



“School of Social Sciences”

“Master’s in business administration (MBA)”

Postgraduate Dissertation

“Evaluating the Financial Performance of Chemical Companies
during the energy crisis and the relation of ESG factors”

Sarai Maria (Σαράη Μαρία)

Supervisor: Dimitrios Karlis

Patras, Greece, May 2026

© Hellenic Open University, 2017

The content of this thesis/dissertation along with its results is owned by the Hellenic Open University and his/her author, where each of them has the sole and exclusive right to use, reproduce, and publish it (totally or partially) for educational or research purposes, with the obligation to make reference to the thesis's title, the author's name and to the Hellenic Open University where the thesis / dissertation was written.



**“Evaluating the Financial Performance of Chemical Companies
during the energy crisis and the relation of ESG factors”**

“Sarai Maria”

Supervising Committee

Supervisor:

“Dimitrios Karlis”

Co-Supervisor:

“Emmanouil Mamatzakis”

Patras, Greece, May 2026

“Acknowledgments and / or Dedication”

Abstract

The purpose of this thesis is to examine the relationship between ESG (Environmental, Social, and Governance) factors and financial performance of companies operating in the chemical industry. This thesis examines how ESG scores and some basic financial ratios, such as Return on Assets (ROA), Return on Equity (ROE), the Net profit Margin ratio, and Ebitda Margin affect each other. The study uses data from financial statements and ESG scores to assess whether statistically significant relationships exist among these variables. Furthermore, the study explores global chemical industry trends (2020–2024), corporate Background and Historical Development of the Selected Firms and Importance of ESG in corporate strategy. The aim of this thesis findings' is to improve understanding of the role of sustainability in financial performance and highlight the challenges in modern financial management. As ESG factors have become increasingly important in recent years, the results offer useful insights for investors and businesses.

Keywords

ESG, Ratios, financial performance, Chemical Industry

Περίληψη

Ο σκοπός αυτής της διπλωματικής εργασίας είναι να εξετάσει τη σχέση μεταξύ των παραγόντων ESG (Environmental, Social, and Governance – Περιβάλλον, Κοινωνία και Εταιρική Διακυβέρνηση) και της χρηματοοικονομικής απόδοσης των εταιρειών που δραστηριοποιούνται στον χημικό κλάδο βιομηχανίας. Η εργασία αναλύει πώς οι βαθμολογίες ESG και ορισμένοι βασικοί χρηματοοικονομικοί δείκτες, όπως η Απόδοση Ενεργητικού (ROA), η Απόδοση Ιδίων Κεφαλαίων (ROE), το περιθώριο καθαρού κέρδους και το περιθώριο EBITDA, επηρεάζονται μεταξύ τους. Η μελέτη αυτή, χρησιμοποιεί δεδομένα από τις χρηματοοικονομικές καταστάσεις των επιλεγμένων εταιρειών και βαθμολογίες ESG για να εξετάσει κατά πόσο υπάρχει στατιστικά σημαντική σχέση μεταξύ αυτών των μεταβλητών.

Επιπλέον, η διπλωματική εξετάζει τις παγκόσμιες τάσεις του χημικού κλάδου για την περίοδο 2020–2024, το εταιρικό υπόβαθρο και την ιστορική εξέλιξη των επιλεγμένων εταιρειών, καθώς και τη σημασία του ESG πλαισίου στη διαμόρφωση της εταιρικής στρατηγικής. Τα ευρήματα της εργασίας στοχεύουν στη βελτίωση της κατανόησης του ρόλου της βιωσιμότητας στη χρηματοοικονομική απόδοση των εταιρειών και στην ανάδειξη των προκλήσεων της σύγχρονης χρηματοοικονομικής διοίκησης. Καθώς το πλαίσιο που ορίζει τα ESG έχει αποκτήσει ολοένα και μεγαλύτερη σημασία τα τελευταία χρόνια, τα αποτελέσματα προσφέρουν χρήσιμες πληροφορίες για επενδυτές και επιχειρήσεις.

Λέξεις – Κλειδιά

ESG, Αριθμοδείκτες, οικονομική απόδοση, Χημικός Βιομηχανικός Κλάδος

Table of Contents

Abstract	v
Περίληψη.....	vi
Table of Contents	vii
List of Figures	viii
List of Tables.....	ix
List of Abbreviations & Acronyms.....	x
1. Introduction	1
1.1 Global chemical industry trends (2020–2024).....	1
1.2 Impact of the energy crisis on production, costs, and competitiveness	2
1.3 Corporate Background and Historical Development of the Selected Firms	3
1.3.1 Dow Chemicals	3
1.3.2 Arkema	3
1.3.3 BASF.....	4
1.3.4 Covestro	4
1.3.5 Wacker	4
1.3.6 LyondellBasell	4
1.3.7 Celanese Corporation	5
1.4 The Current Global Energy - Background and context of the energy crisis	5
1.5 Importance of ESG in corporate strategy.....	7
2. Literature Review	12
2.1 Overview of financial performance metrics in the chemical industry	12
2.2 ESG frameworks and rating methodologies	15
2.2.1 ESG Practices and Their Impact on Financial Performance.....	16
2.3 Previous studies on ESG and financial resilience	18
2.4 Theoretical Framework	20
3. Research Methodology.....	25
3.1 Data sources	25
3.2 Limitations and ethical considerations.....	26
3.3 Variable Definition.....	28
4. ESG Analysis	32
4.1 ESG Performance of the Chemical Industry	32
4.2 ESG performance of selected chemical companies	34
5. Financial Performance Evaluation	36
5.1 Most widely used ratios	36
5.2 Regression Tests.....	36
5.2.1 Regression Test EcoVadis.....	37
5.2.2 Regression Test LSEG ESG Rates.....	41
6. Conclusion.....	47
6.1 Suggestions for Future Research.....	47
Bibliography.....	49

List of Figures

Figure 1:Development of electricity prices	6
Figure 2:Evolution of key regional natural gas prices	6
Figure 3: ROA trend 2020-2024	13
Figure 4: ROE trend 2020-2024.....	13
Figure 5: Net Profit Margin trend 2020-2024	14
Figure 6: Ebitda Margin trend 2020-2024	14
Figure 7: Key Components and Performance Indicators of ESG	15
Figure 8:Positive and/or neutral results for investing in sustainability dominate. Very few studies found a negative correlation between ESG and financial performance (based on 245 studies published between 2016 and 2020).....	19
Figure 9:Long-Term Production Trends of Key Petrochemical Products	33
Figure 10:Forecasted Energy Demand in the Global Petrochemical Industry (2010–2050)	33
Figure 11:ROE Residual Plot for 1 st Regression Test.....	39
Figure 12:Net profit margin Residual Plot for 1 st Regression Test.....	39
Figure 13:EBITDA margin Residual Plot for 1 st Regression Test.....	39
Figure 14:EcoVadis Rating Residual Plot for 1 st Regression Test	40
Figure 15:ROE Line Fit Plot for 1 st Regression Test.....	40
Figure 16:Net profit margin Line Fit Plot for 1 st Regression Test.....	40
Figure 17:EBITDA margin Line Fit Plot for 1 st Regression Test.....	40
Figure 18:EcoVadis Rating Line Fit Plot for 1 st Regression Test.....	41
Figure 19:Normal Probability Plot for 1 st Regression Test.....	41
Figure 20: ROE Residual Plot for 2nd Regression Test.....	44
Figure 21:Net profit margin Residual Plot for 2nd Regression Test	45
Figure 22:EBITDA margin Residual Plot for 2nd Regression Test	45
Figure 23:LSEG Sustainability Ratings and Data Residual Plot for 2nd Regression Test	45
Figure 24:ROE Line Fit Plot for 2nd Regression Test.....	45
Figure 25:Net profit margin Line Fit Plot for 2nd Regression Test.....	46
Figure 26:EBITDA margin Line Fit Plot for 2nd Regression Test.....	46
Figure 27:LSEG Sustainability Ratings and Data Line Fit Plot for 2nd Regression Test ..	46
Figure 28:Normal Probability Plot for 2nd Regression Test	46

List of Tables

Table 1: ESG Scores of the selected Chemical Companies	34
Table 2: EcoVadis Rating Data per Company	35
Table 3: Most widely used ratios	36
Table 4: Data set for Regression Test Ecovadis.....	37
Table 5: Regression Results 1	38
Table 6: Data set for Regression Test LSEG	43
Table 7: Regression results 2	44

List of Abbreviations & Acronyms

ANOVA	Analysis of Variance
APAC	Asia-Pacific
BRSR	Business Responsibility and Sustainability Report
CAGR	Compound annual growth rate
CapEx	Capital Expenditure
CSRD	Corporate Sustainability Reporting Directive
D/E	Debt-to-Equity Ratio
DAX	Deutscher Aktienindex(German Stock Index)
EBITDA	Earnings Before Interest, Taxes, Depreciation, and Amortization
ESG	Environmental,Social,Governance
ESRS	European Sustainability Reporting Standards
EVA	Economic Value Added
GRI	Global Reporting Initiative
ISSB	International Sustainability Standards Board
LSEG	London Stock Exchange Group
LSEG	London Stock Exchange Group
MSCI	Morgan Stanley Capital International
MVA	Market Value Added
P/E	Price-to-Earnings Ratio
R&D	Research and Development
ROA	Return on Assets
ROE	Return on Equity
ROI	Return on Investment
SASB	Sustainability Accounting Standards Board
SEBI	Securities and Exchange Board of India
TCFD	Task Force on Climate-related Financial Disclosures

1. Introduction

The chemical industry is an important sector in the global economy, driving innovation across multiple markets such as pharmaceuticals, energy, packaging, infrastructure, mobility and consumer applications. It plays a important role in producing essential products that support modern life—from everyday consumer goods to specialized chemicals used in high-tech applications. This industry is characterized by innovation and research that means continuous development of new compounds and sustainable processes. It also has global impact by Serving diverse markets including healthcare, manufacturing, and environmental solutions. It should be emphasized that in recent years, driven by heightened climate awareness and increasingly stringent regulatory frameworks, numerous sustainability challenges have emerged. Chemical sector is transitioning toward greener technologies and reducing environmental footprints.

In this thesis, we will explore several leading companies in the chemical industry.

1.1 Global chemical industry trends (2020–2024)

The period from 2020 to 2024 has been transformative for the global chemical industry, marked by significant challenges and opportunities. Following the disruptions caused by the COVID-19 pandemic, the industry faced volatile demand patterns, supply chain constraints, and geopolitical uncertainties. At the same time, growing climate awareness and stricter regulatory frameworks accelerated the push toward sustainability and innovation. From market growth and revenue perspective of the Chemical Industry recorded revenues of \$5.44 trillion in 2024, representing a compound annual growth rate (CAGR) of 5.9% between 2019 and 2024,(Chemicals Global Industry Almanac 2020 2029" report, ResearchAndMarkets.com).

The commodity chemicals segment accounted for the market's largest proportion in 2024, with total revenues of \$2.94 trillion, equivalent to 54.2% of the market's overall value. Growth was regionally uneven as China dominated, accounting for 86% of global chemical growth in 2024, with production up 6.8%,[\[report.basf.com\]](#).European Union saw modest recovery (+1.6%) after sharp declines in 2023 and the U.S. chemical industry has undergone a phase of limited growth (0% growth in 2024) due to weak industrial demand. Under these market conditions, chemical companies should balance their short- and long-term goals. Moreover, the rising climate awareness and regulatory pressure drove investment in carbon-neutral processes, battery materials, and clean ammonia.

A significant trend shaping the global chemical industry, particularly in the petrochemicals segment, during the period 2020–2024 has been persistent overcapacity and resulting margin pressure. This imbalance come from capacity additions, especially in China, outpacing global demand growth, leading to structural supply–demand mismatches. As a consequence, industry utilization rates declined to relatively low levels (around or below 82%), placing downward pressure on prices and profitability across key product chains. This

environment has led to sustained margin compression, alongside delays or cancellations of new investment projects, as companies reassess capital allocation under uncertain market conditions. Overcapacity has been particularly pronounced in core petrochemical products such as ethylene, polymers, and their derivatives, where excess supply has weakened market balance. In response, industry players have increasingly shifted toward rationalization strategies, including plant closures, mostly in higher-cost regions such as Europe, and a stronger emphasis on operational efficiency and cost competitiveness. Overall, this trend reflects a structural adjustment phase in the petrochemical sector, as companies adapt to a more constrained and competitive environment

1.2 Impact of the energy crisis on production, costs, and competitiveness

The energy crisis of 2022–2023 had a significant impact on chemical production, particularly in Europe, highlighting the sector's vulnerability to energy price shocks. As a highly energy-intensive industry, relying on processes such as steam cracking, ammonia synthesis, and polymers production, the chemical sector faced severe cost pressures due to soaring natural gas prices. During this period, European chemical output contracted sharply, declining by more than 6% in 2023 as is stated in Global Chemical Industry Outlook 2024 from MarketsandMarkets. Especially pronounced effects in energy-intensive segments such as fertilizers and basic chemicals, where temporary shutdowns and reduced capacity utilization were widely observed. Elevated gas prices, which directly affect both energy input and feedstock costs, forced producers to curtail ammonia and fertilizer production while lowering operating rates in crackers and other high-energy facilities. At the same time, the region increasingly shifted toward imports from lower-cost producers such as China, the Middle East, and the United States, as domestic production became less competitive. This growing reliance on external supply has led to structural concerns regarding industrial dependence and the gradual erosion of Europe's domestic chemical manufacturing base. Overall, these developments resulted in a contraction of local production capacity and underscored the broader competitiveness challenges faced by the European chemical industry in a high-energy-cost environment. Asia-Pacific was the largest chemical market in 2023 and witnessed a high growth rate of 4.0% in market size from 2022 to 2023. At the same time, Europe experienced a 1% growth in market size despite the decline in regional production. This is due to increased imports from interregional countries such as China and India. Moreover, Chemical production volumes in Europe dropped by 6.6% in 2023, and output is forecasted to make only a fragile recovery in 2024, according to Global Chemical Industry Outlook 2024 from MarketsandMarkets.

Furthermore, from the perspective of cost, the energy crisis led to a significant surge in production expenses across the chemical industry, primarily driven by sharp increases in the

prices of key inputs such as natural gas, electricity, and oil-derived feedstocks, on which chemical manufacturing is heavily dependent. These cost pressures were particularly acute in Europe following the disruption of Russian gas supplies, resulting in substantially higher energy and feedstock costs compared with other regions. At the same time, many chemical producers were unable to fully pass these increased costs on to customers due to weak downstream demand and intense global competition, which exerted downward pressure on pricing. Consequently, profit margins contracted significantly, especially in basic chemicals and petrochemicals, leading to declining profitability across the sector. In addition, broader macroeconomic factors—including inflation and ongoing logistics disruptions—further escalated operational costs by increasing transportation expenses and inventory holding costs, thereby compounding the overall financial strain on chemical producers.

1.3 Corporate Background and Historical Development of the Selected Firms

An examination of the corporate background and historical development of the selected firms is essential for understanding their strategic evolution and current positioning within the chemical industry. This section traces the origins of these organizations, their foundational objectives. By analyzing historical patterns of expansion, technological innovation, and structural transformation, we gain insights into how these firms have adapted to changing market conditions and regulatory environments, thereby establishing their competitive advantage in a global context. The following subsections present detailed profiles of each company, outlining their historical development and corporate structure.

1.3.1 Dow Chemicals

Dow Inc., formerly known as The Dow Chemical Company, is an American multinational corporation headquartered in Midland, Michigan. It is one of the world's leading suppliers of chemicals, plastics, and agricultural products. The company operates in sectors such as performance materials, industrial intermediates, and coatings. Its mission emphasizes innovation, sustainability, and customer-centric solutions. Dow has approximately 37,000 employees, revenues \$45 billion and operates to over 160 countries.

1.3.2 Arkema

Arkema S.A. is a French multinational company specializing in specialty chemicals and advanced materials, headquartered in La Défense, near Paris, France. Arkema is publicly traded on Euronext Paris and is part of the CAC Next 20 index. As of 2024, the company reported revenues of approximately €9.5 billion, employs over 21,000 people, and operates in 55 countries with 157 production plants and 17 R&D centers. Its mission emphasizes innovation, sustainability, and high-performance materials for a better future.

1.3.3 BASF

BASF SE, headquartered in Ludwigshafen, Germany, is the largest chemical producer in the world. Founded in 1865, BASF SE operates as a chemical company worldwide. BASF comprises subsidiaries and joint ventures in more than 80 countries, operating six integrated production sites and 390 other production sites across Europe, Asia, Australia, the Americas and Africa. It operates through six segments: Chemicals, Materials, Industrial Solutions, Surface Technologies, Nutrition & Care, and Agricultural Solutions. Its corporate philosophy revolves around “creating chemistry for a sustainable future. It has approximately 106,428 employees with total revenue of 59.17 billion.

1.3.4 Covestro

Covestro AG, headquartered in Leverkusen, Germany and formerly listed on the DAX, operates as a global leader in high-performance polymers. The company is structured into two main segments: Performance Materials, which focuses on commodity products such as, polyols, and polycarbonate resins, and Solutions & Specialties, comprising six business units—Engineering Plastics, Coatings & Adhesives, Tailored Urethanes, Thermoplastic Polyurethanes, Specialty Films, and Elastomers. With a global footprint spanning over 55 consolidated companies and approximately 18,000 employees across Europe, North America, and Asia-Pacific, Covestro serves diverse industries including automotive, construction, electronics, and healthcare.

1.3.5 Wacker

Wacker Chemie AG is a German multinational chemical company founded in the early 20th century. Headquartered in Munich, it started as an electrochemical enterprise and quickly became a pioneer in producing acetaldehyde and acetic acid. Over the decades, Wacker expanded into polymers, silicones, and semiconductor-grade silicon, establishing a strong global presence. Today, it operates in four main segments—Silicones, Polymers, Polysilicon, and Biosolutions—while focusing on sustainability and innovation, including biotech and specialty chemicals. The company remains majority-owned by the Wacker family and continues to invest in green technologies and advanced materials. As of December 31, 2024, Wacker Chemie AG employed a total of 16,637 people.

1.3.6 LyondellBasell

LyondellBasell Industries N.V. is a global leader in the chemical and refining industry, headquartered in Houston, Texas, with legal incorporation in the Netherlands and additional offices in London. The company was officially formed in December 2007 through the \$12.7 billion merger of Lyondell Chemical Company and Basell Polyolefins, creating one of the largest plastics, chemicals, and refining entities worldwide. LyondellBasell employs approximately 20,000 people worldwide as of December 31, 2024.

1.3.7 Celanese Corporation

Celanese Corporation is a U.S.-based global chemical and specialty materials company founded in 1918 as the American Cellulose & Chemical Manufacturing Company to produce cellulose acetate for aircraft coatings. The company adopted the name “Celanese” in 1925 and expanded globally into synthetic fibers and chemicals. Over time, it transitioned from fibers to specialty chemicals and engineered materials, going public in 2005.

Today, Celanese operates worldwide across engineered polymers, acetyl chain products, and food ingredients, driven by innovation and sustainability initiatives. From its broad portfolio of Materials Solutions, the company advances automotive and consumer electronics design and enables life-improving medical, food, and beverage products, offering tailored solutions that help customers succeed.

Celanese employs approximately 12,000 people worldwide (as of 2024), with total annual revenue of about \$10 billion as of December 31, 2024.

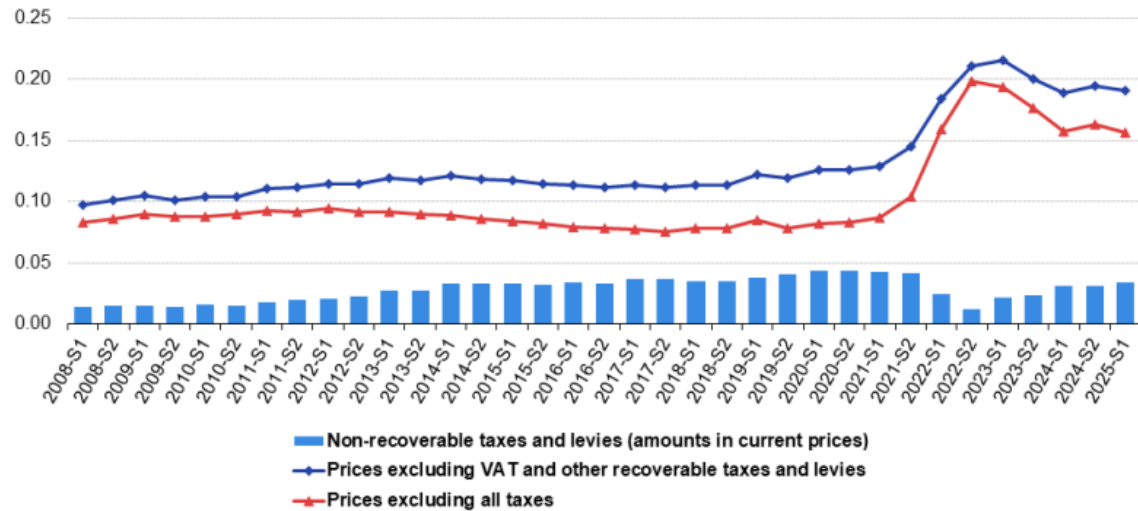
1.4 The Current Global Energy - *Background and context of the energy crisis*

The origins of the 2021–2023 global energy crisis stem from multiple factors. Following the COVID-19 pandemic, energy demand rebounded sharply, outpacing supply recovery and straining oil and gas markets. At the same time, global supply chain disruptions hampered the delivery of fuels and essential equipment, adding further stress to energy systems.

Geopolitical developments have further intensified the crisis, most notably the Russia–Ukraine war, which began in February 2022 and triggered major disruptions in global energy markets. Europe, which previously relied on Russia for around 40% of its gas imports, experienced a sharp decline in supply, leading to significant price volatility and supply insecurity.

Additionally, coal disputes, such as China’s ban on Australian imports and extreme weather events, including droughts in Brazil and Europe that reduced hydropower output, tightened overall energy availability. The impacts of the 2021–2023 global energy crisis were widespread and severe. Natural gas and electricity prices soared to record highs across multiple regions, driving inflation and placing immense financial strain on households and industries, particularly those reliant on gas-intensive processes. Rising energy costs pushed millions into poverty and forced production cuts in several sectors. Energy security became a critical concern, with Europe facing potential rationing and emerging economies struggling under the weight of higher import bills. Unlike previous crises focused primarily on oil, this event encompassed all major fossil fuels, making it the first truly global energy crisis. Overall, the global energy crisis reflects not only short-term supply disruptions but also deeper structural challenges within the global energy system. It underscores the urgent need for coordinated policies and investment strategies that balance energy security, affordability, and environmental sustainability, particularly as demand continues to grow and geopolitical uncertainties persist.

**Development of electricity prices for non-household consumers, EU, 2008-2025
(€ per kWh)**



Source: Eurostat (online data codes: nrg_pc_205)

eurostat

Figure 1: Development of electricity prices

Evolution of key regional natural gas prices, June 2021-October 2022

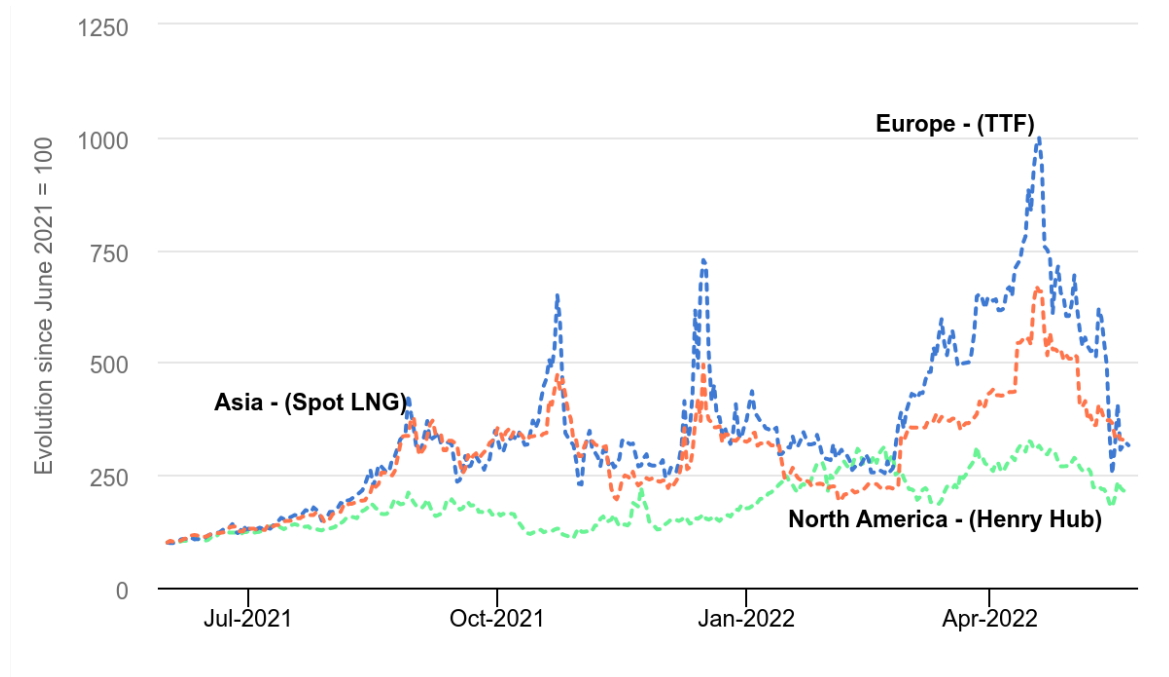


Figure 2: Evolution of key regional natural gas prices

1.5 Importance of ESG in corporate strategy

ESG (Environmental, Social, and Governance) has become a critical component of modern corporate strategy because it directly influences long-term sustainability, risk management, and stakeholder trust. We will examine below some reasons why it's important.

Firstly, risk management constitutes a fundamental pillar of corporate sustainability and long-term value creation, with Environmental, Social, and Governance (ESG) factors playing an increasingly critical role in helping organizations identify, assess, and mitigate a wide range of risks. Specifically, ESG considerations enable firms to proactively address challenges associated with climate change, such as extreme weather events, rising temperatures, and stricter environmental regulations, all of which can disrupt operations, increase costs, and threaten asset viability. In addition, issues of resource scarcity—particularly in relation to energy, water, and raw materials—require companies to adopt more efficient and sustainable practices to ensure business continuity and resilience. On the social dimension, ESG frameworks highlight risks linked to social inequality, labor rights violations, poor working conditions, and community relations, which can lead to workforce instability, decreased employee morale, and public backlash. Furthermore, governance-related risks, including lack of transparency, weak internal controls, corruption, and ineffective leadership, can undermine organizational integrity and erode stakeholder trust. Importantly, companies that fail to implement robust ESG practices are exposed to significant adverse consequences. Poor environmental performance or non-compliance with evolving regulations can result in substantial legal and regulatory penalties, while social or ethical misconduct may trigger widespread reputational damage that diminishes brand equity and customer loyalty. Governance failures, such as financial mismanagement or lack of accountability, can also lead to investor dissatisfaction and reduced access to capital. Collectively, these risks often translate into tangible financial losses, including declining revenues, increased operational costs, and diminished shareholder value. Therefore, integrating ESG factors into risk management strategies is not only essential for safeguarding against potential threats but also for enhancing organizational resilience, maintaining competitive advantage, and ensuring sustainable growth in an increasingly complex and regulated global business environment.

Secondly, investor expectations have undergone a significant transformation in recent years, with Environmental, Social, and Governance (ESG) criteria emerging as a central component in the evaluation and selection of investment opportunities. Institutional investors, including pension funds, asset managers, insurance companies, and sovereign wealth funds, increasingly incorporate ESG considerations into their decision-making processes as they seek to balance financial returns with long-term sustainability and

responsible business conduct. This shift reflects a broader recognition that strong ESG performance is closely linked to reduced risk exposure, enhanced operational efficiency, and improved resilience in the face of global challenges. Consequently, companies that demonstrate robust ESG practices are more likely to attract capital inflows, as investors view them as better positioned for sustainable growth and long-term value creation. In many cases, firms with high ESG scores benefit from improved market perception, which can translate into higher valuations, lower cost of capital, and increased investor confidence. Moreover, ESG ratings and metrics have become deeply embedded in both investment analysis and credit assessment frameworks. Rating agencies, financial institutions, and specialized ESG data providers systematically evaluate companies based on their environmental impact, social responsibility, and governance structures, producing standardized scores that investors use to compare performance across industries and regions. These ratings increasingly influence portfolio allocation decisions, as well as lending practices, with banks and creditors integrating ESG factors into their risk assessment models. As a result, companies with weak ESG profiles may face restricted access to funding, higher borrowing costs, or exclusion from certain investment portfolios, particularly those focused on sustainable or responsible investing. Overall, the growing importance of ESG in shaping investor expectations underscores the need for organizations to adopt transparent, accountable, and forward-looking practices, not only to meet stakeholder demands but also to remain competitive in an evolving global financial landscape.

Thirdly, regulatory compliance has become an increasingly critical dimension of corporate strategy, particularly considering the growing emphasis on Environmental, Social, and Governance (ESG) standards by governments and regulatory authorities worldwide. In recent years, policymakers have introduced a wide array of stringent ESG-related disclosure requirements aimed at enhancing transparency, accountability, and comparability across organizations. Prominent examples include the European Union's Corporate Sustainability Reporting Directive (CSRD), which significantly expands the scope and depth of non-financial reporting obligations for companies operating within the EU, as well as the climate-related disclosure rules proposed and implemented by the U.S. Securities and Exchange Commission (SEC). These regulatory developments reflect a broader global trend toward mandating standardized ESG reporting, requiring firms to systematically disclose information on issues such as greenhouse gas emissions, climate-related risks, social impacts, and governance structures. As a result, ESG compliance is no longer optional or merely reputational but has become a legal and operational necessity. In this evolving regulatory landscape, companies that proactively integrate ESG considerations into their core business strategies are better positioned to meet and exceed compliance requirements. By embedding ESG principles into governance frameworks, risk management systems, and operational processes, organizations can ensure that they are not only adhering to current regulations but also anticipating future legislative developments. This forward-looking approach reduces the likelihood of non-compliance, which could otherwise result in financial penalties, legal liabilities, and reputational harm. Furthermore, early adoption of

ESG standards enables firms to streamline reporting processes, improve data collection and management systems, and build internal capabilities that support long-term regulatory alignment. In contrast, companies that adopt a reactive stance may face significant challenges in adapting to rapidly changing requirements, potentially incurring higher compliance costs and operational disruptions. Therefore, integrating ESG into corporate strategy is essential not only for fulfilling regulatory obligations but also for enhancing organizational resilience, fostering stakeholder trust, and securing a competitive advantage in an increasingly regulated and sustainability-driven global economy.

Fourthly, competitive advantage has increasingly become closely intertwined with the integration of Environmental, Social, and Governance (ESG) principles into corporate strategy, as organizations seek to differentiate themselves in an increasingly complex and sustainability-oriented global marketplace. ESG-driven innovation plays a pivotal role in enabling firms to develop unique value propositions, such as environmentally sustainable products, low-carbon technologies, circular economy initiatives, and ethically managed supply chains that prioritize transparency, fair labor practices, and responsible sourcing. These innovations not only contribute to reducing environmental impact and enhancing social well-being but also position companies as forward-thinking and responsible market leaders. By embedding ESG considerations into product development, operational processes, and business models, organizations can create new market opportunities, respond to emerging consumer demands, and strengthen their brand identity. In turn, this differentiation can lead to increased customer loyalty, stronger competitive positioning, and improved long-term performance. At the same time, shifting consumer preferences have further reinforced the strategic importance of ESG in building and sustaining competitive advantage. Modern consumers, particularly younger generations, are increasingly conscious of the environmental and social implications of their purchasing decisions and show a clear preference for brands that align with their personal values on issues such as sustainability, social responsibility, ethical conduct, and corporate transparency. As a result, companies that actively demonstrate commitment to ESG principles are more likely to gain trust, enhance their reputation, and cultivate deeper emotional connections with their customer base. In contrast, businesses that fail to address these expectations risk losing relevance, market share, and credibility in the eyes of increasingly informed and values-driven stakeholders. Ultimately, the integration of ESG into organizational strategy is not merely a matter of compliance or risk mitigation, but a powerful driver of innovation, differentiation, and sustained competitive advantage in the evolving global business environment.

Moreover, long-term value creation has emerged as a central objective for organizations seeking sustainable growth and enduring success in an increasingly dynamic and uncertain global business environment, and the integration of Environmental, Social, and Governance (ESG) principles plays a crucial role in achieving this objective. By embedding ESG considerations into their strategic frameworks, operational processes, and decision-making mechanisms, companies enhance their capacity for resilience and adaptability in the face of rapid economic, environmental, and societal changes. For instance, organizations that proactively address environmental challenges such as climate change and resource

efficiency are better equipped to withstand regulatory pressures, market shifts, and operational disruptions, while those that prioritize social responsibility and inclusive practices are more capable of maintaining workforce stability and fostering innovation. Furthermore, strong governance structures contribute to effective leadership, risk oversight, and ethical conduct, all of which are essential for navigating complex and evolving business conditions. As a result, ESG integration enables firms to not only respond to external challenges more effectively but also to anticipate future trends and position themselves for long-term competitiveness. In addition to strengthening resilience, ESG practices play a fundamental role in fostering trust among a wide range of stakeholders, including employees, customers, investors, and local communities. This trust is built through transparent communication, ethical behavior, and a demonstrated commitment to sustainability and social impact, which collectively enhance the credibility and legitimacy of the organization. Employees are more likely to feel engaged, motivated, and loyal when they perceive their employer as responsible and aligned with societal values, while customers increasingly support brands that reflect their own ethical and environmental concerns. At the same time, investors tend to favor companies with strong ESG performance, as these firms are perceived to offer more stable and sustainable returns over the long term. Moreover, positive relationships with local communities and other external stakeholders contribute to a supportive operating environment and reduced social conflict. Ultimately, this widespread trust translates into a stronger brand reputation, enhanced customer loyalty, and sustained stakeholder support, all of which are critical drivers of long-term value creation and organizational success in the modern business landscape.

Last but not least, talent attraction and retention have become increasingly important strategic priorities for organizations, particularly in the context of a rapidly evolving labor market where employee expectations are shifting toward purpose-driven work and socially responsible employers. In this regard, the integration of Environmental, Social, and Governance (ESG) principles into corporate strategy serves as a powerful mechanism for attracting high-quality talent and maintaining a committed and motivated workforce. Modern employees, especially younger generations such as Millennials and Generation Z, are placing greater emphasis on working for organizations that demonstrate a genuine commitment to sustainability, ethical practices, and positive social impact. These individuals are more likely to seek employment with companies whose values align with their own, prioritizing factors such as environmental stewardship, diversity and inclusion, fair labor practices, and community engagement. Consequently, organizations that actively promote and implement ESG initiatives are better positioned to appeal to this growing pool of socially conscious talent, thereby enhancing their ability to recruit skilled and motivated employees in competitive labor markets. Furthermore, ESG initiatives play a significant role in strengthening corporate culture and fostering higher levels of employee engagement, satisfaction, and loyalty. By cultivating a workplace environment that emphasizes ethical behavior, inclusivity, and responsibility, companies can create a sense of purpose and belonging among employees, which in turn boosts morale and productivity. Employees who perceive their organization as socially responsible and committed to making a positive

impact are more likely to feel engaged with their work, exhibit stronger organizational commitment, and contribute more effectively to overall business objectives. Additionally, ESG-driven practices such as volunteer programs, sustainability initiatives, and diversity and inclusion policies provide employees with opportunities to actively participate in meaningful activities that reinforce their connection to the organization. This not only enhances job satisfaction but also reduces employee turnover and associated costs. Ultimately, the integration of ESG principles into human resource strategies contributes to the development of a resilient, motivated, and purpose-driven workforce, which is essential for sustaining long-term organizational success and maintaining a competitive advantage in an increasingly values-oriented global business environment.

2. Literature Review

The connection between ESG performance and financial outcomes has shifted from a theoretical assumption to a well-supported empirical reality. A growing body of research and market evidence shows that companies with strong ESG practices consistently achieve superior long-term results compared to their peers. In this sense, ESG is not only about ethical commitments, it is a strategic pathway to value creation.

2.1 Overview of financial performance metrics in the chemical industry

Financial performance in the chemical industry is typically assessed through a combination of profitability, efficiency, liquidity, and investment indicators. Due to the capital-intensive and energy-dependent nature of the sector, traditional metrics such as Return on Assets (ROA), Return on Equity (ROE), EBITDA margins, and operating margins are widely used to evaluate firm performance.

Scholars emphasize that EBITDA and operating profit margins are particularly important in chemicals, as they reflect operational efficiency and the ability to absorb fluctuations in energy and raw material costs. During periods of energy price volatility, such as the 2021–2023 crisis, firms with higher margins demonstrated greater resilience.

Additionally, revenue growth and cost structure analysis are essential, as chemical companies are exposed to cyclical demand and external shocks. Fixed-cost intensity makes the sector vulnerable to declining production volumes, while variable costs, especially energy and feedstocks that strongly influence profitability.

Capital investment metrics, including Capital Expenditure (CAPEX) and asset turnover ratios, are also relevant. The literature suggests that firms maintaining consistent investment during downturns tend to outperform competitors in the long term, as they preserve production capacity and innovation pipelines.

Furthermore, cash flow indicators, particularly operating cash flow, are crucial for assessing financial flexibility during crises. Researchers argue that strong liquidity positions allow firms to withstand supply shocks and maintain strategic investments.

For the purposes of this thesis, we will examine ROA, ROE, Net profit margin and EBITDA margin.

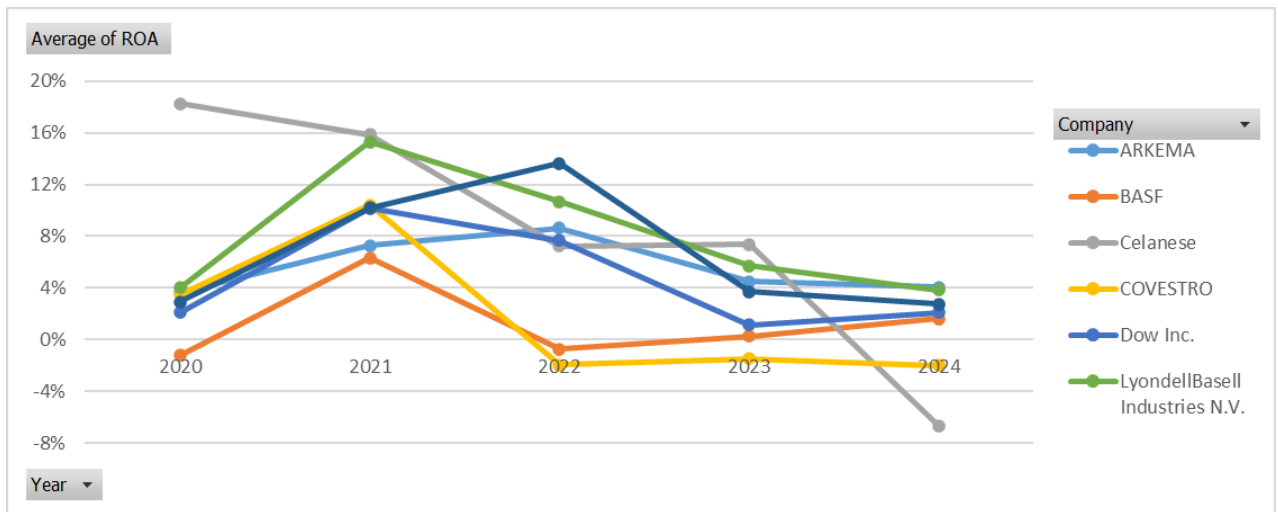


Figure 3: ROA trend 2020-2024

For most companies we observe strong ROA with pick years 2021-2022. On 2024 many firms decline toward.

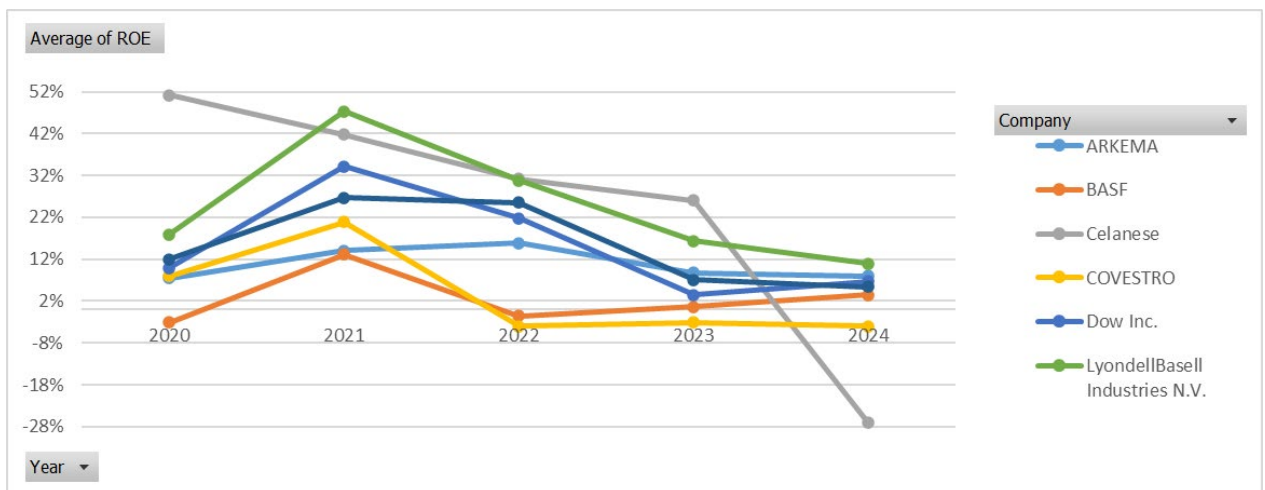


Figure 4: ROE trend 2020-2024

For ROE trend we observe that almost all companies had exceptional ROE in 2021 that declined after 2022. On 2024, the sector declined further with two Companies to turn negative ROE.

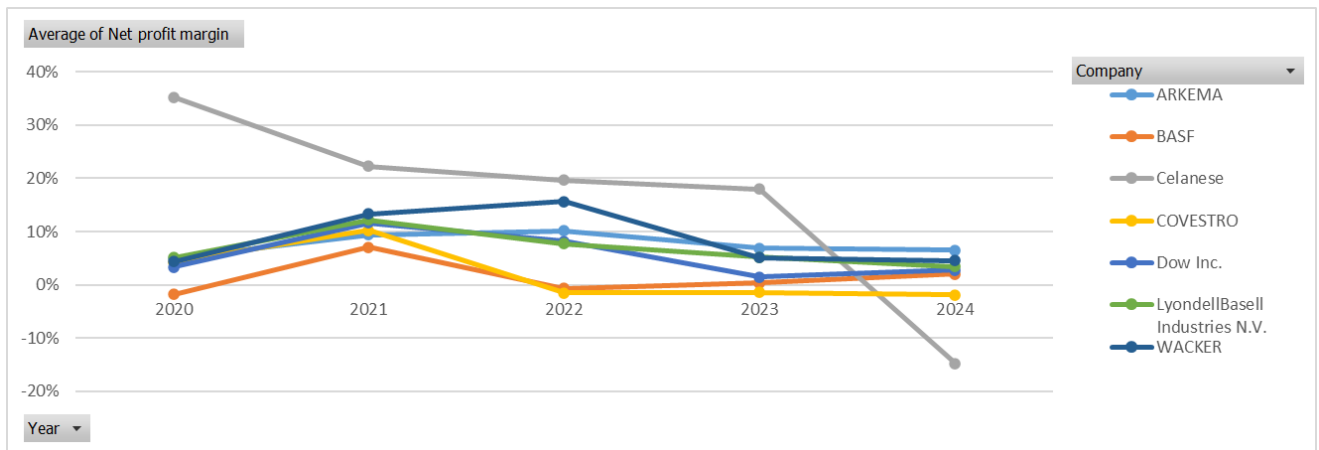


Figure 5: Net Profit Margin trend 2020-2024

From above diagram we observe that most companies reached highest margins in 2021 and this confirms a sector-wide profitability peak, consistent with ROE and ROA trends, but net profit margins fall across almost all companies for the years from 2022 to 2024.

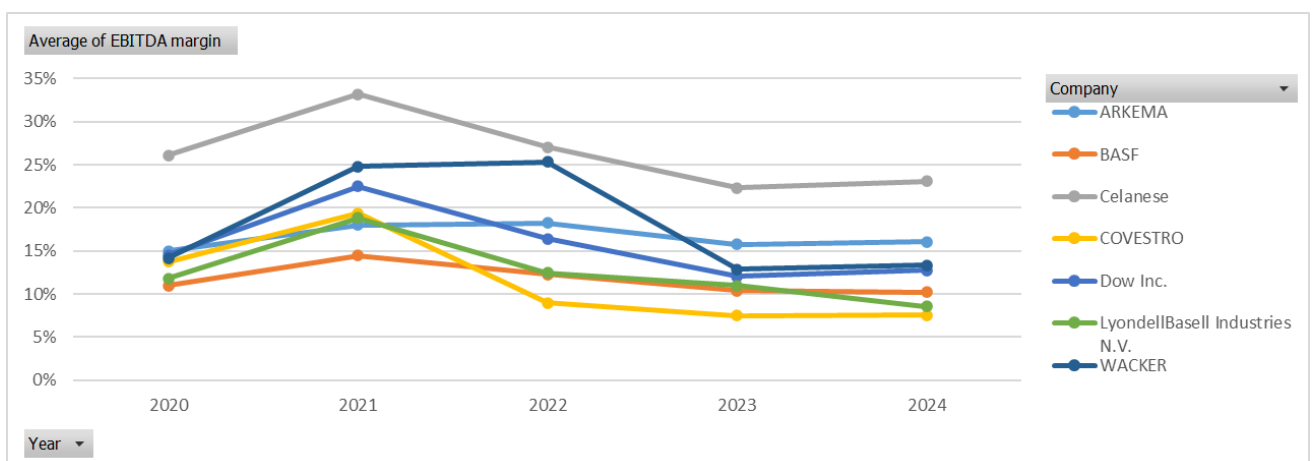


Figure 6: Ebitda Margin trend 2020-2024

Finally, above diagram confirms that 2021 was a strong year for the sector with pick profitability. From 2022 there is a decline in profitability that remains stabilized in the following years.

As a conclusion, the decline in margins between 2022 and 2023 reflects the direct transmission of the energy crisis into the chemical sector's profitability. As a highly energy- and feedstock-intensive industry, chemical production relies heavily on natural gas both as a fuel source and as a key raw material, making it particularly vulnerable to price spikes—especially in Europe. Energy costs increased much faster than companies were able to pass them on through selling prices, while at the same time demand weakened due to economic slowdown in key regions such as Europe and China. In addition, inventory corrections

across downstream industries reduced volumes, further amplifying the pressure on EBITDA margins.

2.2 ESG frameworks and rating methodologies

The concept of Environmental, Social, and Governance (ESG) has gained increasing attention in the corporate finance literature, with firm performance in these areas commonly assessed through standardized scoring systems provided by agencies such as MSCI ESG Ratings, Sustainalytics, Refinitiv, and Bloomberg. ESG is typically analyzed across three key dimensions. First, the environmental dimension is particularly critical in industries such as chemicals, where firms face high carbon emissions and significant regulatory scrutiny; key indicators include greenhouse gas (GHG) emissions, energy efficiency, waste and water management, and the adoption of renewable energy sources. Existing literature suggests that firms with strong environmental performance are better positioned to avoid regulatory penalties and achieve cost efficiencies through improved resource management. Second, the social dimension evaluates factors such as employee safety, especially relevant in hazardous production environments, labor practices, community impact, and diversity and inclusion. Strong social performance has been linked to reduced operational risks, including workplace accidents and labor disputes, which can otherwise disrupt production processes. Third, the governance dimension encompasses indicators such as board independence, executive compensation structures, transparency and reporting quality, and the effectiveness of risk management systems; robust governance practices are associated with improved decision-making, enhanced crisis management, and lower agency costs. Despite the growing importance of ESG metrics, the literature highlights notable limitations, particularly the lack of consistency across rating agencies. Divergent methodologies often result in significantly different ESG scores for the same firm, raising concerns about comparability and reliability, especially in cross-company analyses.



Figure 7: Key Components and Performance Indicators of ESG

ESG reporting frameworks enable organizations to present their environmental, social, and governance performance in a clear, reliable, and comparable way. As global regulations become more stringent and investors push for greater transparency, selecting the right ESG reporting framework or standard has become essential for companies of every size.

ESG reporting frameworks provide guidance on how organizations should structure and present ESG-related disclosures. They outline what topics to cover, how information should be organized, and how ESG performance can be communicated consistently to stakeholders. These frameworks do not always mandate specific metrics. Instead, they offer a reporting structure that allows companies to explain their ESG strategy, risks, opportunities, and impacts in a standardized way. ESG reporting frameworks are commonly used by Corporates and listed companies, financial institutions and asset managers, Private equity and venture capital firms and Multinational organizations operating across jurisdictions. A clear understanding of the differences between frameworks, standards, and regulations is important for ensuring accurate and effective ESG reporting. Below are explained three basic categories.

ESG Reporting Frameworks: Frameworks define the structure of ESG disclosures. They explain what topics to report on and how to present information. Examples include GRI (Global Reporting Initiative), and TCFD (Task Force on Climate-related Financial Disclosures).

ESG Reporting Standards: Standards define specific, measurable requirements for ESG disclosures. They often include detailed metrics and indicators. Some standard examples are SASB Standards, ISSB Standards, and ESRS (European Sustainability Reporting Standards).

ESG Regulations: Regulations make ESG reporting mandatory under law. They specify who must report, what must be disclosed, and when. Examples include CSRD (EU), and SEBI BRSR (India).

[Breathe ESG (2026). ESG Reporting Frameworks & Standards: A Complete Guide.]

2.2.1 ESG Practices and Their Impact on Financial Performance

Environmental, Social, and Governance (ESG) practices have become increasingly important in shaping firms' financial performance, particularly in high-impact industries such as chemicals, where environmental risks, safety concerns, and regulatory pressures are especially pronounced. The literature suggests that strong ESG performance can enhance firm value through multiple channels, including improved operational efficiency, reduced risk exposure, and enhanced stakeholder trust. From an environmental perspective, chemical companies that invest in emissions reduction, energy efficiency, and sustainable resource management are better positioned to manage their substantial carbon footprint and comply with strict environmental regulations, leading to cost savings and reduced likelihood of

penalties. The social dimension is equally critical in this industry, where employee safety, responsible labor practices, and community engagement directly influence operational continuity; strong social performance reduces the risk of workplace accidents, regulatory violations, and production disruptions. Governance practices, including board independence, transparent reporting, and robust risk management systems, play a vital role in overseeing complex operations and ensuring compliance with evolving regulatory frameworks, thereby improving strategic decision-making and lowering agency costs. While the ESG–financial performance relationship may vary depending on firm characteristics and measurement approaches, the evidence is particularly compelling in high-impact sectors such as chemicals, where effective ESG integration is not only a driver of long-term financial performance but also a key determinant of operational resilience and regulatory compliance.

Strong research evidence indicates that these companies, with good ESG practices, delivered higher levels of financial performance because of better risk management, operational efficiencies, and reputation of their brands. For example, BASF, one of the world's largest chemical companies, has integrated ESG principles into its core strategy by focusing on reducing carbon emissions, improving energy efficiency, and ensuring high safety standards in its operations. As a result, BASF has been able to lower production costs through more efficient resource use while simultaneously reducing regulatory and environmental risks. In addition, the company's strong safety record and commitment to sustainable practices have enhanced its reputation among stakeholders, contributing to stable revenues and long-term value creation. This example illustrates how ESG integration in high-impact industries such as chemicals can translate into tangible financial benefits. In his sustainability report published in March 17, 2025 for the 2024 fiscal year it highlights the launch of its 'Winning Ways' strategy focused on enabling customers' green transformation. The company conducted its first double materiality assessment in accordance with ESRS, identifying key impacts in climate change, pollution, and workforce management. BASF achieved a 22.4% reduction in Scope 1 and 2 emissions compared to its 2018 baseline and increased its renewable electricity share to 26%. A new circular economy target aims for €10 billion in sales from 'Loop Solutions' by 2030. Despite progress, the company reported two fatal work-related injuries involving contractors and is addressing challenges in sourcing certified palm kernel oil.

Strong research evidence is the study conducted by Othman Hel Al-Dhaimesh (2020) indicated that green accounting practiced by Qatari firms has benefited the (EVA) Economic Value Added, while Wingard & Vorster (2001) found a positive association between environmental performance and financial performance.

2.3 Previous studies on ESG and financial resilience

According to ESG Performance and Financial Stability: A Bibliometric and Meta-Analysis published by Sage Journals, that was a large-scale bibliometric and meta-analysis synthesizing 140 studies across 40 countries found that ESG performance is widely linked to financial stability, though evidence remains scattered across models and theories.

The comprehensive NYU Stern review, which synthesized evidence from more than 1,000 empirical studies Published between 2015 – 2020, indicates that the relationship between ESG performance and financial outcomes is predominantly positive. Specifically, in reviewing over 1,000 studies published between 2015 – 2020, study found a positive relationship between ESG and financial performance for 58% of the “corporate” studies focused on operational metric such as ROE, ROA, or stock price with 13% showing neutral impact, 21% mixed results (the same study finding a positive, neutral or negative results) and only 8% showing a negative relationship. For investment studies typically focused on risk-adjusted attributes such as alpha or the Sharpe ratio on a portfolio of stocks, 33% found positive performance 26% found neutral impacts (in other words, performed similar to conventional investments), 28% had mixed results (positive, neutral, or negative, generally because they examined a variety of variables and time periods as well as multiple samples in one study) and 14% found negative results. In other words, 59% showed similar or better performance relative to conventional investment approaches while only 14% found negative results. Study also found positive results when we reviewed 59 climate change, or low carbon, studies related to financial performance. On the corporate side, 57% arrived at a positive conclusion, 29% a neutral impact, 9% mixed and, 6% negative. Looking at investor studies, 65% showed positive or neutral performance compared to conventional investments with only 13% indicating negative findings.

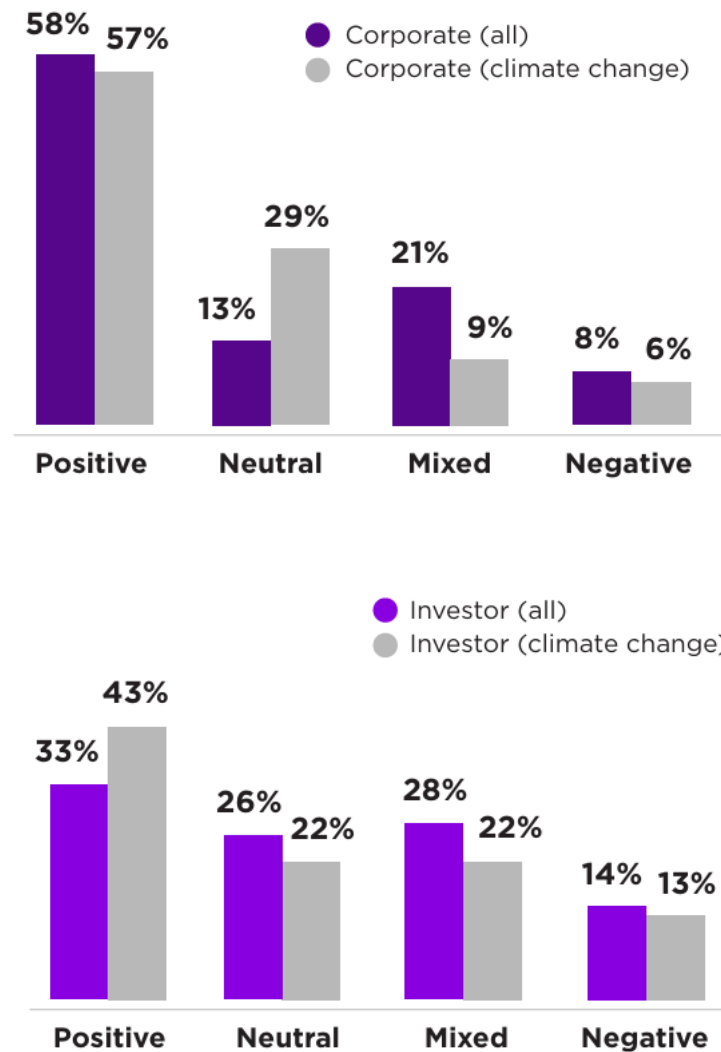


Figure 8: Positive and/or neutral results for investing in sustainability dominate. Very few studies found a negative correlation between ESG and financial performance (based on 245 studies published between 2016 and 2020).

Investor-focused studies tend to look at a direct relationship between ESG and performance based on benchmarks and a portfolio level view of themes such as materiality or governance structure. Meta-analytical effects are Hedges' g or Cohen's d (effect size).

Corporate-focused studies may include mediating factors such as innovation, operational efficiency, or risk management for a better understanding of how sustainability initiatives lead to CFP. Meta-analytical effects are partial correlations from regression models.

A master's thesis conducting in the university of Vaasa in Finland analyzing 1,740 European companies over the period 2011–2021, using the Altman Z-score as a measure of financial distress, finds that the relationship between ESG performance and bankruptcy risk is complex and non-linear. The study concludes that the results are generally neutral or mixed,

offering no strong evidence that higher ESG ratings systematically reduce the likelihood of corporate failure.

One of the most influential studies is conducted by Friede, Busch, and Bassen (2015), which synthesizes more than 2,000 empirical studies and finds that approximately 90% report a non-negative relationship between ESG and financial performance, with the majority indicating positive effects. This large-scale meta-analysis strongly supports the argument that ESG integration contributes to long-term value creation.

2.4 Theoretical Framework

Many of the studies reviewed described a finding and tried to explain it through the lens of a social science derived model of the world. Several social science theories dominate the research:

1. Stakeholder theory (successful companies need to manage for a wide variety of stakeholders such as employees, civil society, suppliers and investors).

Stakeholder Theory, originally developed by R. Edward Freeman (1984), is one of the most widely used theoretical frameworks in the study of corporate social responsibility and Environmental, Social, and Governance (ESG) performance. The theory argues that a firm should create value for all stakeholders, not just shareholders. His award-winning book *Strategic Management: A Stakeholder Approach* identifies and models the groups which are stakeholders of a corporation, and both describes and recommends methods by which management can give due regard to the interests of those groups. The theory argues that organizations should not focus solely on maximizing shareholder wealth but rather create value for a broad range of stakeholders, including employees, customers, suppliers, investors, governments, and local communities. According to this perspective, firms operate within a network of relationships, and their long-term success depends on how effectively they manage these relationships. Companies that take into account the needs and expectations of various stakeholders are more likely to achieve sustainable performance, as they reduce conflicts, enhance trust, and strengthen their reputation. In contrast, neglecting stakeholder interests may lead to reputational damage, regulatory sanctions, or reduced market competitiveness. In the context of ESG, Stakeholder Theory provides a strong foundation for explaining why firms invest in sustainability practices. Environmental initiatives, such as reducing emissions and improving resource efficiency, address concerns from regulators and environmental groups. Social practices, including employee safety and diversity, respond to workforce and community expectations, while governance practices enhance transparency and accountability toward investors and shareholders.

Empirical research suggests that firms with strong stakeholder-oriented strategies tend to demonstrate better risk management and improved long-term financial performance. This is particularly relevant in high-impact industries such as chemicals, where companies face intense scrutiny from regulators, local communities, and environmental organizations. By integrating ESG principles into their operations, chemical companies can mitigate risks related to environmental damage, workplace safety, and regulatory compliance, thereby improving their overall performance and resilience.

Overall, Stakeholder Theory supports the argument that ESG performance is not only a cost but a strategic investment that contributes to long-term value creation. However, the short-term financial impact of ESG initiatives may vary, as the benefits from stakeholder engagement often materialize over a longer time horizon.

2. Shared value (companies that create shared value for all stakeholders do better financially)

The concept of Creating Shared Value (CSV) was introduced by Porter and Kramer (2011) as a strategic management approach that emphasizes the simultaneous creation of economic value for companies and social value for society. Unlike traditional Corporate Social Responsibility (CSR), which is often viewed as a separate philanthropic activity or a compliance-driven obligation, CSV is embedded within a firm's core business strategy and operations. Porter and Kramer argued that businesses and society are mutually dependent and that long-term corporate success cannot be achieved without addressing the social and environmental challenges that affect stakeholders, communities, and markets. Consequently, companies can enhance their competitiveness by identifying societal needs and integrating solutions to these needs into their business models.

According to the shared value perspective, firms can create economic value in three primary ways: by reconceiving products and markets, redefining productivity within the value chain, and enabling local cluster development. Reconceiving products and markets involves designing products and services that address social and environmental problems while meeting consumer demand. For example, companies may develop more sustainable products, energy-efficient technologies, or environmentally friendly chemical solutions that simultaneously generate profits and contribute to societal well-being. By meeting evolving stakeholder expectations and responding to sustainability challenges, firms can access new market opportunities and strengthen customer loyalty.

The second dimension of shared value focuses on redefining productivity within the value chain. Companies can improve operational efficiency and reduce costs by addressing social and environmental issues directly linked to their business activities. Investments in energy efficiency, waste reduction, sustainable resource management, employee well-being, and

responsible supply chain practices can lead to significant productivity gains while also delivering environmental and social benefits. In industries such as chemicals, where energy consumption and environmental impacts are substantial, improvements in resource efficiency can lower operating costs, reduce regulatory risks, and enhance profitability.

The third dimension emphasizes the importance of supporting local economic and social development through the creation of strong business ecosystems or clusters. Companies operate more effectively when the communities, suppliers, institutions, and infrastructure surrounding them are healthy and productive. Therefore, investments in education, workforce development, local supplier networks, research partnerships, and community engagement can strengthen the competitive environment in which firms operate while simultaneously generating broader societal benefits.

The CSV framework is particularly relevant to the growing importance of ESG principles. Companies that successfully integrate ESG considerations into their strategic decision-making often create shared value by balancing the interests of shareholders, employees, customers, suppliers, communities, and regulators. Strong ESG performance may therefore be viewed as an indicator of a firm's ability to create value not only for investors but also for a broader set of stakeholders. Organizations that effectively address environmental challenges, invest in human capital, promote ethical governance practices, and maintain constructive stakeholder relationships are often better positioned to achieve sustainable competitive advantages and long-term financial success.

Several empirical studies have supported the link between shared value creation and financial performance. Firms that prioritize stakeholder interests frequently experience enhanced reputation, stronger customer loyalty, improved employee engagement, lower operational risks, and greater innovation capacity. These factors can contribute to higher profitability, stronger financial performance, and increased shareholder value over time. For example, investments in sustainability initiatives may reduce environmental liabilities and compliance costs, while responsible labor practices can improve employee productivity and retention. Similarly, transparent governance structures can enhance investor confidence and lower the cost of capital.

From a theoretical perspective, the CSV concept closely aligns with Stakeholder Theory, which argues that organizations create sustainable value when they consider the interests of all stakeholders rather than focusing exclusively on shareholders. Both theories challenge the traditional view that firms exist solely to maximize short-term profits. Instead, they propose that addressing societal and environmental concerns can strengthen corporate performance and contribute to long-term value creation. In this context, shared value serves

as a mechanism through which companies can transform social and environmental challenges into opportunities for innovation, growth, and competitive differentiation.

The relevance of Creating Shared Value is particularly evident within the chemical industry. Chemical companies face increasing pressure from governments, investors, customers, and society to reduce environmental impacts, improve resource efficiency, support sustainable development, and enhance transparency. Firms that successfully integrate sustainability into product innovation, production processes, and stakeholder engagement strategies may create significant shared value while simultaneously improving financial performance. Consequently, the CSV framework provides a useful theoretical lens for examining the relationship between ESG performance and financial outcomes, as it suggests that responsible corporate behavior can be a source of competitive advantage, resilience, and long-term shareholder value rather than merely a cost of doing business.

In conclusion, the Creating Shared Value approach extends beyond traditional CSR by positioning societal progress as a driver of corporate success. By aligning business objectives with social and environmental needs, firms can generate benefits for both shareholders and stakeholders, strengthen their competitive position, and enhance long-term financial performance. The theory therefore provides a strong conceptual foundation for understanding why companies with effective ESG practices and stakeholder-oriented strategies may achieve superior financial outcomes and sustainable value creation over the long term.

3. Legitimacy theory (a social contract between the corporation and society, which, if broken, leads to consumers reducing demand or governments imposing regulatory restrictions).

Legitimacy Theory is a key theoretical framework used to explain why firms engage in Environmental, Social, and Governance (ESG) activities. Although researchers can use different theories to explain the concepts of Earning Power (EP) and (ER) Efficiency Ratio, legitimacy theory (Dowling and Pfeffer, 1975) remains the most important theoretical lens. The theory is based on the idea that organizations continuously seek to ensure that their operations are perceived as legitimate by society. Legitimacy is defined as a generalized perception that the actions of an entity are appropriate and aligned with socially accepted norms, values, and expectations.

According to Legitimacy Theory, companies operate under a “social contract” with society. This contract implies that firms are expected to conduct their activities in a manner that is acceptable to the public. When companies fail to meet these expectations, such as through environmental damage, unethical practices, or lack of transparency, their legitimacy may be threatened. This can result in negative consequences, including reputational damage, regulatory sanctions, loss of investor confidence, and reduced market value.

In this context, ESG practices can be viewed as a mechanism through which firms maintain or restore legitimacy. By adopting environmentally responsible strategies, such as reducing emissions or improving energy efficiency, companies demonstrate alignment with societal concerns about climate change. Similarly, social initiatives, including employee welfare, community engagement, and diversity policies, help firms respond to stakeholder expectations. Governance practices, such as transparency, accountability, and ethical leadership, further reinforce organizational legitimacy by building trust among investors and regulators.

Legitimacy Theory is particularly relevant in high-impact industries such as the chemical sector, which faces significant scrutiny due to its environmental footprint and safety risks. Chemical companies often operate under strict regulatory frameworks and are subject to public pressure regarding pollution, waste management, and product safety. As a result, they are more likely to engage in ESG reporting and sustainability initiatives to justify their operations and demonstrate compliance with societal expectations.

However, the theory also suggests that ESG activities may sometimes be symbolic rather than substantive. In some cases, firms may engage in “greenwashing,” where they communicate sustainability efforts without implementing meaningful changes. This highlights a limitation of Legitimacy Theory, as it assumes that disclosures reflect actual practices, while in reality, there may be a gap between reported and actual ESG performance.

Overall, Legitimacy Theory provides a useful explanation for why firms adopt ESG practices, particularly in industries with high environmental and social risks. It supports the argument that ESG is not only driven by financial objectives but also by the need to maintain societal acceptance and ensure long-term organizational survival.

4. Resource-based view (emphasizing internal resources such as employees and intangible assets for achieving a competitive advantage).

The Resource-Based View (RBV) is a strategic management theory that explains how firms achieve sustainable competitive advantage through the effective use of their internal resources and capabilities. Originating from the work of Barney (1991) and Wernerfelt (1984), RBV shifts the focus from external market conditions to the unique characteristics within the firm. According to RBV, firms are heterogeneous in terms of their resources, and these differences, if properly leveraged, can lead to superior performance and long-term profitability.

3. Research Methodology

3.1 Data sources

The present study adopts a mixed research approach, incorporating both qualitative and quantitative elements, while relying exclusively on secondary data obtained from existing academic literature, industry reports, sustainability disclosures, annual reports, and peer-reviewed scholarly articles. The qualitative component focuses on the systematic review, evaluation, and synthesis of previous research concerning the relationship between Environmental, Social, and Governance (ESG) practices and corporate financial performance. Through an extensive examination of theoretical and empirical studies, the research aims to identify prevailing trends, key findings, and existing gaps in the literature regarding the role of ESG initiatives in enhancing organizational value and long-term competitiveness.

The quantitative component is based on the collection and analysis of financial and ESG-related data from selected publicly listed chemical companies. Financial performance is assessed using value-relevant indicators such as Return on Assets (ROA), Return on Equity (ROE), EBITDA Margin, and other profitability and efficiency measures, while ESG performance is evaluated through established ESG scores and ratings provided by recognized sustainability assessment agencies. By examining these indicators over a specified period, the study seeks to explore whether higher levels of ESG performance are associated with stronger financial outcomes and greater value creation for shareholders.

Furthermore, the literature review serves as a foundation for understanding how financial performance metrics have been applied across different industries and economic environments to assess corporate value creation. Particular attention is given to prior research examining the ways in which ESG integration influences operational efficiency, risk management, stakeholder relations, and overall corporate performance. The synthesis of existing evidence enables the study to compare and contrast findings from diverse contexts, thereby providing a comprehensive understanding of the mechanisms through which ESG practices may contribute to sustainable financial success.

By combining insights from both quantitative financial analysis and qualitative literature evaluation, the study aims to develop a holistic perspective on the relationship between ESG performance and financial performance within the chemical industry. This approach enhances the reliability of the findings by drawing upon multiple sources of evidence and contributes to the broader academic discussion concerning the extent to which ESG factors can serve as drivers of long-term shareholder value and corporate resilience.

3.2 Limitations and ethical considerations

Despite the growing importance of Environmental, Social, and Governance (ESG) criteria in investment decision-making and corporate evaluation, the assessment of ESG performance remains subject to several significant limitations that affect its reliability, validity, and comparability across firms and industries. One of the most widely discussed challenges is the absence of a universally accepted ESG measurement framework. ESG rating agencies such as MSCI, Sustainalytics, Refinitiv/LSEG, and S&P Global employ different methodologies, weighting schemes, and assessment criteria when evaluating corporate sustainability performance. Consequently, the same company may receive substantially different ESG ratings from different providers, creating confusion among investors, researchers, and other stakeholders. This inconsistency reduces the comparability of ESG scores and complicates efforts to draw robust conclusions regarding the relationship between ESG performance and financial outcomes.

Another major limitation concerns data availability and disclosure quality. Although ESG reporting has expanded significantly in recent years, disclosure practices continue to vary considerably across companies, industries, and geographical regions. In many jurisdictions, ESG reporting remains partially voluntary, allowing organizations substantial discretion regarding what information they disclose and how that information is presented. As a result, firms may selectively report positive sustainability achievements while omitting unfavorable environmental impacts, social controversies, or governance deficiencies. This issue is particularly pronounced in emerging economies, where regulatory requirements, monitoring mechanisms, and reporting standards may be less developed than in more mature markets. Such inconsistencies can lead to incomplete datasets and reduce the reliability of ESG assessments.

Furthermore, ESG ratings are heavily dependent on self-reported information provided by companies themselves. While some disclosures are subject to external assurance or audit procedures, a large proportion of ESG-related data remains unaudited. This dependence on corporate reporting increases the risk of measurement bias and information asymmetry between firms and stakeholders. Companies with greater resources and more sophisticated sustainability reporting capabilities may achieve higher ESG scores not necessarily because of superior sustainability performance, but because of their ability to communicate and document their activities more effectively. Consequently, ESG ratings may reflect reporting quality rather than actual sustainability outcomes.

The backward-looking nature of many ESG metrics represents another important limitation. Most ESG assessments rely on historical disclosures and previously reported sustainability activities, making them retrospective indicators of performance. While historical data can provide valuable insights into a company's past behavior, it may not adequately capture emerging risks, changing stakeholder expectations, future sustainability commitments, or ongoing environmental and social controversies. As a result, ESG scores may fail to

accurately reflect a firm's capacity to manage future challenges related to climate change, supply chain disruptions, human rights concerns, or evolving regulatory requirements.

In addition, ESG assessments often struggle to account for industry-specific characteristics. Different sectors face fundamentally different sustainability challenges, risk profiles, and regulatory environments. Technology and service-based companies, for example, generally generate lower direct environmental impacts and therefore tend to achieve higher environmental scores. In contrast, sectors such as chemicals, mining, energy, and heavy manufacturing face inherently higher environmental risks and emissions profiles. Although companies operating within these industries may invest substantially in sustainability initiatives, energy efficiency improvements, circular economy practices, and emission reduction programs, they may still receive lower ESG ratings due to the structural characteristics of their sectors. This creates potential biases and may disproportionately penalize companies operating in so-called "hard-to-abate" industries.

Another concern relates to the subjectivity embedded within ESG evaluation frameworks. Determining the relative importance of environmental, social, and governance factors requires judgment regarding weighting and materiality. Different rating agencies may place greater emphasis on specific issues such as carbon emissions, board diversity, labor practices, executive compensation, or stakeholder engagement. Consequently, ESG ratings may reflect the evaluators' assumptions and priorities rather than an objective assessment of corporate sustainability performance. This subjectivity contributes to rating divergence and weakens confidence in ESG metrics as standardized measures of corporate responsibility.

The issue of materiality also remains unresolved within the ESG field. Not all ESG factors are equally relevant across firms and industries, yet many rating systems apply standardized indicators to a broad range of organizations. As a result, companies may be evaluated on criteria that have limited relevance to their business models, while highly material issues may receive insufficient attention. This challenge raises concerns about whether ESG scores accurately capture the sustainability risks and opportunities that are most consequential for long-term firm value.

Moreover, ESG ratings often fail to measure the actual impact of sustainability initiatives. Many evaluation frameworks focus on policies, commitments, governance structures, and disclosure practices rather than on measurable real-world outcomes. For example, a company may receive favorable ESG scores for establishing climate policies or diversity targets without demonstrating substantial improvements in emissions reduction, resource efficiency, employee welfare, or community development. This distinction between ESG performance and ESG impact has become increasingly important in academic and professional discussions regarding sustainable finance.

Greenwashing represents an additional and persistent ethical challenge. As investor demand for sustainable investments continues to grow, organizations may face increasing incentives to portray themselves as environmentally and socially responsible without implementing meaningful operational changes. Through selective disclosure, marketing campaigns, or

symbolic sustainability initiatives, firms may create an appearance of strong ESG performance while underlying practices remain largely unchanged. Inadequate verification mechanisms and limited regulatory oversight can make it difficult for investors and analysts to distinguish genuine sustainability efforts from superficial ESG claims. Consequently, capital may be allocated inefficiently, and stakeholder trust may be undermined.

Finally, the relationship between ESG performance and financial performance remains complex and difficult to establish with certainty. Numerous external factors, including macroeconomic conditions, industry dynamics, regulatory environments, firm size, management quality, and market sentiment, may influence both ESG ratings and financial outcomes. Therefore, isolating the direct impact of ESG practices on profitability, shareholder value, and long-term corporate performance presents significant methodological challenges. Researchers must exercise caution when interpreting correlations between ESG scores and financial metrics, as such relationships may not necessarily imply causation.

Overall, these limitations highlight the ongoing challenges associated with ESG measurement and underscore the need for greater harmonization, transparency, standardization, and external assurance within ESG reporting frameworks. The development of internationally recognized standards, such as those promoted by the International Sustainability Standards Board (ISSB), the Corporate Sustainability Reporting Directive (CSRD), and other global initiatives, may help improve the consistency, credibility, and usefulness of ESG assessments in the future. Such improvements are essential for enhancing investor confidence, supporting informed decision-making, and strengthening the role of ESG factors in evaluating long-term corporate performance and value creation.

3.3 Variable Definition

For this thesis, in order to examine the relationship between Environmental, Social, and Governance (ESG) performance and financial outcomes in the chemical industry, we selected dependent and independent variables. The selection of these variables is based on their extensive use in academic literature and their relevance to assessing firm performance within capital-intensive industries.

The primary dependent variable used in this study is Return on Assets (ROA). ROA is defined as the ratio of net income to total assets and measures how efficiently a firm utilizes its assets to generate profits.

$$ROA = \frac{\text{Net income}}{\text{Total Assets}}$$

This thesis incorporates four independent variables, including both financial performance indicators and ESG scores, in order to evaluate their relationship with ROA.

The ROE, which we used, has the following type:

$$ROE = \frac{\text{Net income}}{\text{Shareholders' Equity}}$$

Return on Assets (ROA) and Return on Equity (ROE) are among the most commonly used financial performance metrics, especially in corporate finance, accounting, and investment analysis. They are used very frequently because they provide clear insights into profitability and efficiency from different perspectives. In practice, ROA and ROE are almost always included in financial statement analysis, particularly when evaluating a company's profitability over time or comparing it with competitors. They are standard indicators in annual reports, financial databases, and analyst reports, and are widely used by investors, analysts, and managers to assess firm performance. ROE is especially popular because it reflects the return generated on shareholders' investments, making it highly relevant for equity investors, while ROA is commonly used to evaluate how effectively a company utilizes its assets regardless of financing structure. In academic research, especially in fields such as finance, accounting, and ESG studies, ROE are among the most frequently used dependent variables to measure firm performance. Many empirical studies rely on them because they are widely available, comparable across firms and industries, and relatively easy to interpret. ROA tends to be preferred when researchers want a measure independent of leverage, whereas ROE is often used to capture shareholder value creation. Overall, ROA and ROE are used consistently and extensively across both practice and research, making them two of the most standard profitability metrics in financial analysis.

The Net profit margin, which we used, has the following type:

$$\text{Net profit margin} = \frac{\text{Net income}}{\text{Revenue}}$$

The Net Profit Margin (NPM) is also widely used, though its role is slightly different from ROA and ROE. While ROA and ROE focus on returns relative to assets and equity, the net profit margin measures how much profit a company generates from its revenues, making it a key indicator of operational efficiency and cost management. In practice, net profit margin is very commonly used in financial analysis, especially in evaluating a company's profitability from a sales perspective. It is routinely reported in financial statements and is frequently used by managers and analysts to assess how effectively a company converts revenue into profit. It is particularly useful for comparing firms within the same industry, as it reflects differences in pricing strategies, cost control, and operational efficiency. Compared to ROA and ROE, net profit margin is more focused on operational performance rather than overall capital efficiency. For this reason, it is often used alongside ROA and

ROE to provide a more complete picture of financial performance. In academic research, it is also used as a proxy for profitability, although slightly less frequently than ROA and ROE, which are generally preferred due to their ability to incorporate balance sheet information.

The EBITDA margin, which we used, has the following type:

$$EBITDA \text{ margin} = \frac{\text{earnings before interest and tax} + \text{depreciation} + \text{amortization}}{\text{Total Revenue}}$$

The EBITDA margin is another widely used profitability indicator, particularly in corporate finance, valuation, and industry analysis. It measures a company's earnings before interest, taxes, depreciation, and amortization (EBITDA) as a percentage of its revenue, and is commonly used to assess operating performance independent of capital structure and accounting policies. In practice, EBITDA margin is frequently used by analysts, investors, and management, especially when comparing companies across different countries, tax regimes, or capital structures. Because it excludes non-operating expenses and non-cash charges such as depreciation and amortization, it provides a clearer view of a firm's core operating profitability and cash-generating ability. This makes it particularly relevant in capital-intensive industries, such as chemicals, energy, and manufacturing, where depreciation can significantly distort net income measures. Compared to net profit margin, EBITDA margin is considered a simpler measure of operational efficiency, as it focuses on earnings generated from core business activities. However, it is less comprehensive than ROA and ROE because it does not account for how assets are financed or utilized. For this reason, it is typically used in combination with other metrics, rather than as a standalone indicator. In academic research, EBITDA margin is also used, especially in studies related to firm performance, mergers and acquisitions, and ESG analysis, but somewhat less consistently than ROA and ROE. Nonetheless, it remains a highly relevant and widely accepted metric, particularly when the objective is to isolate operational performance and compare companies on a more standardized basis.

The last independent variable is ESG Score. The key non-financial independent variable used in this study is the ESG score, which reflects a firm's performance in environmental, social, and governance dimensions. ESG data are obtained from recognized rating agencies, such as EcoVadis and the London Stock Exchange Group (LSEG), which provide standardized assessments based on multiple sustainability criteria.

ESG scores are included in the model to evaluate whether firms with stronger sustainability practices exhibit better financial performance. The theoretical expectation, based on existing literature, is that higher ESG performance may contribute to improved financial outcomes through better risk management, enhanced reputation, and increased operational efficiency. However, the relationship between ESG scores and financial performance is not always straightforward, as it may be influenced by factors such as industry characteristics, time horizon, and measurement differences across rating agencies.

The selection of the above variables is grounded in both theoretical and empirical considerations. Financial ratios such as ROE, net profit margin, and EBITDA margin are widely used in corporate finance and accounting research as key indicators of profitability and efficiency. At the same time, ESG scores have gained increasing importance in recent years as measures of corporate sustainability and non-financial performance.

By combining traditional financial indicators with ESG metrics, this study aims to provide a comprehensive assessment of the factors influencing firm performance in the chemical industry, particularly during periods of economic disruption such as the energy crisis.

4. ESG Analysis

4.1 ESG Performance of the Chemical Industry

The chemical industry plays a key role in global ESG outcomes, as it supports economic development while also being one of the most resource- and energy-intensive sectors. This dual role means it faces significant environmental and social risks, tighter regulations, and increasing expectations from investors to adopt more sustainable practices.

Firstly, we must understand the importance of ESG in the chemical industry. The importance of ESG in the chemical industry comes from the sector's significant environmental footprint and its growing exposure to external pressures. As one of the most energy-intensive industries, it contributes substantially to global greenhouse gas emissions, exhaustion of natural resources, and pollution, making sustainability a critical concern. At the same time, chemical companies face increasing expectations from regulators, investors, and customers to operate more responsibly and transparently. Strong ESG performance is no longer optional, as it directly influences company valuation, access to financing, and long-term competitiveness. In response to these pressures, the vast majority of leading chemical firms have committed to ambitious climate goals, with over 90% setting net-zero or carbon neutrality targets, typically aimed at achieving these objectives by 2050 as it is stated in the research conducted by McKinsey & Company "Sustainability value in chemicals".

Secondly, the key ESG dimensions in the chemical sector reflect the industry's wide-ranging impacts across environmental, social, and governance areas. Environmentally, the sector is examined very carefully and thoroughly for its high greenhouse gas emissions, energy consumption, waste generation, and use of hazardous substances, making emissions reduction, resource efficiency, and circular economy practices critical priorities. From a social perspective, chemical companies must ensure employee health and safety, given the hazardous nature of operations, while also addressing community impacts, product safety, and responsible supply chain management. In terms of governance, strong oversight, transparency, regulatory compliance, and ethical business practices are essential, particularly as the industry operates under strict safety and environmental regulations. Together, these ESG dimensions shape how chemical companies manage risks, meet stakeholder expectations, and transition toward more sustainable and responsible business models.

More specifically, regarding environmental impact the chemical industry accounts for approximately 7-10% of global greenhouse gas emissions, making it a significant contributor to climate change according to Nexdigm, market research article. Currently, among all industries, chemicals is the second-highest emitter of CO₂, after steel industry according to PwC's article "Sustainable chemicals pathways". Higher levels of annual

chemicals production will require greater volumes of energy—even as the pressure to defossilise, meaning to replace fossil carbon sources with renewable alternatives, supply chains increases.

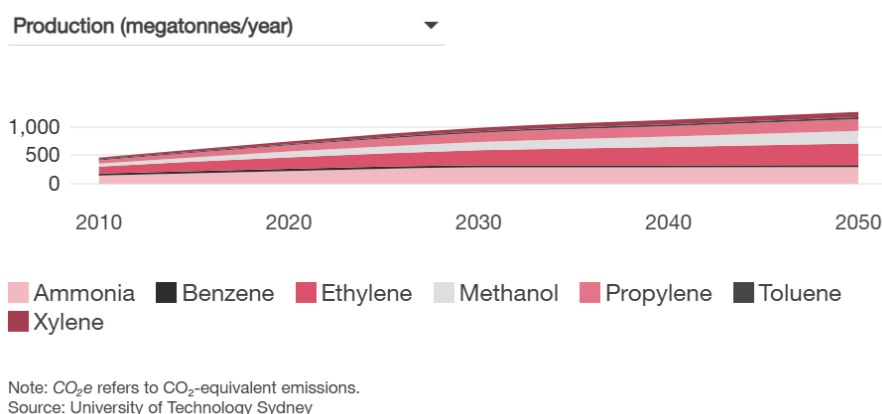


Figure 9: Long-Term Production Trends of Key Petrochemical Products

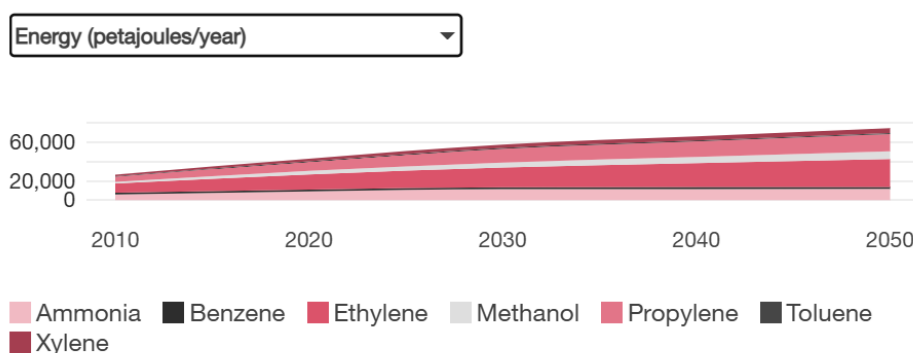


Figure 10: Forecasted Energy Demand in the Global Petrochemical Industry (2010–2050)

From the social perspective of ESG, the sector faces one of the highest levels of environmental and social risk among industries according to G&A Institute article “Sustainability Challenges and Reporting Frameworks in the Chemical Industry”. There is major concern over worker and consumer health and safety in producing and using the products. There are chemicals which are still being used despite being hazardous. These chemicals are often supplied to other industries and can be polluted into water streams, causing health problems for workers, local residents, and ecosystems. In 1985, the International Council of Chemical Associations (ICCA) launched the Responsible Care program as a voluntary global initiative aimed at improving the industry’s performance in health, safety, and environmental protection. The program encourages companies to adopt rigorous standards for safe chemical management, minimize environmental impact, and contribute to sustainable development across their operations. Over time, Responsible Care has become a cornerstone of ESG practices in the sector, demonstrating collective commitment to accountability and continuous improvement. By 2021, approximately 580 chemical companies, representing around 96% of the global industry, according to the same

article, had joined the initiative, highlighting its widespread adoption and the growing importance of responsible practices within the industry.

4.2 ESG performance of selected chemical companies

We researched ESG Scores of the selected chemical companies and the most popular indexes was EcoVadis Rating , LSEG Sustainability Ratings and Data ,S&P Global ESG Score and CDP Climate.

In the table below presents ESG Score of the selected chemical companies:

Company	ESG Rating/Index	Score	Last Update
Dow Inc.	EcoVadis Rating	68/100	2024
Dow Inc.	LSEG Sustainability Ratings and Data	4.1/5	2024
Dow Inc.	CDP Climate	A	2025
Covestro AG	CDP Climate	C	September, 2025
Covestro AG	MSCI ESG	AA (Leader)	June, 2025
Covestro AG	Sustainalytics ESG Rating	26.7 Points	July, 2025
Covestro AG	EcoVadis Rating	71/100 Points	February, 2025
Arkema S.A.	EcoVadis Rating	84/100	2024
Arkema S.A.	LSEG Sustainability Ratings and Data	3.6/5	2024
BASF SE	EcoVadis Rating	75/100	2024
BASF SE	LSEG Sustainability Ratings and Data	3.5/5	2024
Wacker Chemie AG	EcoVadis Rating	77/100	2024
Wacker Chemie AG	LSEG Sustainability Ratings and Data	3.5/5	2024
LyondellBasell Industries N.V.	LSEG Sustainability Ratings and Data	3.5/5	2024
Dow Inc.	S&P Global ESG Score	78	April 01, 2025
Arkema S.A.	S&P Global ESG Score	42	July 28, 2025
BASF SE	S&P Global ESG Score	28	July 18, 2025
Covestro AG	S&P Global ESG Score	42	July 18, 2025
Wacker Chemie AG	S&P Global ESG Score	56	April 09, 2025
LyondellBasell Industries N.V.	S&P Global ESG Score	61	September 12, 2025
Celanese Corporation	S&P Global ESG Score	51	October 03, 2024

Table 1: ESG Scores of the selected Chemical Companies

From the above research and as detailed explained in section 3.3 *Limitations and ethical considerations* ESG evaluations suffer from data gaps meaning that we could not find ESG Scores for prior years for all companies.

Based on a second, more extensive research and focusing on EcoVadis Rating we had the data below that we used for the first regression test.

Company	Year	EcoVadis Rating
Dow Inc.	2024	0,68
Dow Inc.	2023	0,67
Dow Inc.	2022	0,58
Dow Inc.	2021	0,62
Dow Inc.	2020	0,62
ARKEMA	2024	0,84
BASF	2024	0,75
BASF	2023	0,75
BASF	2022	0,75
BASF	2021	0,72
BASF	2020	0,72
COVESTRO	2024	0,71
WACKER	2024	0,77
WACKER	2023	0,73
WACKER	2022	0,8
WACKER	2021	0,75
WACKER	2020	0,75
Celanese	2024	0,85

Table 2: EcoVadis Rating Data per Company

EcoVadis has grown into a globally trusted provider of business sustainability ratings, covering more than 150,000 companies worldwide. Beyond its role as a rating agency, it functions as an integrated ESG management platform, offering enterprise solutions in areas such as sustainable procurement, risk management, sustainable finance, and regulatory compliance. This dual role enhances its strategic importance, as it not only evaluates firms' sustainability performance but also actively supports organizations in embedding ESG criteria into operational and supply chain decision-making processes. Consequently, EcoVadis contributes to standardizing ESG practices across industries while enabling firms to identify risks, improve transparency, and strengthen their overall sustainability performance.

5. Financial Performance Evaluation

5.1 Most widely used ratios

Research examining the relationship between ESG performance and financial outcomes typically relies on three major categories of financial ratios: profitability, market-based, and leverage/efficiency indicators.

Here are the most widely used ones:

Metric Category	Key Ratios	Why Used in Sustainability Research
Profitability	ROA, ROE, ROI, Net Margin	Measures of financial efficiency affected by ESG practices
Market-based	Tobin's Q, P/E, MVA	Captures market reaction to sustainability performance
Leverage & Efficiency	D/E, Asset Turnover, Operating Margin	Shows risk, capital structure, and efficiency outcomes
ESG-Adjusted Metrics	Carbon Intensity, Environmental CapEx	Industry-specific linkage between sustainability and financial results

Table 3: Most widely used ratios

5.2 Regression Tests

A regression test or regression analysis is a statistical method used to examine the relationship between one dependent variable and one or more independent variables.

In the following analyses, we investigate whether a relationship exists between selected financial performance indicators, namely return on assets (ROA), return on equity (ROE), and Net profit Margin, Ebitda Margin and ESG scores. To this end, we first collected financial data from companies' balance sheets and income statements, using information obtained from the respective companies' official disclosures. In addition, we retrieved ESG scores for the years available from the EcoVadis Rating database and LSEG.

Company	Year	Financial Ratios				ESG Scores
		ROA	ROE	Net profit margin	EBITDA margin	EcoVadis Rating
Dow Inc.	2024	0,02	0,07	0,03	0,13	0,68
Dow Inc.	2023	0,01	0,03	0,01	0,12	0,67
Dow Inc.	2022	0,08	0,22	0,08	0,16	0,58
Dow Inc.	2021	0,10	0,34	0,12	0,23	0,62
Dow Inc.	2020	0,02	0,10	0,03	0,15	0,62
ARKEMA	2024	0,04	0,08	0,06	0,16	0,84
BASF	2024	0,02	0,04	0,02	0,10	0,75
BASF	2023	0,00	0,01	0,00	0,10	0,75
BASF	2022	-0,01	-0,02	-0,01	0,12	0,75
BASF	2021	0,06	0,13	0,07	0,14	0,72
BASF	2020	-0,01	-0,03	-0,02	0,11	0,72
COVESTRO	2024	-0,02	-0,04	-0,02	0,08	0,71
WACKER	2024	0,03	0,05	0,05	0,13	0,77
WACKER	2023	0,04	0,07	0,05	0,13	0,73
WACKER	2022	0,14	0,25	0,16	0,25	0,80
WACKER	2021	0,10	0,27	0,13	0,25	0,75
WACKER	2020	0,03	0,12	0,04	0,14	0,75
Celanese	2024	-0,07	-0,27	-0,15	0,23	0,85

Table 4: Data set for Regression Test Ecovadis

5.2.1 Regression Test EcoVadis

In order to examine if there is a statistically significant relationship between ROA and ESG scores, we run a regression test at a 95% confidence interval. Our F-test has the following two hypotheses:

Our F-test has the following two hypotheses:

H0: $b_1=b_2=...b_k=0$ (There is no linear relationship between the dependent variable ROA and the independent variables ROE, Net profit margin ratio, EBITDA margin ratio and Ecovadis ESG score.)

H1: At least one $b_j \neq 0$, $j=1,2,...,k$ (There is linear relationship between the dependent variable ROA and the independent variables ROE, Net profit margin ratio, EBITDA margin ratio and Ecovadis ESG score.)

The results we got are the following:

SUMMARY OUTPUT	
<i>Regression Statistics</i>	
Multiple R	0,9912
R Square	0,9825
Adjusted R Square	0,9771
Standard Error	0,0075
Observations	18

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	4	0,041	0,010	182,332	0,000
Residual	13	0,001	0,000		
Total	17	0,041			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95,0%</i>	<i>Upper 95,0%</i>
Intercept	0,0085	0,0327	0,2603	0,7987	-0,0622	0,0793	-0,0622	0,079275
ROE	-0,0276	0,0855	-0,3226	0,7521	-0,2123	0,1571	-0,2123	0,157099
Net profit margin	0,6732	0,1496	4,4988	0,0006	0,3499	0,9965	0,3499	0,996466
EBITDA margin	0,2352	0,0509	4,6172	0,0005	0,1252	0,3452	0,1252	0,345248
EcoVadis Rating	-0,0482	0,0497	-0,9683	0,3506	-0,1556	0,0593	-0,1556	0,059284

Table 5: Regression Results 1

The above results declare that there is no significant relationship between the above-mentioned independent variables. We reject H₀ as p-value is, much lower than 0,05. The ESG coefficient is not statistically significant ($p = 0,35 > 0,05$)

The relevant diagrams are presented below.

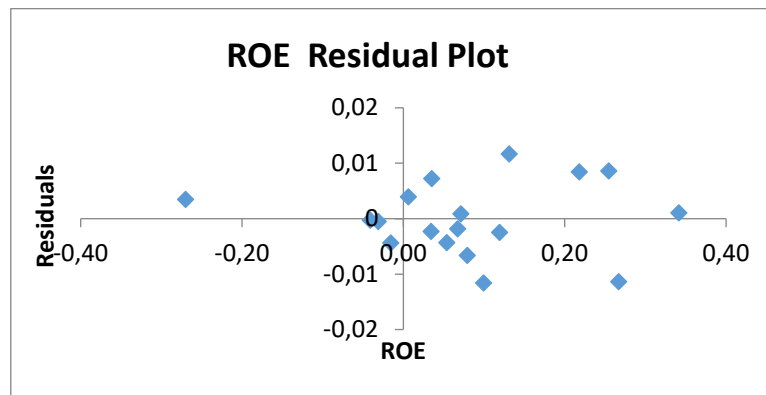


Figure 11:ROE Residual Plot for 1st Regression Test

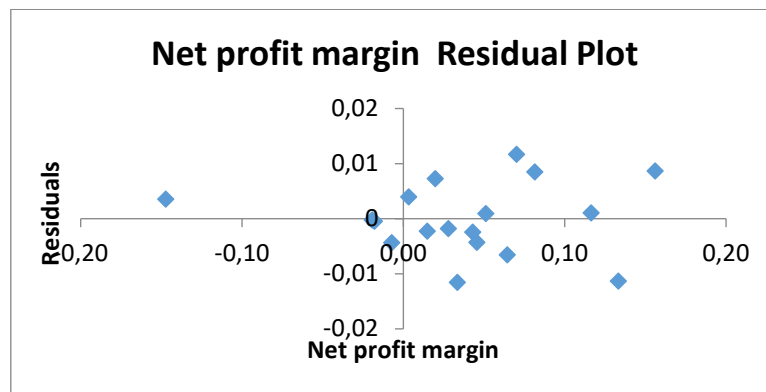


Figure 12:Net profit margin Residual Plot for 1st Regression Test

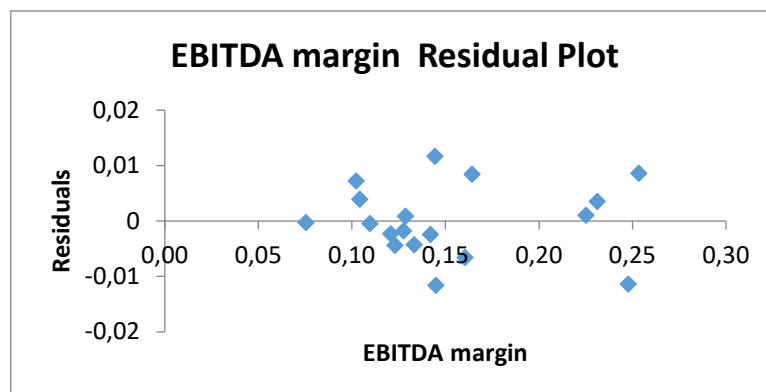


Figure 13:EBITDA margin Residual Plot for 1st Regression Test

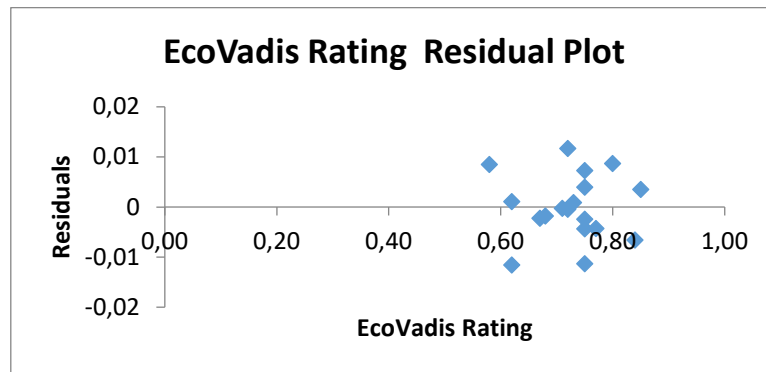


Figure 14:EcoVadis Rating Residual Plot for 1st Regression Test

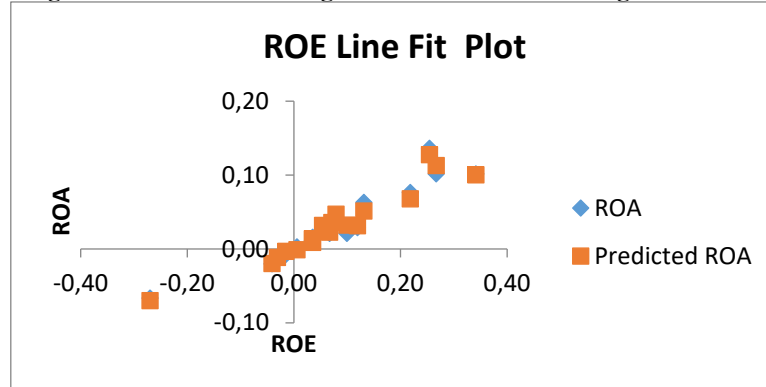


Figure 15:ROE Line Fit Plot for 1st Regression Test

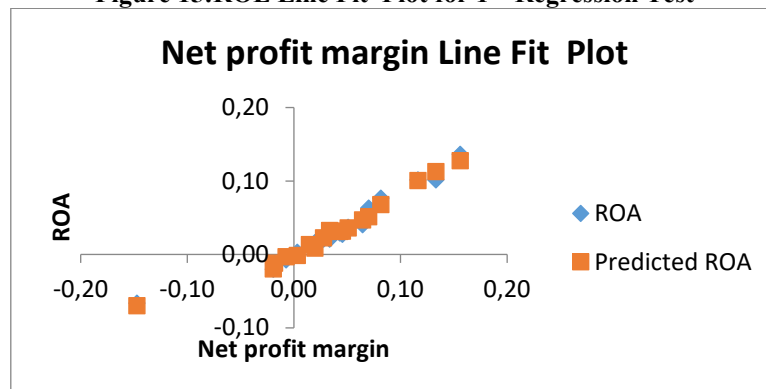


Figure 16:Net profit margin Line Fit Plot for 1st Regression Test

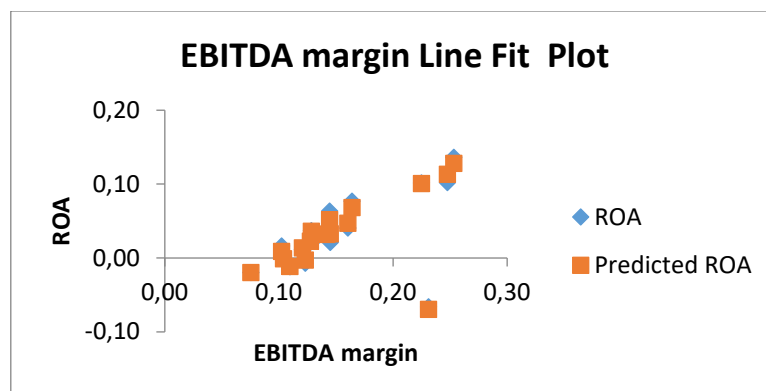


Figure 17:EBITDA margin Line Fit Plot for 1st Regression Test

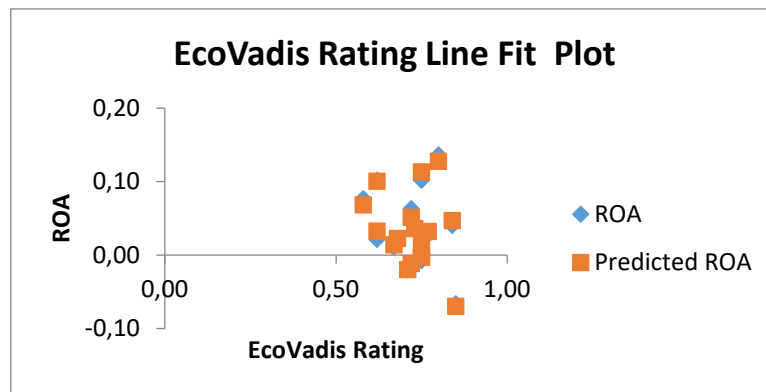


Figure 18:EcoVadis Rating Line Fit Plot for 1st Regression Test

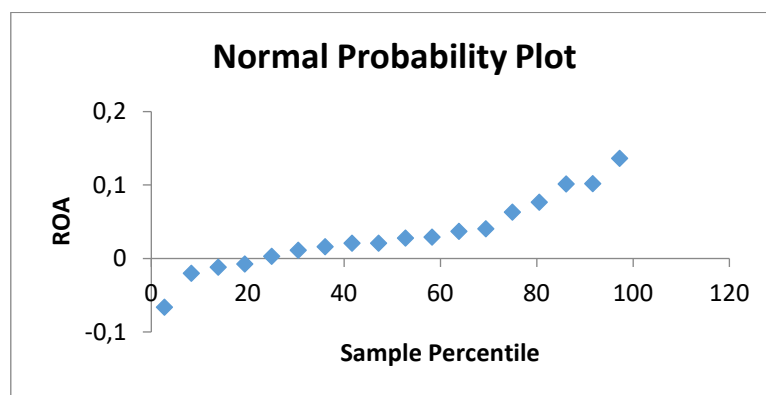


Figure 19:Normal Probability Plot for 1st Regression Test

5.2.2 Regression Test LSEG ESG Rates

In addition to the above regression test we performed an alternative approach where historical ESG data were unavailable. We retrieved baseline ESG scores for the year 2024 from the LSEG database. As LSEG does not publish historical numeric ESG scores by year for individual companies we followed methodology that LSEG states to calculate reasonably inferred scores, “*The new ESG scores are relatively stable over time, with the median ESG Score rising from 2.3 (2022) to 2.6 (2024) across large and mid-caps, with the most rapid improvements seen in China (+0.5), Japan (+0.4) and wider APAC (+0.3) markets.*” [Introducing the LSEG ESG Scores | Data Analytics](#)

For clarification we did not used Eco Vadis Score to calculate reasonably inferred scores as methodology followed were more complex.

Based on the above, below is presented the new database where LSEG Ratings for years 2020-2023 are reasonably inferred scores.

Company	Year	ROA	ROE	Net profit margin	EBITDA margin	LSEG Sustainability Ratings and Data
Dow Inc.	2024	0,02	0,07	0,03	0,13	0,82
Dow Inc.	2023	0,01	0,03	0,01	0,12	0,80
Dow Inc.	2022	0,08	0,22	0,08	0,16	0,76
Dow Inc.	2021	0,10	0,34	0,12	0,23	0,72
Dow Inc.	2020	0,02	0,10	0,03	0,15	0,68
ARKEMA	2024	0,04	0,08	0,06	0,16	0,72
ARKEMA	2023	0,04	0,09	0,07	0,16	0,70
ARKEMA	2022	0,09	0,16	0,10	0,18	0,66
ARKEMA	2021	0,07	0,14	0,09	0,18	0,62
ARKEMA	2020	0,04	0,07	0,05	0,15	0,58
BASF	2024	0,02	0,04	0,02	0,10	0,70
BASF	2023	0,00	0,01	0,00	0,10	0,68
BASF	2022	-0,01	-0,02	-0,01	0,12	0,64
BASF	2021	0,06	0,13	0,07	0,14	0,60
BASF	2020	-0,01	-0,03	-0,02	0,11	0,56
COVESTRO	2024	-0,02	-0,04	-0,02	0,08	0,60
COVESTRO	2023	-0,01	-0,03	-0,01	0,08	0,58
COVESTRO	2022	-0,02	-0,04	-0,02	0,09	0,54
COVESTRO	2021	0,10	0,21	0,10	0,19	0,50
COVESTRO	2020	0,04	0,08	0,04	0,14	0,46
WACKER	2024	0,03	0,05	0,05	0,13	0,70
WACKER	2023	0,04	0,07	0,05	0,13	0,68
WACKER	2022	0,14	0,25	0,16	0,25	0,64
WACKER	2021	0,10	0,27	0,13	0,25	0,60
WACKER	2020	0,03	0,12	0,04	0,14	0,56
LyondellBasell Industries N.V.	2024	0,04	0,11	0,03	0,09	0,78
LyondellBasell Industries N.V.	2023	0,06	0,16	0,05	0,11	0,76
LyondellBasell Industries N.V.	2022	0,11	0,31	0,08	0,12	0,72
LyondellBasell Industries N.V.	2021	0,15	0,47	0,12	0,19	0,68
LyondellBasell Industries N.V.	2020	0,04	0,18	0,05	0,12	0,64
Celanese	2024	-0,07	-0,27	-0,15	0,23	0,62

Celanese	2023	0,07	0,26	0,18	0,22	0,60
Celanese	2022	0,07	0,31	0,20	0,27	0,56
Celanese	2021	0,16	0,42	0,22	0,33	0,52
Celanese	2020	0,18	0,51	0,35	0,26	0,48

Table 6: Data set for Regression Test LSEG

To examine if there is a statistically significant relationship between ROA and ESG scores, we run a regression test at a 95% confidence interval. Our F-test has the following two hypotheses:

Our F-test has the following two hypotheses:

H0: $b_1=b_2=...b_k=0$ (There is no linear relationship between the dependent variable ROA and the independent variables ROE , Net profit margin ratio, Ebitda margin ratio and Total LSEG ESG score.)

H1: At least one $b_j \neq 0$, $j=1,2,...,k$ (There is no linear relationship between the dependent variable ROA and the independent variables ROE , Net profit margin ratio, Ebitda margin ratio and LSEG ESG score.)

SUMMARY OUTPUT	
<i>Regression Statistics</i>	
Multiple R	0,9627
R Square	0,9267
Adjusted R Square	0,9170
Standard Error	0,0161
Observations	35

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	4	0,0978	0,0245	94,8687	0,0000
Residual	30	0,0077	0,0003		
Total	34	0,1055			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95,0%</i>	<i>Upper 95,0%</i>
--	---------------------	-----------------------	---------------	----------------	------------------	------------------	--------------------	--------------------

Intercept	-0,0174	0,0256	-0,6827	0,5001	-0,0696	0,0347	-0,0696	0,0347
ROE	0,2720	0,0436	6,2312	0,0000	0,1828	0,3611	0,1828	0,3611
Net profit margin	0,0714	0,0885	0,8058	0,4267	-0,1095	0,2522	-0,1095	0,2522
EBITDA margin	0,1120	0,0632	1,7723	0,0865	-0,0171	0,2410	-0,0171	0,2410
LSEG Sustainability Ratings and Data	0,0136	0,0343	0,3953	0,6954	-0,0565	0,0836	-0,0565	0,0836

Table 7: Regression results 2

There is no statistically significant relationship between ESG scores and ROA at the 95% confidence level. We reject H0 as p-value is, much lower than 0,05. ESG p-value = 0,695 > 0,05.

Generally, the model is statistically significant although there is no evidence of a statistically significant relationship between ESG performance, as measured by the LSEG ESG score, and ROA at the 5% significance level.

The relevant diagrams are presented below:

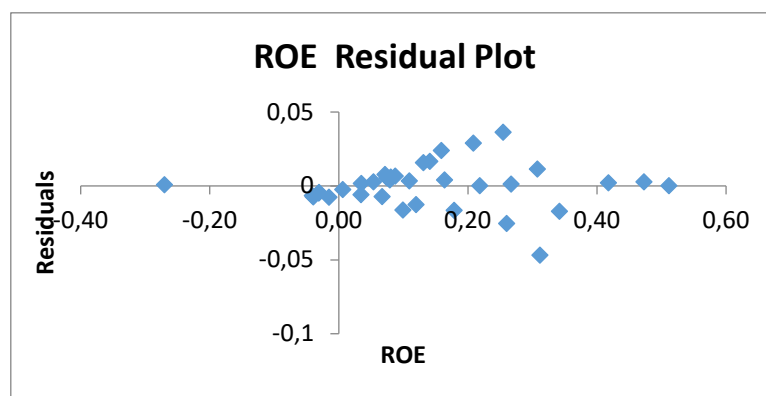


Figure 20: ROE Residual Plot for 2nd Regression Test

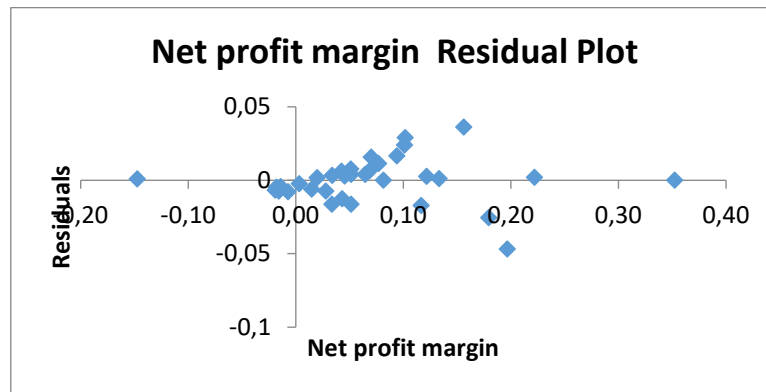


Figure 21:Net profit margin Residual Plot for 2nd Regression Test

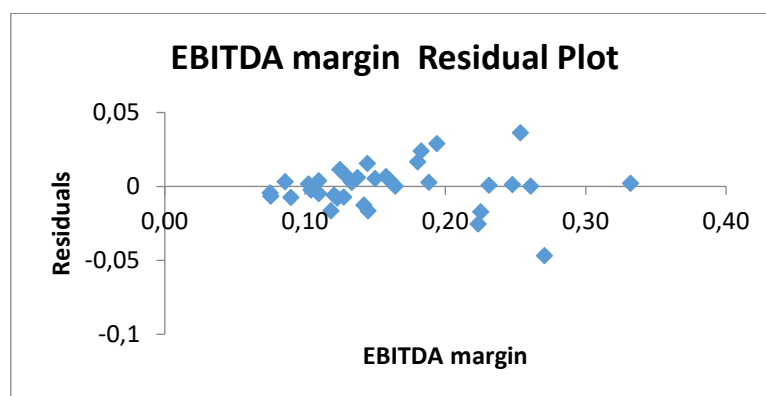


Figure 22:EBITDA margin Residual Plot for 2nd Regression Test

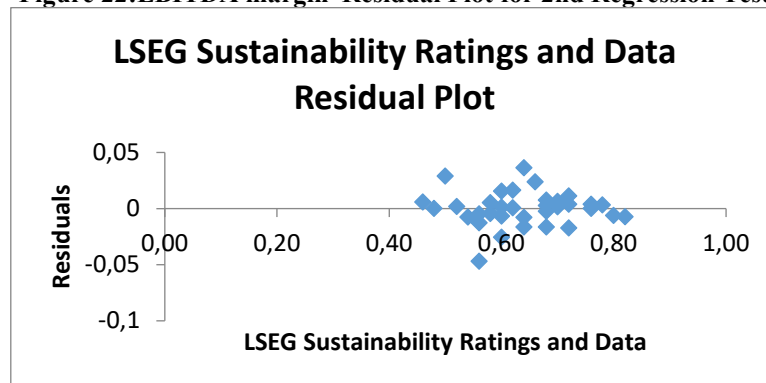


Figure 23:LSEG Sustainability Ratings and Data Residual Plot for 2nd Regression Test

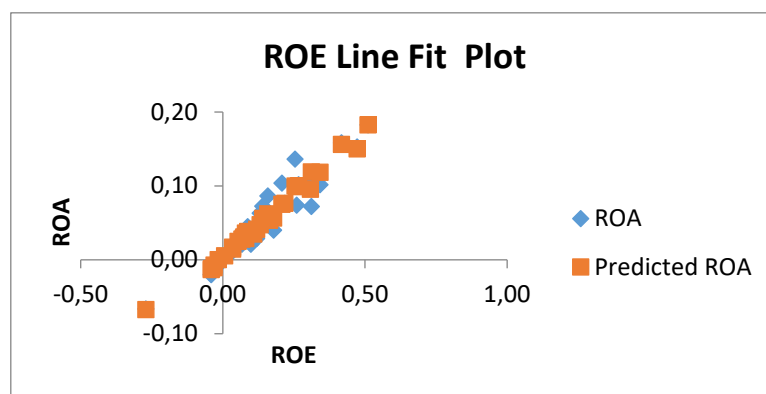


Figure 24:ROE Line Fit Plot for 2nd Regression Test

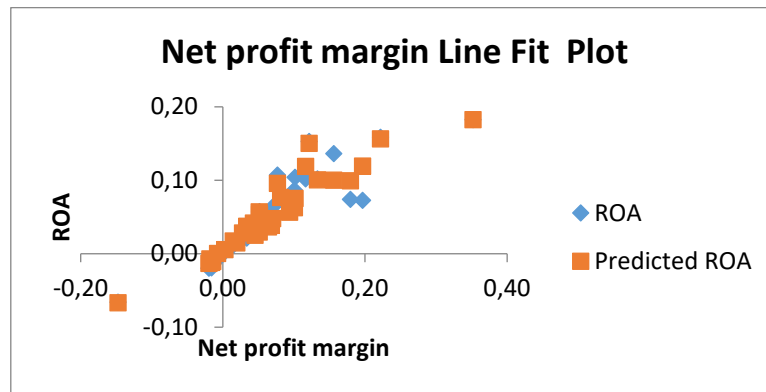


Figure 25:Net profit margin Line Fit Plot for 2nd Regression Test

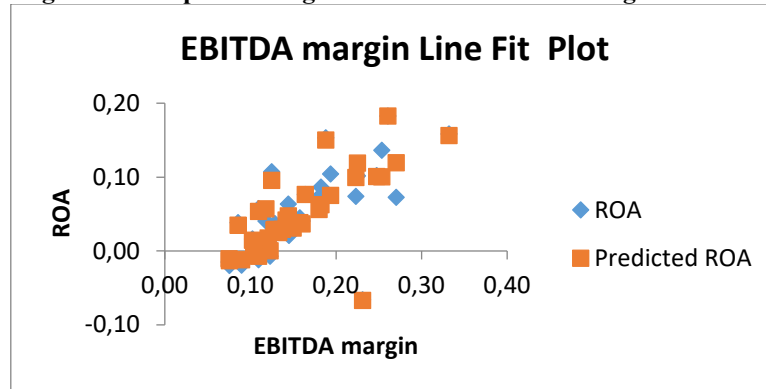


Figure 26:EBITDA margin Line Fit Plot for 2nd Regression Test

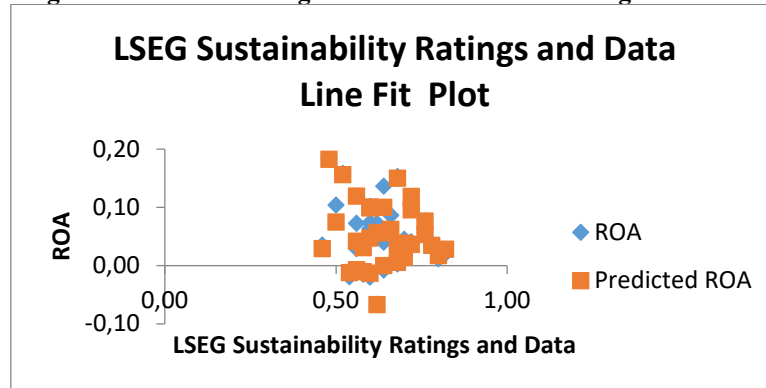


Figure 27:LSEG Sustainability Ratings and Data Line Fit Plot for 2nd Regression Test

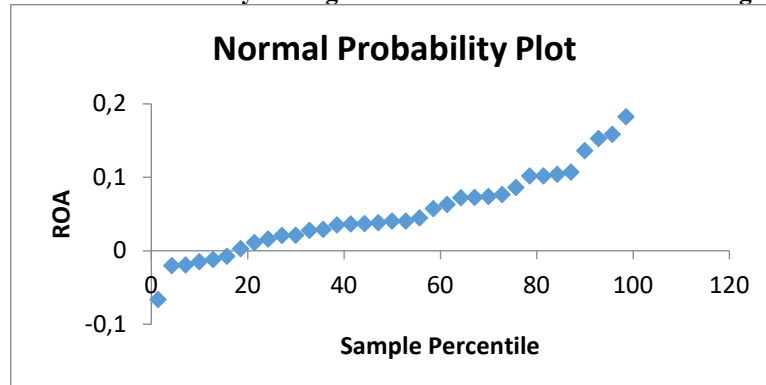


Figure 28:Normal Probability Plot for 2nd Regression Test

6. Conclusion

To sum up, this study examines the financial performance of major chemical companies during the period 2020–2024 and its relationship with ESG factors, highlighting several important findings. Firstly, we analyzed profitability cycle, with most financial ratios (ROA, ROE, net profit margin and EBITDA margin) to have a peak in 2021 and declining significantly from 2022 onward, mainly due to the energy crisis and weakening global demand. Secondly, the study demonstrates that the energy crisis had a direct and substantial negative impact on the chemical industry, primarily through rising natural gas and electricity costs, which increased production expenses and reduced competitiveness. This led to lower production volumes and decline of margins and in some cases even negative profitability indicators. Moreover, in the regression analysis, despite the growing importance of sustainability, the results show that no statistically significant relationship was found between ESG scores and financial performance (ROA), both when using EcoVadis and LSEG ESG ratings. Last but not least, the thesis highlights that while ESG does not appear to directly affect short-term profitability, it remains important for long-term resilience, risk management, and investor confidence, indicating that its value may be more strategic and forward-looking rather than immediately reflected in financial ratios. Investments aimed at decarbonization, biodiversity protection, and health & safety can affect companies' profitability.

6.1 Suggestions for Future Research

As ESG considerations become increasingly central to investment decisions and stakeholder expectations, future research should adopt a more analytical perspective to better understand the mechanisms through which ESG performance influences firm outcomes. One important direction concerns the temporal dimension of ESG impacts. Existing studies often focus on short-term financial indicators, potentially overlooking the fact that ESG initiatives typically involve substantial initial investments and delayed returns. Future research should therefore employ longitudinal and dynamic approaches to capture how ESG performance contributes to long-term value creation, firm resilience, and financial stability, rather than immediate profitability. This could include the analysis of lag effects and the identification of non-linear relationships between ESG engagement and financial performance.

Another promising avenue is the disaggregation of ESG components. While many studies rely on aggregate ESG scores, this approach may obscure the distinct effects of environmental, social, and governance factors. Future research could provide more nuanced insights by examining each dimension separately, allowing for the identification of which factors—such as decarbonization efforts, workplace safety, or governance quality—have the strongest and most consistent impact on financial performance. Such analysis is

particularly relevant for the chemical industry, where environmental risks and regulatory pressures may play a more prominent role compared to other sectors.

In addition, cross-country and regional comparative studies could significantly enhance understanding of ESG dynamics. Differences in regulatory frameworks, energy dependence, and market maturity across regions (e.g., the European Union, the United States, and Asia) are likely to influence both ESG adoption and its financial implications. Future research could explore how stricter environmental regulations or varying levels of reliance on fossil fuels shape corporate behavior and outcomes, thereby revealing whether ESG performance has a stronger financial impact in certain institutional contexts.

Furthermore, there is a clear need to investigate the link between ESG performance and capital market outcomes. While accounting-based indicators such as ROA and ROE are widely used, future studies could place greater emphasis on market-based measures, including stock returns, firm valuation (e.g., Tobin's Q), and cost of capital. This would help clarify how ESG performance is priced by investors and whether it contributes to enhanced market valuation or reduced financial risk.

Beyond these established directions, several additional areas merit attention. First, future research could examine the role of energy transitions and resource dependency, particularly in energy-intensive industries such as chemicals. Understanding how exposure to energy price volatility or reliance on fossil fuels interacts with ESG performance may provide deeper insights into firm risk profiles. Second, there is scope to explore the impact of innovation and technological change, including green chemistry and digitalization, as potential mediators between ESG strategies and financial performance.

Finally, methodological advancements could strengthen the robustness of future studies. The use of advanced econometric techniques, such as panel data models, causal inference methods, or machine learning approaches, would help address issues of endogeneity and improve the reliability of findings. Complementing quantitative analysis with qualitative research, such as case studies or interviews, could also provide valuable insights into how ESG strategies are implemented in practice and how they influence managerial decision-making.

Overall, future research should move toward a more integrated and context-sensitive framework, combining different performance measures, methodological tools, and industry-specific considerations to better understand the strategic significance of ESG in driving long-term corporate performance.

Bibliography

1. BASF SE. (2025). Chemical industry. In BASF Report 2024. <https://report.basf.com/2024/en/combined-managements-report/fundamentals-of-the-group/basf-groups-business-year/economic-environment/chemical-industry.html>
2. BASF SE. (2025). BASF SE 2024 sustainability report. BASF. <https://report.basf.com>
3. Chemical Industry Insights. (n.d.). Chemical industry sustainability challenges ESG reporting.
4. Dow Inc. (n.d.). Corporate governance. <https://corporate.dow.com>
5. Emerald Publishing. (n.d.). Enhancing ESG integration in corporate strategy: A bibliometric study and content analysis. *International Journal of Law and Management*.
6. EurekAlert! (n.d.). Doing good pays off: Environmentally and socially responsible companies drive value and market efficiency.
7. European Commission, Eurostat. (2025). Development of electricity prices for non-household consumers, EU, 2008–2025 [Graph]. http://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Development_of_electricity_prices_for_non-household_consumers,_EU,_2008-2025_.png
8. Harvard Business School. (n.d.). Creating shared value. <https://www.hbs.edu/faculty/Pages/item.aspx?num=39071>
9. International Energy Agency. (n.d.). Evolution of key regional natural gas prices, June 2021–October 2022.
10. International Energy Agency. (n.d.). Global energy crisis. <https://www.iea.org/topics>
11. LyondellBasell Industries. (n.d.). Investors. <https://investors.lyondellbasell.com/overview/default.aspx>
12. MarketLine. (2025). Chemicals global industry almanac 2020–2029. MarketLine.
13. McKinsey & Company. (n.d.). Sustainability value in chemicals: Market tailwinds versus ESG scores.
14. Nexdigm. (n.d.). Sustainability benchmarking chemicals industry: Chemical ESG analysis, sustainability KPIs, competitive benchmarking, ESG and carbon reduction analysis, market insights, market share key players.
15. NYU Stern Center for Sustainable Business & Rockefeller Asset Management. (2021). ESG and financial performance: Uncovering the relationship by aggregating evidence from 1,000-plus studies.
16. PLOS ONE. (n.d.). From responsibility to value: ESG and long-term corporate value.
17. Porter, M. E., & Kramer, M. R. (2011). Creating shared value. *Harvard Business Review*, 89(1–2), 62–77.
18. PwC. (n.d.). Companies failing to act on ESG issues risk losing investors, finds new PwC survey.
19. ResearchGate. (2025). A study of literature review on financial performance of selected listed chemical companies with reference to EVA and MVA.
20. SAGE Journals. (2025). Article available at <https://journals.sagepub.com/doi/10.1177/21582440251381772>
21. ScienceDirect. (n.d.). Legitimacy theory. <https://www.sciencedirect.com/topics/social-sciences/legitimacy-theory>

22. Stock Analysis. (n.d.). Stock Analysis: Free online stock information for investors. <https://stockanalysis.com>
23. The Council of the European Union. (n.d.). EU sanctions against Russia.
24. The Council of the European Union. (2026). Where does the EU's gas come from?
25. The Sustainability Report. (n.d.). ESG reporting frameworks & standards: A complete guide.
26. Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, 5(2), 171–180.
27. World Economic Forum. (n.d.). The future of ESG investing.
28. Global chemical industry outlook, 2024. (2024).
29. TandF Online figure. (2015). <https://www.tandfonline.com/doi/figure/10.1080/20430795.2015.1118917>
30. Stakeholder theory. (n.d.). <http://stakeholdertheory.org/about/>

Author's Statement:

I hereby declare that, in accordance with article 8 of Law 1599/1986 and article 2.4.6 par. 3 of Law 1256/1982, this thesis/dissertation is solely a product of personal work and does not infringe any intellectual property rights of third parties and is not the product of a partial or total plagiarism, and the sources used are strictly limited to the bibliographic references.