 7.794 * S_{(t-1)} - 1,820 * G_{(t-1)} + 0,129 * D/E_{(t-1)} - 0.012 * DPR_{(t-1)}$$

The second model (Table 24) incorporates firm fixed effects and demonstrates strong explanatory power, accounting for approximately 78.5% of the variance in the dependent variable ($R^2 = 0.785$, Adjusted $R^2 = 0.748$).

$D/E_{(t-1)}$ emerges as the most critical predictor, exhibiting a strong positive impact (0.146; $p < 0.001$) on the dependent variable. The environmental score shows a statistically significant negative relationship (-4.531; $p < 0.05$), indicating an adverse effect in the analysed context. Both the social score and governance score demonstrate limited influence on the dependent variable, while $DPR_{(t-1)}$ reflects a minor negative impact. The intercept is statistically significant, highlighting a meaningful baseline effect.

Table 24: Analyzing the relationship between each factor in ESG score jointly and Return on equity: Regression output with inclusion of Firm fixed effect.

Number of observations = 324

$R^2 = 0.785$

Adjusted $R^2 = 0.748$

R^2 (firm fixed effect) = 0.568

Adjusted R^2 (firm fixed effect) = 0.507

Variable	Coefficient value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)	p-values signification codes
α_0	23.104	8.383	2.756	0.006	6.601	39.607	**
$E_{(t-1)}$	-4.531	2.006	-2.258	0.025	-8.481	-0.581	*
$S_{(t-1)}$	0.640	2.282	0.281	0.779	-3.852	5.132	/
$G_{(t-1)}$	0.992	1.854	0.535	0.593	-2.659	4.642	/
$D/E_{(t-1)}$	0.146	0.015	9.634	<0.0001	0.116	0.175	***
$DPR_{(t-1)}$	-0.008	0.003	-2.854	0.005	-0.014	-0.003	**
$FFE1$	YES						

Signification codes: $0 < *** < 0.001 < ** < 0.01 < * < 0.05$

Source: Own work.

Equation of the regression model with inclusion of Firm fixed effect:

$$ROE_{(t)} = 23.104 - 4.531 * E_{(t-1)} + 0.640 * S_{(t-1)} + 0.992 * G_{(t-1)} + 0.146 * D/E_{(t-1)} - 0.008 * DPR_{(t-1)}$$

A comparison of both models reveals that the social score is a critical factor in improving ROE in the first model, whereas the environmental score exhibits a statistically significant negative impact in the second model. $D/E_{(t-1)}$ consistently emerges as the most vital predictor in both models, emphasizing the importance of capital structure in shaping financial performance. Firm fixed effects in the second model substantially enhance its explanatory power, offering deeper insights into firm-specific traits and their roles in influencing the dependent variable.

Based on this analysis, the hypothesis H3, which states that each of the three factors within the Environmental, Social, and Governance framework has a positive impact on the return on equity of pharmaceutical companies, is not confirmed. Correlation analysis (Table 9) already indicates a positive correlation with the environmental and social scores, while the governance score shows a negative correlation. However, a regression model incorporating firm fixed effects reveals a slightly different relationship, where the environmental score has the largest and only statistically significant influence ($p < 0.05$). The coefficient for the environmental score is negative.

5 CONCLUSION

Based on the performed regression analyses, it is evident that the inclusion of firm fixed effects (*FFE*) in the regression models significantly altered the coefficients, underscoring the critical role of firm-specific factors in shaping the relationships between dependent and independent variables across all cases. The models' explanatory power increased substantially, with more than 80% of the variance in the dependent variables accounted for by the selected independent variables. Regression coefficients within the firm fixed effect models highlight the significant impact of firm-specific traits, explaining approximately 50% of the variance. In nearly all regression models, the intercept values are relatively large, confirming the importance of baseline unique characteristics of individual companies.

The tested hypothesis H1, stating that overall ESG scores of pharmaceutical companies influence their share prices, is confirmed. A negative correlation is evident in the correlation matrix (correlation coefficient: -0.007), nevertheless very weak. This finding is further supported by the linear regression model, including FFE, which demonstrates that the Total ESG combined score from the previous period negatively correlates with the *P/B* ratio in the current period. This relationship is statistically significant ($p < 0.05$). Specifically, a one-unit increase in the Total ESG combined score leads to a 1.07 decrease in the *P/B*, indicating a decline in share price while the book value remains constant.

The hypothesis H2, which states that all three factors within the Environmental, Social, and Governance (ESG) framework jointly have a positive impact on companies' share prices, is not confirmed. The correlation matrix shows that negative correlation coefficients outweigh positive ones, and this is further validated by the regression model with FFE inclusion. Governance and social scores exhibit a negative impact, with only the governance score being statistically significant. The analysis of each individual factor within the ESG framework also does not confirm the hypothesis H3, predicting a positive impact of these factors on *ROE*. The environmental score is the only factor with a statistically significant influence, and its effect is negative.

The hypothesis H4, stating that the environmental factor has the greatest impact on pharmaceutical companies' share prices among all factors within the ESG framework, is not confirmed. The environmental factor is not statistically significant ($p = 0.432$). When analyzed separately, significant impacts are observed for the social score and governance score, but both have negative effects.

This analysis highlights the complex relationships between ESG factors, firm-specific characteristics, and financial performance metrics. Based on the literature review, we expected the factors within the Environmental, Social, and Governance (ESG) framework to have a more positive influence on the share prices of pharmaceutical companies. However, it appears that investors in pharmaceutical companies prioritize unique company-specific

characteristics over ESG parameters. Factors such as companies' portfolios and product pipelines, investments in research and development, financial performance indicators, and regulatory requirements likely play a more significant role. Investing in pharmaceutical companies is generally perceived as a reliable and stable option, with limited dependency on external crisis situations.

The limitations of this research, which may have influenced the final conclusions, include the use of relatively few consecutive years of data, although all analyzed datasets were reliable and robust. The number of consecutive years was selected based on comparability with other research in the literature. Additionally, the sample size of the companies could be expanded, and no distinction was made between originator and generic pharmaceutical companies. The selected datasets were drawn from a highly dynamic time period, during which market conditions such as inflation and the COVID-19 pandemic may have had a greater influence than ESG parameters.

This research highlights the significant role of firm-specific traits in shaping financial outcomes in the pharmaceutical sector. While overall ESG scores negatively and weakly influence share prices, firm-specific factors such as portfolios, pipelines, and R&D investments probably hold greater importance. Hypotheses regarding the positive impacts of ESG factors on financial metrics were largely unsupported, with only the environmental score showing a statistically significant but negative effect on *ROE*.

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APPENDIX

Appendix 1: Povzetek

Trajnostnost pomeni ohranjanje virov in procesov ter temelji na ekonomskih, družbenih in okoljskih stebrih. ESG je ključna metoda za merjenje trajnostnosti, ki pridobiva vse večji pomen med vlagatelji. Za farmacevtska podjetja ESG predstavlja priložnost za izboljšanje inovativnosti, učinkovitosti in dostopa do sredstev ter poudarjanje njihovega vpliva na zdravje in gospodarstvo.

Glavni namen te raziskave je bil zapolniti vrzel z oceno vpliva okoljske, socialne in upravljaljske uspešnosti vodilnih svetovnih farmacevtskih podjetij na njihovo ekonomsko uspešnost. Ekonomska uspešnost je bila ocenjevana prek cene delnice in nekaterih drugih finančnih kazalnikov. S to raziskavo smo želeli odgovoriti na vprašanja, ali morajo vlagatelji pri vlaganju v delnice farmacevtskih podjetij upoštevati ESG uspešnost podjetij in ali morajo podjetja več vlagati v dejavnosti, povezane z ESG uspešnostjo.

Raziskava je bila osnovana na kvantitativni analizi za oceno vpliva ESG uspešnosti na finančne rezultate farmacevtskih podjetij. Finančni in ESG podatki za obdobje 2015–2022 so bili pridobljeni iz baze podatkov LSEG Data&Analytics, ki je znana po svoji celoviti ESG bazi. Vzorec farmacevtskih podjetij je izbran glede na njihovo tržno kapitalizacijo. Analiza podatkov je vključevala opisno statistiko, korelacijsko matriko za pregled odnosov med spremenljivkami in večkratne linearne regresije za oceno povezav med odvisnimi spremenljivkami (razmerje med ceno delnice in njeno knjigovodsko vrednostjo, donosnost kapitala) ter neodvisnimi spremenljivkami, povezanimi z ESG ocenami, ki odražajo okoljsko, socialno in upravljaljsko uspešnost.

Na podlagi rezultatov regresijskih analiz smo ugotovili, da vključitev učinka podjetij (FFE) bistveno spremeni koeficiente, kar poudarja pomembnost specifičnih značilnosti posameznih podjetij – te pojasnjujejo približno 50 % variance, medtem ko izbrani dejavniki skupaj pojasnijo več kot 80 % variance. Velike vrednosti konstante še dodatno potrjujejo ključen pomen edinstvenih lastnosti podjetij.

Hipoteza H1, da skupne ESG vrednosti vplivajo na cene delnic farmacevtskih podjetij, je bila potrjena, čeprav le z zelo šibko in negativno korelacijo (-0,007). Regresijski model z FFE pokaže, da višji ESG rezultati iz prejšnjega obdobja negativno vplivajo na razmerje med ceno in knjigovodsko vrednostjo (koeficient -1,07; $p < 0,05$). Hipotezi H2 in H3, ki predvidevata, da družbeni, upravljaljski in okoljski dejavniki pozitivno vplivajo na cene delnic in donosnost kapitala, nista bili potrjeni – družbeni in upravljaljski dejavniki kažeta negativen vpliv (le upravljaljski je statistično pomemben), okoljski dejavnik pa, čeprav statistično pomemben, vpliva negativno. Prav tako hipoteza H4, da ima okoljski dejavnik največji vpliv na cene delnic, ni bila potrjena, saj njegov vpliv ni statistično pomemben ($p = 0,432$), medtem ko so družbeni in upravljaljski dejavniki statistično pomembno negativni.

Rezultati te raziskave poudarjajo pomembno vlogo specifičnih značilnosti podjetij pri oblikovanju finančnih rezultatov v farmacevtskem sektorju. Medtem ko skupni ESG rezultati negativno in šibko vplivajo na cene delnic, hipoteze o pozitivnem vplivu ESG dejavnikov na finančne kazalnike v večji meri niso bile potrjene, saj se je le okoljski rezultat pokazal statistično pomemben, vendar negativen vpliv na donosnost kapitala. Na podlagi rezultatov lahko predvidevamo, da vlagatelji v farmacevtska podjetja dajejo prednost specifičnim značilnostim podjetij, kot so npr. portfelji, razvoj produktov in vlaganja v raziskave, pred ESG parametri. Ta dejstva podpirajo percepcijo farmacevtskih naložb kot stabilnih in zanesljivih, z manjšo odvisnostjo od zunanjih kriz. Omejitve raziskave, kot sta zmerno velik vzorec, omejeno časovno obdobje podatkov in dinamični tržni pogoji (inflacija, pandemija covid-19), nakazujejo možnosti za nadaljnje raziskave, ki bi še bolje razjasnile te odnose.

Appendix 2: List of selected pharmaceutical companies include in regression analyses

Pharmaceutical company	Assigned Number
Johnson&Johnson	1
Pfizer	2
Sinopharm Group Co Lth	3
Roche Holding Ag	4
Novartis	5
Merck&Co.	6
Bayer	7
Abbvie Inc	8
Sanofi SA	9
Suzuken Co Ltd	10
Bristol-Myers Squibb Co	11
Fresenius SE & Co KGaA	12
Takeda Pharmaceutical Co Ltd	13
AstraZeneca PLC	14
Gilead Sciences Inc	15
Shanghai Pharmaceuticals Holding	16
Amgen	17
Elli Lilly	18
NovoNordix	19
Teva	20
Biogen	21
Otsuka Holdings	22
Astellas	23
Viartis	24
Baxter	25
Regeneron Pharmaceuticals	26
Eisai	27
UCB SA	28
Daiichi Sankyo	29
CSL LTD	30
Organon&Co	31
Alcon	32
Lonza Group AG	33
Perrigo Company PLC	34
Catalent	35
Sun Pharmaceutical Industries Ltd	36
Shanghai Fosun Pharmaceutical Group Co Ltd	37
Grifols SA	38
Nipro Corp	39
Aurobindo Pharma Ltd	40

to be continued

Appendix 2: List of selected pharmaceutical companies include in regression analyses (cont.)

Pharmaceutical company	Assigned Number
Ipsen	41
Incyte	42
Dr Reddy's Laboratories	43
Jazz Pharmaceuticals PLC	44
Krka, d.d., Novo Mesto, Slovenia	45

Source: Own work.