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AN INVESTORS PERSPECTIVE: CAN AN ESG AWARE INVESTOR ACHIEVE AB-NORMAL RETUNS ON THE STOCK MARKET?
THE CASE OF THE CHEMICAL INDUSTRY

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Abstract

This thesis analyzes the impact of ESG performance on stock returns in capital markets. Datasets of globally listed companies in the chemical industries are considered. Portfolios with the best (worst) ranked companies in terms of ESG are constructed. The results of four multiple regression models show no significant results for portfolios composed of the best ESG companies in any of the considered industries. Portfolios consisting of the lowest-rated chemical companies generate significantly positive abnormal returns.

Keywords: ESG, Sustainable Finance, Investment Approach, Stock Returns

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Content

1 Introduction

The concept of ESG investing refers to the inclusion of environmental, social, and governance aspects within the investment decision of responsible investors. This represents an entirely new and fast-growing investment approach in which companies are evaluated beyond their profitability. BlackRock (2020) categorizes climate risk as major investment risk incorporating the impact of the climate change. Rating agencies have been developing scores that not only consider the environmental impact of companies but also the influence on society. These developments demonstrate the strong interest of the investment industry in this newly formed sector, as it continues to gain momentum through opening opportunities. Additionally, literature has extensively studied the implications for arising ESG issues on investment decision making.

Although this topic is of great importance to numerous actors in the financial industry, such as asset and fund managers, institutional investors, and conscious private investors, the effects on investment performance is not yet fully discovered. Latest research suggests a dynamic relationship between ESG scores and stock performance, resulting in increased stock performance for European companies that engage in ESG measures and disclose their reports (Ye, Song, and Liang 2022). In contrast, most Asian markets do not reward companies with strong corporate social responsibility practices through better stock performance (Yen, Shiu, and Wang 2019). Not only different perceptions in the capital market, but also regulations and the exposure of different industries to ESG are relevant. While literature revealed geographical differences, there is limited research focusing on specific industries on a global level. As geographic boundaries in many industries are disappearing due to globalization, a more holistic perspective is beneficial for investors.

To unfold the potential of ESG performance on stock performance from an international perspective, this thesis investigates effects on stock returns within the global automotive, chemical, apparel manufacturers and retailers, and utilities industry.

First, the concept of ESG is introduced and presented within an investment context. Then, investment approaches are highlighted and theoretical foundations in the investment context are presented. The analysis subsequently focuses on stock returns of high and low ESG performing companies across four different global industries. In addition, the impact of individual pillars environment, social, and governance are described in more detail. Afterwards, the results are presented and discussed. Finally, the findings of this thesis are summarized, and limitations are stated before an outlook to further research is given.

2 Background

This chapter discusses the concept of ESG and further investigates sustainability in an investing context. Therefore, different approaches to the dimensions of ESG establish a fundamental understanding for the subject and its significance in the context of the capital market. Based on a theoretical foundation of ESG in the investment context, hypotheses are then developed.

2.1 Concept of Sustainability and ESG

As a basis for the analysis and to gain a common understanding of sustainability and ESG, the terms need to be discussed and definitions derived. In literature, there is no uniform definition of the term “sustainability” yet. The most universal and globally known understanding goes back to the Brundtland Report of the United Nations in 1987, where sustainable development “meets the needs of the present without compromising the ability of future generations to meet their own needs“ (WECD 1987). Ultimately, it is about responsibly meeting current needs without risking that future generations will not be able to meet theirs. While this suggests sacrifices and trade-offs in terms of environmental actions and resource allocation, sustainability also includes the social and economic dimensions. Accordingly, sustainability consists of three pillars: Environmental, Social and Economic, which are also known as the Triple Bottom Line, as established by Elkington (1998). This emphasizes the importance of social and environmental

goals within any organizations, however only if they amount to the economic goals of a company and ensure long-term survival in the market.

In this context another framework has evolved, that helps understand and measure the degree of sustainability within a company's operations. With growing awareness about environmental (e.g., global warming, loss of biodiversity) and social (e.g., human rights) issues, stakeholder pressure and objections are increasing. From this need, the term ESG has evolved, referring to the three interrelated and interdependent dimensions environment (E), social (S), and governance (G). The OECD (2020, 6) has defined ESG as "an approach that seeks to incorporate environmental, social, and governance factors into asset allocation and risk decisions, so as to generate sustainable, long-term financial returns". Therefore, ESG presents a specific set of criteria in a broader sense than sustainability, as the governance perspective extends to business ethics, stakeholder diversity, and community engagement, among others.

2.1.1 Development of the term ESG

While the term ESG became prominent only within the last decade, the concept is not new but has gradually evolved over time. In the 1970s with the passing of the Occupational Safety and Health (OSH) Act in the United States, the focus on environment, health, and safety in the workplace began (Clark 1999). The aim was to reduce negative externalities on nature and communities, as well as establishing labor and safety standards for all workers. As this developed further, Corporate Social Responsibility (CSR) appeared in the early 2000s. Within that concept, the social perspective is added distinctively while also going beyond legal expectations and compliance (European Commission 2001). Through this voluntary, self-regulated characteristic, sustainable, and responsible actions became much more proactive rather than reactive within an organization's environment. This is also expressed through corporate philanthropy,

such as financial contributions and long-term partnerships with NGOs or employee volunteering. When this was not sufficient for the increasing stakeholder demands, ESG practices expanded as a more quantitative and externally regulated concept.

The updated view on sustainability also included measurable goals within all three dimensions which could even be supported through external audits. Sets of specific KPIs allow for transparency for all stakeholders, simplified comparability within industries, investments and finally compliance with upcoming legislature around sustainability. Indicating the importance of sustainability, ESG created a momentum within organizations. With environmental and social issues presenting some of the most difficult challenges of the decade, particularly investors recognize and value ESG as a key area of focus. This is also reflected in the all-time high of USD 650bn being invested in ESG-focused funds worldwide in 2021, now accounting for 10 % of worldwide fund assets (Kerber and Jessop 2021).

Due to open markets, technologies, regions, policies, and industries there is a dynamic and open approach to ESG. Several ESG categorization schemes have been developed in literature, with the structure of Dimson, Karakaş, and Li (2015) being considered meaningful. Therefore, the following ESG framework with the pillars environment, social, and governance is derived from the author's work. Further adaptations to this are inspired by the CFA Institute (2015), to provide a list of standard ESG criteria. All three ESG components will be explored in-depth with the respective sub-levels in Figure 1 and their implications for an organizations' performance through measurable KPIs. Keeping in mind that the three dimensions are interconnected and interdependent, some indicators refer to more than one dimension and are therefore difficult to categorize.

ENVIRONMENT	SOCIAL	GOVERNANCE
Climate Change	**Human Rights**	**Corporate Governance**
Emission accounting and reporting	Child and forced labor	Audit and control
Climate change strategy	Community relations	Board composition
Ecosystem Service	Privacy and free expression	Shareholder rights
Access to land	Security	Executive compensation
Biodiversity management	**Labor Standards**	Tax transparency
Water and waste water management	Diversity	Leadership
Environmental Mangement	Inclusion	**Business Ethics**
Pollution control	Health and Safety	Bribery and corruption
Waste and recycling	Supply chain labor standards	Political influence
Supply chain environmental standards	**Product and Consumer Responsibility**	Lobbying
Product opportunities	Product safety	Responsible marketing
Environmental standards	**Society**	Whistle-blowing system
	Charity	**Sustainable mangagement and reporting**
	Education	Disclosure and reporting
	Employment	Governance of sustainability issues

Figure 1: ESG pillars with sub-levels

2.1.2 Environment

The environmental dimension focuses on an organizations effort to minimize its negative impact on nature. Environmental disclosure, according to Burritt, Hahn, and Schaltegger (2002), entails both qualitative and quantitative data that estimates the effects on environment through a company's operations. Focusing on the use of natural resources and negative environmental externalities, reporting also reflects positive sustainability impacts which translate into a long-term business advantage.

In line with the current public responses to the urgency of climate change, the environmental aspect of ESG plays a significant role in the adoption of ESG the economy. Chen and Yang (2020) researched the asymmetric response of investors on ESG disclosure and found that investors overreact to the environmental dimension more than to social or governance factors. With environmental factors being particularly prominent within the ESG framework, the three sub-categories climate change, ecosystem service, and environmental management can be further explored. One of the most important and consequently most reported indicators is emission accounting and reporting, with focus on greenhouse gases. Other key performance indicators are waste amounts and recycling rates, wastewater management and pollution control. Many of

the environmental performance indicators are tangible and quantifiable, setting standards-based and performance-oriented measurements enabling comparability within industries. The indicators can predominantly be applied universally to all industries. Nevertheless, there are some industry-specific environmental issues which need to be evaluated separately, such as biohazards in the medical field or flaring in oil and gas.

2.1.3 Social

The social dimension focuses on the impact and issues around human rights, labor, product safety and quality and workplace health and safety. Over the past two decades, the scope of the social dimension has progressively widened, incorporating impacts of modern supply chain systems and technology adoption. The focus lies on the impact and issues around human rights, labor, product safety and quality, and workplace health and safety. Over the past two decades, the scope of the social dimension was constantly expanded, incorporating impacts of modern supply chain systems and technology adoption. With relationships to employees, community members and financial stakeholders in the focus, Neilan et al. (2020) even suggest that the term ‘stakeholder’ instead of ‘social’ dimension would be more appropriate. Social practices within organizations are often also considered reflecting workplace culture and characteristics like strong bonds and shared values.

The social dimension can be divided into four sub-categories: human rights, labor standards, product and consumer responsibility, and society. Human rights cover child and forced labor malpractice and policies and guidelines for prevention, especially towards suppliers and along the supply chain, community relations, privacy and freedom of expression and security. Diversity and inclusion within the workplace and health and safety standards are addressed within labor standards. Finally, society is all about the community an organization operates in and includes charity, education and employment opportunities. Baier, Berninger, and Kiesel (2020) found “diversity” to be the most reported issues within the social dimension, which is in line

with current discussions about diversity requirements and the findings that diversity is believed to be one of the most important components of a successful board structure (Hartmann and Carmenate 2021). Nevertheless, there are gaps when it comes to quantifying, measuring and reporting the social dimension within organizations, making it difficult to deal with stakeholder expectations. A major challenge is the complex and intangible nature of social phenomena, resulting in a lack of comparable metrics and consistent standards. Many social performance enhancing initiatives are only likely to pay off in the longer-term (O'connor and Labowitz 2017). Besides those issues in the social dimension, it is a not less important aspect of ESG.

2.1.4 Governance

With governance as a well-researched area of study, many definitions of governance have derived. Brickley and Zimmermann (2010, 236) put it in broad terms as "the system of laws, regulations, institutions, markets, contracts, and corporate policies and procedures (such as the internal control system, policy manuals, and budgets) that direct and influence the actions of the top-level decision makers in the corporation (shareholders, boards, and executives)". Brennan and Solomon (2008) include the perspective of accountability towards all stakeholders and socially responsible actions throughout all business areas. Ultimately, the governance dimension is about accountability and transparency and therefore a vital basis for environmental and social criteria.

Baier, Berninger, and Kiesel (2020) found that 88.9 % of ESG words in financial reports are governance related, with the strongest category of "corporate governance" addressing shareholder-related subcategories. Therefore, the governance pillar is the one which is already integrated to a higher degree into a company's reporting, compared the social or environmental aspects. It can be explained by mandatory reporting requirements and regulations, with many countries having corporate disclosure codes, laws or stock exchange rules (Inderst and Stewart

2018). These often include governance related metrics like board structure, executive compensation, and director independence. Since some indicators are already part of financial statements, information collection, processing, and disclosure for governance criteria is easier accessible to many organizations.

The developed framework shows the three sub-levels corporate governance, business ethics, and sustainable management and reporting. Derivable KPIs are variable compensation factor, independence of board composition and diversity in corporate bodies.

2.2 Sustainability in the context of investing

Following the classification and definition of ESG, this chapter describes and derives the relationship between ESG and investing from an investor's perspective. Firstly, the main drivers will be highlighted, and then the individual investment strategies will be presented and differentiated. Finally, metrics and investment vehicles are shown in the context of sustainable investing.

2.2.1 Main drivers for sustainable investing

With the importance of ESG and sustainability in today's economy and its impact in global focus, it also expands to the world of finance. Sustainable investing is defined as "a range of practices in which investors aim to achieve financial returns while promoting long-term environmental or social value" (Stobierski 2022, 2). It should be understood as an investment decision based on ESG influenced by all three dimensions (Silvola and Landau 2021a; Global Sustainable Investment Alliance 2018; Talan and Sharma 2019). There are three main drivers that can be identified and are responsible for shaping the relevance of sustainable investing: purpose, regulation, and performance.

As previously described, sustainability is a structural force that is causing a rising awareness for environmental protection, climate change, and social responsibility. This shift in mindset is

also changing the way investors make investment decisions. In addition to achieving a financial return, many of today's investors strive to promote long-term environmental or social value – a purpose. To align with investors ethics, sustainable objectives are integrated into the entire investment process from the mission onward.

The second driver, which is currently also gaining the most momentum, is regulation. The push for that originated in political visions, expressed for example through the 17 Sustainable Development Goals (SDGs) set by the United Nations as part of the Paris Agreement with the goal of ending poverty, protecting the planet, and ensuring peace and prosperity until 2030 (United Nations 2015). According to SDG Impact (2018) these ambitions will need between USD 5tn and 7tn of investments per year by governments, agencies, and the private sector's assets. While this is a more general approach, it still signals a political push towards sustainable investments. More recently, regulations are shifting towards concrete legislation and efforts that incorporate sustainability transparently into investment information and decision making. A pioneer for this is the European Union with the regulation EU 2020/852 ("EU Taxonomy"). The goal is to establish a common understanding of sustainability to determine whether an economic activity can be considered sustainable or not (Bengo, Boni, and Sancino 2022). Thereby, investors can benefit from standardization which creates security for investors and protects them from greenwashing (European Commission 2020).

The third driver comes from the proven performance increase when integrating an ESG approach into the classical investment approach. Comparing the results of various studies, most literature concludes positive and significant results. J.P. Morgan (2016) also finds a high degree of overlap when considering the impact on total price returns. Caused by different methods and observation scopes, it is not possible to draw a generalized conclusion since several other results in literature show either no significant relationship, or a negative and significant relationship (Giannopoulos et al. 2022; Hvidkjær 2017; Boffo and R. Patalano 2020a). However, based on

the majority of research, ESG should be important for all types of rational investors to fulfill their fiduciary duties and better align their interests with the broader goals of society (Friede, Busch, and Bassen 2015).

With this broader understanding a more comprehensive analysis is needed to make better investment decisions (Stobierski 2022). Therefore, the traditional investment criteria profitability, liquidity, and security are extended by an additional criterion, sustainability, as shown in Figure 2 according to Bruns and Meyer-Bullerdiek (2020):

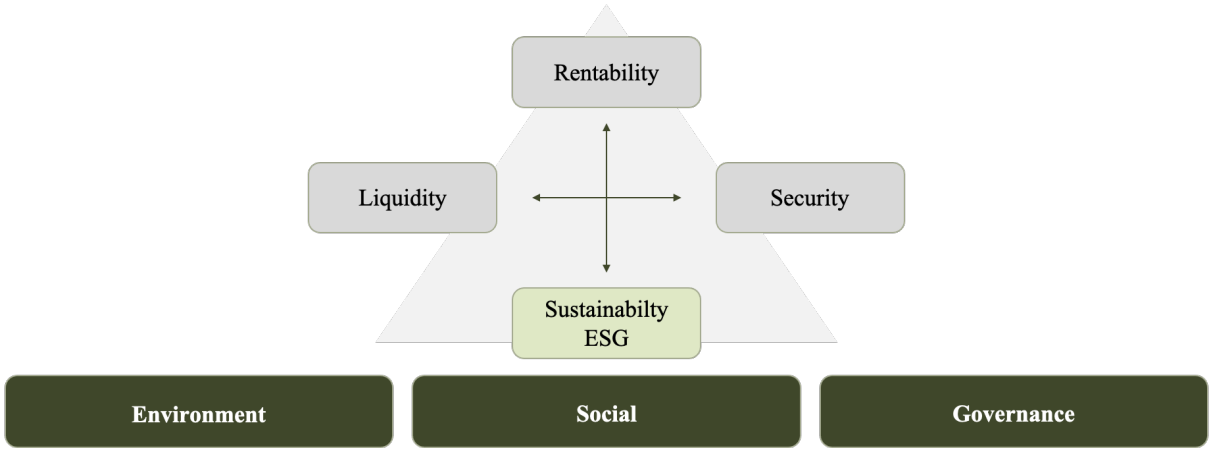

Figure 2: Magic triangle of investments extended by ESG criteria

2.2.2 Investment strategies

An investment strategy supports individual investors in achieving their financial aspirations. Investment strategies are always based on individual preferences, risk tolerance, and available capital. Sustainability can be included in the development of an investment strategy through various methods.

Sustainable investments contemplate multiple approaches, referring to “socially responsible investing” (SRI), “ESG investing”, and “impact investing” that often are used synonymously (Caplan, Griswold, and Jarvis 2013). Since all investment approaches refer to the three ESG factors and include them as a fundamental influence, the separation is further complicated. The

various approaches combine different strategies shown in Figure 3, which form the foundation for investment decisions.

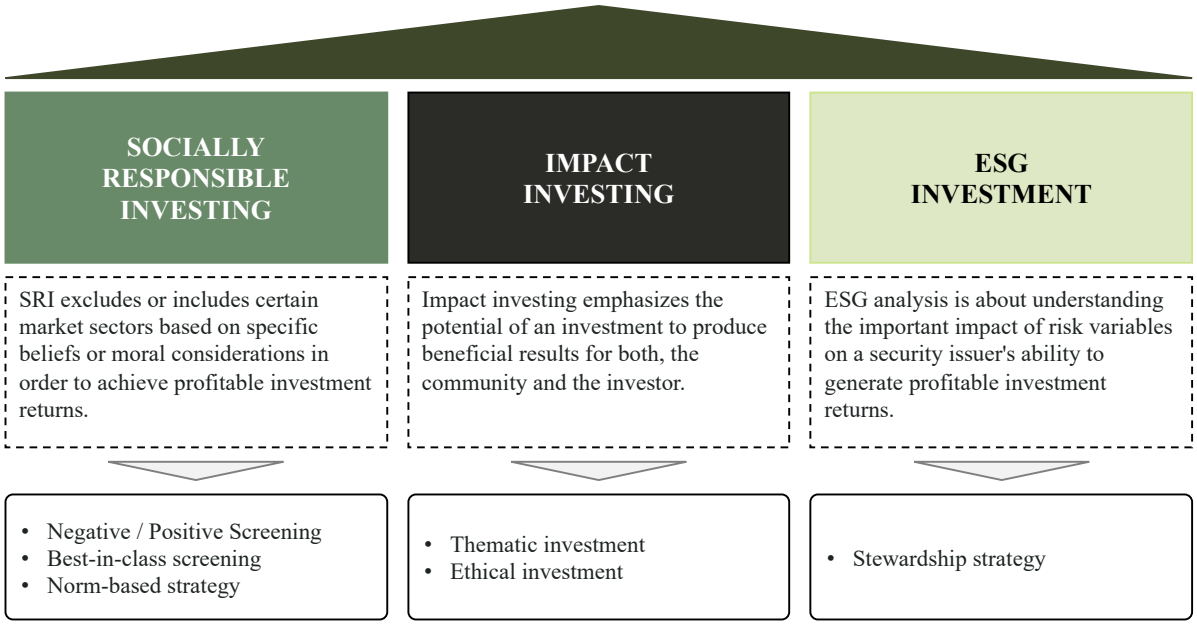

Figure 3: The three different sustainable investment approaches

(Based on Breckinridge Capital Advisors 2022)

Socially responsible investing

In the process of SRI an investor includes or excludes specific stocks from their portfolio premised on individual values and moral considerations, known as positive and negative screening (Nakajima 2021; Caplan, Griswold, and Jarvis 2013). Negative screening represents the simplest of selection strategies for sustainable investments. Thereby, an investor excludes specific shares or securities from their portfolio at their own discretion. Commonly, companies associated with “weapons, nuclear power, child labor, alcohol, tobacco and gambling are excluded from the portfolio” (Nakajima 2021, 6). However, no clear distinction is made on either the company itself or the company's environment with its suppliers and retailers should be excluded (Häßler and Wilhelm 2017; Silvola and Landau 2021; Inderst and Stewart 2018). Today, companies are increasingly turning away from negative screening. Additional characteristics are

sought that include other criteria that allow for deeper and more specific selection of portfolio companies (Caplan, Griswold, and Jarvis 2013).

Negative screening is contrasted with positive/best-in-class and norm-referenced screening. Positive/best-in-class screening involves investing in sectors, companies or projects attributed to their positive ESG performance relative to peers across all industries. Although companies with positive ESG performance are expected to have excellent financial performance in the medium to long term, the number of companies eligible for investment is comparably small (Louche, Arenas, and van Cranenburgh 2012; Inderst and Stewart 2018).

The norm-based strategy reviews investments against minimum standards of business practices based on international norms issued by the Organization for Economic Cooperation and Development, the International Labor Organization, the United Nations, and the United Nations Children's Fund. The United Nations Global Compact, officially launched in 2000, represents international standards. It provides wider investment scope than the positive/best-in-class screening and is mainly used in Europe (Nakajima 2021).

Impact Investment

Impact investments focus on tangible social benefits, thereby complementing the approach of SRI. The aim is to help organizations to generate positive, measurable social and environmental impact in addition to financial return (Barber, Morse, and Yasuda 2021). Efforts are directed to balance economic and social benefits, with different weightings. Therefore, the financial aspect is not the sole purpose and investments do not have to generate high returns (Louche, Arenas, and van Cranenburgh 2012; Caplan, Griswold, and Jarvis 2013).

Besides SRI strategies primarily that are focused on constructing investment portfolios by including or excluding various criteria, a thematic investment strategy can be applied. Consequently, portfolios are constructed by investing in topics or assets that are directly related to the promotion of sustainable development and have an ESG connection. For example, investments

in renewable energy generation assets, green technologies, sustainable education, culture or social projects are recognized (Häßler and Wilhelm 2017; Nakajima 2021). Additionally, impact investing incorporates ethical investing, based on moral and ethical principles and values of the investor, which may include religious beliefs (Michelson et al. 2004).

ESG investment

The ESG investment approach explores how a company's performance is impacted by the three factors E, S, and G (Caplan, Griswold, and Jarvis 2013). Thus, ESG analysis materializes the impact of risk factors on financial health of a security issuer and its ability to generate positive investment returns. Despite the often-synonymous use, ESG investments form a broader approach pursuing profits (He, Liu, and Hamori 2021; Nakajima 2021).

The literature stresses the importance of combining traditional investment approaches with ESG insights. Governance is also included in this perception but is not clearly and specifically defined and delimited (Official Journal of the European Union 2019a; Messini et al. 2020). Nevertheless, investors should pay attention to good governance practices according to the precautionary principle (Official Journal of the European Union 2019; Global Sustainable Investment Alliance 2018). As part of the ESG investment approach, the stewardship engagement strategy describes the dialogue on ESG issues between stock issuers and investors, through ownership and "say-on-pay" rights. By addressing perceived shortcomings in sustainability performance, investors aim to contribute to their elimination (Inderst and Stewart 2018; Häßler and Wilhelm 2017; Nakajima 2021).

Concluding, sustainable investing can be seen as an umbrella and ESG as a data toolkit to identify solutions (BlackRock 2022). Thus, this thesis builds on the broader understanding that ESG investments aim for returns, financially, socially, and environmentally, showing a significant difference to traditional investments.

2.2.3 ESG Analysis Tools

For investors, ESG information of individual companies is difficult to understand and evaluate. Since it often cannot be classified in regulatory terms, helpful metrics from established independent agencies can be used as a tool (Busch, Bauer, and Orlitzky 2016). The most popular tool for quantifying ESG data, are ESG ratings which consolidate different ESG risks into a single number (Boffo and Patalano 2020). Based on ESG scores, investors can better compare investment products, make more informed decisions, and derive actions from them.

Relevant criteria are specified and reviewed for each of the three pillars, E, S, and G, during ESG score assessment procedures. For example, a bad environmental record leaves a corporation more exposed to fines and lawsuits, lowering the E score. Many staff absence days might have a negative influence on the S score since it reflects poor employee treatment. The G score considers elements such as wage differences that cannot be traced and fraud (Boffo and R. Patalano 2020). These factors are combined to provide several sub-metrics that can be allocated to one of the three pillars. The ESG score is then calculated by combining the individual subscores.

Determining which data is included in the rating, how the individual metrics are weighted, and how comparable the scores are between different industries resides with the individual rating providers (Bloomberg 2020; MSCI 2022; Sustainalytics 2022). Currently, rating agencies and the ESG ratings they produce, are in a transitional phase. This is due to ratings becoming more and more comparable with each other, but not yet being completely substitutable (Boffo and Patalano 2020). Among the most well-known and relevant providers at present are Bloomberg, Refinitiv, Thomson Reuters, MSCI and Sustainalytics. Despite different indicators being used to determine ESG scores, the focus for rating agencies and investors is on identifying the companies with the highest ESG compliance.

Other ESG indicators are ESG or SRI indices. These use comparative models that compare the performance of SRI portfolios to either conventional portfolios or market benchmarks. The most used SRI indexes are Domini400 (based on KLD data), FTSE4Good (data from EIRIS), and Dow Jones Sustainability Index (data from SAM) (Widyawati 2020).

In addition to the previously mentioned ESG ratings and indices, there are further methods such as sustainability labels and sustainability-based impact assessments, which focus on social and environmental impact (Popescu, Hitaj, and Benetto 2021). Sustainability labels, unlike ESG scores, are not independently determined but are awarded upon application for a fee. Based on underlying data, it is checked whether all criteria for this seal are fulfilled (Becker, Martin, and Walter 2022; Popescu, Hitaj, and Benetto 2021).

2.2.4 Investment vehicles in sustainable finance

By consciously deploying capital, the financial sector has the power to actively shape the economic model and the environment in which it operates. To create value in the short- and long-term and build a resilient economy, all three factors need to be balanced with the financial aspect (Sandberg et al. 2009). Successful implementation of ESG strategy enables companies to attract new capital on the market, to engage employees efficiently and optimize business processes. In most legal systems, the appointment and removal of board members is carried out through election during the general meeting, assigning investors a great deal of power indirectly. Due to greater awareness among investors, their decision-making power is exercised to an increasing extent. Shareholder activism is driving companies to adopt more sustainable practices (Kai H.E. Liekefett 2021).

To understand how ESG shapes investment decisions, it is important to first understand which investors are considering ESG issues predominantly and what their motives are. Here, a distinction is made between two types of investors: institutional and private investors. According to Boston Consulting Group (2021), institutional investors accumulate USD 61tn of assets

whereas private investors represent USD 42tn with an even growing importance. A survey from Amel-Zadeh et al. (2018) has shown, that the dominant type of investor among institutional investors besides corporate pension funds, public pension funds, charity and family offices are asset managers. In Europe, major ESG adoption factors are given through local regulations, mitigation of ESG risk and avoidance of reputational risk as well as their fiduciary duty. Among private investors, hedge funds and specialized private equity funds are explicitly investing into ESG, driving the demand for a sustainable approach in investing due to their strategic positioning to integrate that trend towards established investment standards (Alfonso-Ercan 2020).

Not only the investment philosophy but also the investment vehicles available to the type of investor is varying. Institutional investors are investing capital from third party investors and are mainly investing their assigned capital on the stock market. In comparison, private investors are individuals that invest their own capital directly on the stock market, in retail funds (Jansson and Biel 2011) or private companies. Within this study, only investments into the stock market are considered since these entail beneficial characteristics especially for private investors as opposed to direct equity investments in the traditional context of private equity and venture capital. Assets being broadly accessible for private investors are categorized into four different asset classes: stocks, bonds, options, and derivatives.

A stock represents the ownership of a fraction of a company, where multiple shares aggregated by one investor form a portfolio. The traditional investor always selects the portfolio that maximizes expected return (Nagy and Obenberger 1994). ESG criteria are supposed to characterize unrepresented topics within environmental, social, and governance areas, reflected for each company. These dimensions are now brought together through a new consciousness, when making an investment decision. In literature, the impact of ESG scores on stock performance has been studied extensively to put that relation into context. Kempf and Osthoff (2007) and Eccles et al. (2011) found evidence that good ESG performance can create a positive impact on

stock performance. To balance risk and reward within a portfolio, investors are investing in different asset classes to diversify their assets and limit individual asset exposure (Goetzmann and Kumar 2008).

Bonds are fixed income instruments that enable companies to borrow funds on the capital market while debtholders, typically investors, receive a fixed interest rate. In sustainable finance, bonds have a special significance since green bonds offer investors a viable investment opportunity into environmental projects. Investments in green bonds by governments are pioneering this trend, encouraging private capital to invest in green assets. Over the past few years, the rapid growth in corporate green bonds also reflects the popularity with investors. While in 2013, only USD 5bn in corporate green bond were issued, it soared to USD 95.7bn by 2018 (Flammer 2021). This trend has remained strong, putting global green bond volume at USD 422bn to date (Matthew Toole 2022). Environmental projects that corporates typically engage in are the use of renewable energy and improvement of energy efficiency in their operations.

Finally, derivatives and options can be considered as efficient investment vehicles on the stock market. These financial contracts are predominantly used to hedge investment risk associated to underlying assets traded on the stock market and can complement an investor's investment strategy.

This thesis focuses on investments in the stock market, since the stock market provides a high degree of liquidity and short investment cycles whereby no long-term capital commitments are required, providing investors with a high degree of flexibility.

2.3 Theoretical Foundation of ESG in an investment context

In the following, ESG in an investment context is presented and the shareholder, stakeholder and principal agent theory will be examined in more detail.

2.3.1 Shareholder Theory

According to Milton Friedman (1970), the only purpose of business is to maximize shareholder value, forming the foundation of the shareholder theory. It states that the absolute goal and duty of a corporation is to maximize profits for its shareholders. Therefore, shareholders are considered as the only group that a company is socially responsible to. Businesses fulfill their social obligation through maximizing revenues, providing people the most freedom to fulfill their own social responsibilities (Friedman 1970). Maximization of shareholder value can be operationalized through the maximization of the present value of all future cash flows (Tse 2011), as demonstrated in the equation (1) below:

(1) $$V_0 = \frac{CF_n}{r-g}$$

where V_0 represents a firm's value today, CF_n all future cashflows, r the investor's required return and g the growth rate. Hence, shareholder value can be either increased by expanding future cashflows, boosting the growth rate or lowering investor's required return. According to Rappaport (1998) a company's ability to generate economic value for shareholders is the only way to measure its performance. However, shareholder theory disregards that shareholders and corporates may have other objectives that are not based on financial performance to ensure long-term success.

2.3.2 Stakeholder Theory

Besides generating profits for shareholders, several other important factors need to be considered for the prosperity of any organization. The increasing awareness towards the impact of companies on communities and countries, driven by the rise of globalization and continuous innovation through technology, results in an altered understanding of business. Consequently, the transition from the traditional shareholder theory towards the stakeholder theory was initiated. First presented by Freeman (1984), the stakeholder theory suggests that a business has,

besides shareholders, several additional groups of stakeholders to serve and is only considered successful when it creates value to most stakeholders. A corporation's stakeholders can be classified into two main groups: internal and external stakeholders. Employees, managers, and owners can be assigned as internal stakeholders through their direct relationship with the company and are interested in the company's performance to guarantee to be paid, achieve a return and retain their jobs. External stakeholders are not involved in the operations or decisions of a company but are affected by actions and outcome of a business in multiple ways. Although they do not have any direct financial stake in the company, suppliers, customers, creditors, communities, and the government all have a vested interested in the long-term success of the company. The most effective businesses are successful at managing the expectations and interests of all their stakeholders. Nevertheless, not all stakeholders are always equally important and require managerial attention in the same extent. To effectively manage all relationships simultaneously and prioritize stakeholders under situational uniqueness, Mitchell et. al (1997) developed a dynamic model to classify stakeholder according to power, legitimacy, and urgency.

In literature, power is described in different scenarios and receives multiple definitions. Even though it may not be easy to define, power is easy to recognize, being "the ability of those who possess power to bring about the outcomes they desire" (Salancik and Pfeffer 1974, 3).

Legitimacy explains an organization's behavior of disclosing environmental and social information to attain to their social commitment to recognize their objectives and assert in an unpredictable environment. Suchman (1995, 574) declares, that "Legitimacy is a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions". Governing the interaction with society, legitimacy is establishing a mutual basis for interaction and acceptable behavior. As a part of the community, companies must adapt their behavior according to norms and values to satisfy the expectations. Through active social and environmental efforts, it has

been shown that resource allocation is beneficial for companies that engage in this area, resulting in a deep interrelation among profit and legitimacy (Milanes-Montero and Perez-Calderon 2011). The community legitimizes an organization through its rational and legal framework and may serve as a strategic component to develop the organization further. By disclosing their social responsibility, valuation from an investor's perspective and the perceived value from society can be increased (Reverte 2016). Considering legitimacy provides managers with a helpful framework to prioritize stakeholders and bundle capacities.

Lastly, urgency expresses a time condition, in which a stakeholder claims a call for immediate action, whereas not only the time constant is considered but also the importance of the relationship. The state of urgency defines modern societies and organizations, confronting involved parties with varying degrees of urgency, requiring different levels of attention (Roux-Dufort 2007).

Aggregating those attributes in stakeholder salience, the authors provide managers with a powerful tool to identify and handle individual stakeholder classes (Mitchell, Agle, and Wood 1997). Generally, stakeholders demonstrate a high degree of salience, the more of these characteristics a stakeholder is considered to possess. According to their salience, stakeholders are prioritized. Since organizations are dependent on divergent interests in their environment, the allocation of managers attention is crucial in stakeholder management, in which salience is only intended to provide guidance. Ultimately, managers decide on the stakeholder that must be prioritized in a specific context. As these relations and perceptions are not static and change continuously, it must always be acknowledged that every situation requires individual examination, as the amount of attention required may vary from time to time, depending on the circumstances.

Despite the above-described heuristic, the environment around the company needs to be taken into consideration, yet beyond the societal aspect and community values to satisfy stakeholders

and generate a better financial performance. Other areas consider environmental and governance performance to complement social perceptions through an organization's legitimacy. Ghoul et. al (2017) figured those activities across all the environmental, social and governance dimensions positively affect company performance through maintaining profitability while simultaneously contributing to the resolution of conflicts between stakeholders. A corporation can engage in individual E, S, and G activities at various levels since the ESG score is based on a company's performance in the environmental (E), social (S), and governance (G) sub-factors in equal measure (Humphrey, Lee, and Shen 2012).

2.3.3 Agency Theory

Stated above, managers of a company have significant decision-making power not only in the prioritization of stakeholders, but also in the strategic and operational steering of a company. With divergence of interests among multiple stakeholders, a problem arises which is known as the agency theory (Jensen and Meckling 1976). The principal-agent theory is based on a contract whereby the principal hires the agent to perform a task on their behalf. This problem could occur in many situations, whereas the most known scenario is the ownership of an asset where the principal is the owner that delegates direct control over that asset to a third party, the agent. Translating that into the context of a company, shareholders act as the principal, appointing a manager (agent) to control their asset, the company. Asymmetric information distribution and opportunistic behavior on the part of the agent are characteristic of the relationship between principal and agent (Eisenhardt 1989). The theory states that managers tend to favor their own interests over the interests of the organization, due to having more information available than the owners and stakeholders. The opportunistic disposition of the agent thus entails the risk that the agent might not act in the principal's interest, resulting in hidden actions where only the results are visible to the principal.

To address these issues, agency theory suggests that conflicts of interest are effectively mitigated by functioning control mechanisms such as corporate governance systems and incentives for the agent (Jensen and Meckling 1976). Through improved board monitoring, the financial performance of an organization can be impacted significantly (Carter, Simkins, and Simpson 2003) and reduce agency conflicts. However, ESG activities potentially create a proxy problem between managers and shareholders since no longer only the shareholder's interests and expectations are satisfied but also environmental and social aspects of all stakeholders (Givel 2007). Therefore, ESG expenditures are not in the best interest of shareholders as the direct outflow of financial resources will reduce profits (Peng and Isa 2020). Furthermore, investing into ESG activities might open three different agency problems.

First, managers might spend company resources to improve their social perception in society, thus following their own interest to obtain a private benefit. Secondly, investing in ESG activities could create a lack of funds for more profitable projects (Schuler and Cording 2006), causing a decline in financial returns. In the long-term, that might create a competitive disadvantage for companies active in the ESG field since capital and other resources are spent (Allouche and Laroche 2006), reducing the budget for further innovation. Lastly, managers tend to cover bad financial performance by engaging in ESG activities, shifting the public's attention towards the engagement in socially esteemed topics.

To counteract drawbacks attached to ESG activities and encourage companies to deliver positive impact to society, regulators around the world introduce legislation requiring companies to disclose their environmental, social, and governance activities. In 2020, the European Union released the sustainable finance taxonomy to facilitate sustainable investment (European Commission 2020), alluding to the signaling theory. Signaling is a mechanism based on information exchange within a business transaction, reducing information asymmetry and opportunistic behavior by sharing information voluntarily with external stakeholders (Hahn and Kühnen 2013;

Marcus M. Neumann 2007). Signals are properties or activities that convey information about the characteristics of an economic agent and are subject to the agent's influence (Spence 1973). Ching and Gerab (2017) figured, that managers effectively disclose information on their sustainability engagement to signal their commitment towards their stakeholders. Thus, the company gains a positive reputation among its stakeholders and increases its creditability, being rewarded with better performance. Moreover, companies that do not take those factors into account are disciplined by the market, resulting in decreasing sales that will eventually decrease performance.

2.4 Hypothesis Development

No consensus in literature regarding the interrelation among ESG activities and financial performance can be found. The ambiguity even within independent theoretical frameworks concerning the above is mainly justified by two aspects. The complex environment in which companies operate in is characterized by constant change, pressure to innovate and an increasing awareness of all market participants exerting strong pressure. As a result, uncertainty is increasing, and proven principles and guidelines are being partially abrogated, complicating managing the business and meeting expectations. Secondly, the natural complexity of the numerous relationships. With an enhanced focus on environmental and ethical issues in an increasingly transparent world, new stakeholders appear, and the balance of power alters, requiring rebalancing and re-managing relations. Whereas in the past companies focused mainly on generating profit for their shareholders, they are now facing increased pressure from various stakeholders such as suppliers, employees, and investors (Kolk and van Tulder 2010). The relation between ESG activities and financial performance is impacted directly or indirectly by geography, stakeholder sensitivity, industry, and legal framework.

In order to contribute to the existing discussion in the literature, this study examines the impact of ESG ratings on stock performance from an investor’s perspective with special attention to

the automotive, chemical, apparel and retail and utilities industries. The hypotheses established to study the relationship are listed below:

H_1: There is a positive relationship between ESG performance and stock returns

H_{1a}: There is a positive relationship between environmental performance and stock returns

H_{1b}: There is a positive relationship between social performance and stock returns

H_{1c}: There is a positive relationship between governance performance and stock returns

3 Methodology

In the following chapter, the previously developed theoretical foundations are substantiated by means of an empirical study. A multiple linear regression analysis is used for this purpose. The data collection and cleaning process as well as the portfolio creation and model setup are presented within this chapter.

3.1 Data Collection and Data Preparation

ESG Score

The Bloomberg database was used to collect data on ESG performance. Bloomberg's environmental, social, and governance (ESG) data collection includes ESG indicators and ESG disclosure ratings for over 14,000 companies across more than 100 countries (Bloomberg 2022b). All disclosed companies can be divided into industry categories and their corresponding subcategories. This thesis focuses on the ESG performance of companies in the global Automotive, Chemical, Apparel Manufacturer and Retailer, and Utility industries.

The Bloomberg data is disclosed in the three sub-dimensions environment, social and governance. To report transparently and consistently, Bloomberg collects ESG information through the company’s sustainability reports, annual reports, and websites as well as through press releases, third-party research, and direct communication (Wong et al. 2021). Some of the metrics

collected are measured quantitatively (e.g., waste disposal or water use), while other information is measured qualitatively (e.g., if the organization has a policy on child labor) (Tamimi and Sebastianelli 2017). As Bloomberg's ESG database has developed, there are over 120 data points with measurements (Wong et al. 2021) known as "Bloomberg indicators" which disclose ESG activity. The environment score incorporates criteria like air quality, waste and water management, and ecological impact. The social score addresses issues like ethics and compliance, safety management, and occupational health, and operational risk management. Meanwhile, the governance score is divided into the three sub-issues board composition, shareholder rights, and executive compensation, which each get an individual score assigned. A more detailed score structure of the three ESG dimensions is illustrated in Appendix A.

Adding to these general metrics, Bloomberg incorporates industry-specific criteria, based on a detailed assessment of each industry's material sustainability issues (Bloomberg 2020). All indicators for each dimension are reflected within a single score that ranges from 0 to 10, with 10 being the highest score that can be achieved (Wang and Sarkis 2017), except governance. For this pillar, a score is assigned for each of the three sub-issues. To derive an overarching ESG score later on, the governance sub-issues are summarized in a single governance score by calculating the unweighted average. Afterwards, the collected data is cleaned to obtain a balanced panel data set, through excluding companies with missing ESG data. The overall ESG score is derived by calculating the average across the environment, social, and governance score, weighting each category in the same magnitude.

Bloomberg publishes data on ESG performance of individual companies from 2015 onwards. Publication of ESG scores for the current year takes place at the end of the following year, therefore the data series considered for the analysis only reaches to 2020.

Market Capitalization

The market value of a company is known as market capitalization and is calculated by multiplying the number of shares with the share price (Companisto Glossar 2022). Market capitalization is a simple way for investors to determine the size of a company, which can help assess the risk of investing (IG Glossar 2022). The market capitalization for every company conserved, is also obtained from Bloomberg on an annual basis. In case there was no market capitalization available due to IPOs after 2015, the company was removed from the dataset. Based on the stock exchange the company is listed on, the market capitalization was converted into USD for better comparability, using the average exchange rates from 2015 to 2020 (OECD, 2022).

Total Monthly Return

The monthly return is the period return rescaled to a one-month period. This allows investors to compare the returns of different assets they own (Smyth 2021). It is calculated as follows:

(2) $$r_t = \frac{P_t}{P_{t-1}} - 1$$

Where:

$r_t = total\ return\ at\ month\ t$

$P_t = adjusted\ stock\ price\ at\ month\ t$

The adjusted monthly stock prices are also obtained from Bloomberg. The data scope in this thesis includes all data from 01.01.2015 to 31.12.2020 and thus covering a period of five years. Companies with incomplete data series are removed from the data set. Stock prices are stated in the currency of the country in which the security is listed. However, the conversion to USD is not necessary for total monthly returns as it expresses a ratio that measures the change in value.

3.2 Portfolio Creation

For each dimension and year, an upper (lower) portfolio of companies whose ESG (environment, social, governance) performance is among the best (worst) of all companies is constructed. The stocks are held for one year within the portfolios before they are being rebalanced according to changes in ESG ratings. Variances in market capitalization are captured by weighting portfolios proportionally. As illustrated in Equation 3, this is achieved by dividing the market capitalization of each company by the total market capitalization of all stocks in the portfolio at the time of rebalancing.

(3) $$w_{ijt} = \frac{Market\ Cap_{it}}{\sum_{n=1}^{N} Market\ Cap_{it}}$$

Where:

$w_{ijt} = weight\ of\ company\ i\ in\ portfolio\ j\ at\ year\ t$

$Market\ Cap_{it} = Market\ Capitalization\ of\ company\ i\ at\ year\ t$

Thus, the monthly return of a portfolio is the sum of the weighted total monthly returns of all stocks in the respective portfolio.

3.3 Regression Model Delineation

To estimate abnormal portfolio returns of the previously constructed upper (UP) and lower (LP) ESG portfolios, Fama-French three-factor model (FF3), Carhart four-factor model (Carhart), Fama-French five-factor model (FF5), and a combination of Fama-French five-factor model and Carhart four-factor model (FF5 + MOM) are applied. The models attempt to explain stock return dispersion by incorporating explanatory variables that describe stock price fluctuations with risk variables. Using the market as performance benchmark, the models reveal if the market is valuating ESG scores so that either companies with high/low ESG scores can achieve access returns on the capital market. The model was built in Python applying ordinary least square regressions (OLS) to determine the coefficients of the respective factors and intercepts.

Appendix B shows the Python code for determining the factors and intercepts of FF3 for an ESG UP, as a proxy for all other models and portfolios evaluated. The requisite risk factors used in the models are sourced from the Kenneth R. French data library (French 2022).

3.3.1 Fama-French Three-Factor Model

In 1992, Eugene F. Fama and Kenneth R. French developed a three-factor model which explains stock returns based on three factors (Mondello 2017). They concluded in numerous cross-sectional linear regressions on the US stock market that the beta factor alone is not sufficient to fully explain market returns (Fama and French 1993). Two groups of shares in particular show significantly higher returns than other shares on the market. First, shares of small companies with a low market capitalization. This finding is referred to as the size effect. Secondly, there are shares of companies with a high book-to-market ratio of equity. This effect is referred to as the value effect (Vorfeld 2008).

Companies with low market capitalization risk having no or insufficient access to the credit market, which could limit their ability to adapt towards a changing business environment. Securities with a high book-to-market ratio usually are undervalued on the capital market, for example due to fundamental financial difficulties (Scheld 2013). The FF3 includes both above mentioned effects and extends the traditional CAPM approach. The two risk factors represent a return compensation for the risk of losing profit due to high market capitalization and low book-to-market ratio (Mondello 2017).

Portfolio returns are explained in FF3 model applying the following three risk factors (Mondello 2017; Vorfeld 2008):

- *Market or R_M(Market Risk Premium):* It refers to the excess return of the market and is calculated as the difference in return between a market-weighted stock index and a risk-free investment.

- *Size or SMB (Small Minus Big):* It refers to the size premium and describes the difference in returns between a portfolio consisting of shares of companies with a small market capitalization and a portfolio consisting of shares of companies with a large market capitalization.
- *Value or HML (High Minus Low):* It refers to the value premium and results from the difference in returns between a portfolio consisting of shares with a high book-to-market ratio of equity and a portfolio consisting of shares with a low book-to-market ratio of equity.

If a long-short portfolio has a net investment of zero, the three risk factors can be considered as the average return of this portfolio. R_M embodies a long position in the market portfolio and a short position in risk-free assets (Mondello 2017). The size premium is the average return that results from a short position in stocks with large market capitalization. The inflow of money resulting from the short sale is invested in securities with small market capitalization (Fama and French 1993). The value premium embodies the average return resulting from a short position in securities with a low book-to-market ratio, with the resulting cash inflow being invested in securities with a high book-to-market ratio (Mondello 2017).

The FF3 of Fama and French (1993) can be represented as follows:

(4) $$R_{j,t} - R_{f,t} = \alpha_{j,t} + \beta_{j,M} \cdot (R_{M,t} - R_{f,t}) + \beta_{j,SMB} \cdot SMB_t + \beta_{j,HML} \cdot HML_t + \varepsilon_{j,t}$$

Where:

$R_{j,t} = total\ return\ in\ month\ t\ of\ individual\ portfolio\ j$

$R_{f,t} = risk\ free\ asset\ return$

$R_{M,t} = total\ market\ portfolio\ return$

$R_{j,t} - R_{f,t} = expected\ excess\ return$

$R_{M,t} - R_{f,t} = excess\ return\ on\ a\ market\ portfolio\ index$

$SMB_t = size\ premium\ at\ month\ t$

$HML_t = value\ premium\ at\ month\ t$

$\beta_{j,i} = sensitivity\ of\ portfolio\ j\ to\ the\ respective\ risk\ factor\ i; i = M, SMB, HML$

$\alpha_{j,t} = intercept$

$\varepsilon_{j,t} = error\ term$

The beta factors represent the slope in the regression. This measures the extent to which a security is exposed to the respective risk, e.g., market risk (Vorfeld 2008). Since the FF3 explains stock return by two additional risk factors (SMB and HML), the beta for the expected market risk premium ($\beta_{j,M}$) no longer matches that from the CAPM (Mondello 2017). The other betas ($\beta_{j,SMB}$ and $\beta_{j,HML}$) are also estimated via linear regression. The changes in the return of the specific value of a security compared to the changes in the return of the risk factors SMB and HML are crucial here (Stahl 2016). The beta factor $\beta_{j,SMB}$ incorporates the company size effect and is thereby higher the lower the market capitalization of the company under consideration. The beta factor $\beta_{j,HML}$ accounts for the book-to-market value ratio and is higher the higher the book-to-market value ratio of the company (Stahl 2016).

Here, $\alpha_{j,t}$ represents the expected return arising from company-specific risks not shown in the respective risk factors (SMB, HML) (Stahl 2016). If the risk factors capture the entire variation in expected return, then the intercept $\alpha_{j,t}$ is zero for all portfolios (Mondello 2017). Therefore, the explanatory power of a model is greater the lower $\alpha_{j,t}$ is (Fama and French 1993). Lastly, $\varepsilon_{j,t}$ represents the error term from company-specific risks, in which measurement errors and unobserved influences on the dependent variable $R_{j,t} - R_{f,t}$ are included (Stahl 2016).

3.3.2 Carhart Four-Factor Model

In 1997, Carhart developed the four-factor model. The aim was to be able to estimate expected returns even more precisely by taking into account return patterns that are not described in the FF3. Carhart extended the FF3 by a fourth risk factor, reflecting the short-term momentum

effect (Carhart 1997). Jegadeesh and Titman (1993) demonstrated, that abnormal return resulted from the short-term momentum effect.

The momentum effect describes the phenomenon that stock returns follow their trend in the short-term period of three to twelve months. In the short term, winning stocks tend to remain winning stocks and losing stocks tend to remain losing stocks, thus showing consistency (Jegadeesh and Titman 1993). The authors further showed in their studies that a portfolio of stocks that had above-average performance in the past three to twelve months will generate a higher return in the next three to twelve months compared to the portfolio of stocks with below-average past performance (Hanauer, Kaserer, and Jäckel 2015). Thus, stock returns are positively correlated with past performance (Jegadeesh and Titman 1993).

In addition to the SMB and HML risk factors, the four-factor model adds the MOM (Winner Minus Loser) risk factor. Therefore, the group of stocks with rising prices (momentum), which have conspicuously higher returns than other stocks on the market is included (Mondello 2017). The MOM factor is calculated by taking the difference in return between two short-term portfolios consisting of stocks with a high prior-year performance (winner portfolios) and portfolios consisting of stocks with a low prior-year performance (loser portfolios) (Hanauer, Kaserer, and Rapp 2013). This short-term view relates in each case to the previous year (Stahl 2016). In other words, MOM is the difference in return between a portfolio with winning stocks in the long position and a portfolio with losing stocks in the short position (Mondello 2017).

The four-factor model of Carhart (1997) can be represented as follows:

(5) $$R_{j,t} - R_{f,t} = \alpha_{j,t} + \beta_{j,M} \cdot (R_{M,t} - R_{f,t}) + \beta_{j,SMB} \cdot SMB_t + \beta_{j,HML} \cdot HML_t + \beta_{j,WML} \cdot MOM_t + \varepsilon_{j,t}$$

Where:

$MOM_t = momentum\ factor\ at\ month\ t$

$\beta_{j,MOM} = sensitivity\ of\ portfolio\ j\ to\ the\ risk\ factor\ MOM$

All further variables have already been described in Equation 4.

Here, the beta factors also represent the slope in the regression that measures the extent to which a security is exposed to the respective risk. The beta factor $\beta_{j,MOM}$ is also estimated via a linear regression and adjusts the expected difference in the returns of the short-term winner and loser stocks individually (Vorfeld 2008). For stocks with a high prior-year price, this leads to a higher beta (Stahl 2016).

3.3.3 Fama-French Five-Factor Model

In the years after the publication of FF3, various scientific studies proved that the computation of the expected stock return with the FF3 is incomplete (Fama and French 2015). Various risk factors have been identified that are supposed to provide noticeably higher returns compared to other stocks on the market. However, many of these risk factors are not universally accepted and can only be demonstrated at certain times or markets (Chiah et al. 2016). For a long time, Fama and French saw no need to revise their three-factor model. Nonetheless, the factors profitability and investment activity caused great stir (Novy-Marx 2013; Titman, John Wei, and Xie 2004) and were reason enough for Fama and French to revise their three-factor model (Fama and French 2015).

The FF5 is based on their FF3 and adds two additional risk factors to forecast expected returns more accurately. First, it is extended to include the risk factor profitability (Fama and French 2015). Studies have shown that shares of companies with high profitability outperform the overall market in the longer term (Novy-Marx 2013). Thereby, profitability is defined as the ratio of gross profit to balance assets (Baron 2020). The RMW (Robust Minus Weak) factor thus represents the expected return difference between stocks with robust and weak profitability (Fama and French 2015). Second, the FF3 is supplemented by the investment activity factor (Fama and French 2015). This factor incorporates that shares of companies with low investments show an above-average performance in the long-term compared to the overall market

and shares of companies with high investments (Titman, John Wei, and Xie 2004). The change in total assets from the previous year is described as investment activity (Fama and French 2015). CMA (Conservative Minus Aggressive) displays the difference in return between portfolios of equities with high and low balance sheet growth (Fama and French 2015).

The FF5 of Fama and French (2015) can be represented as follows:

(6) $$R_{j,t} - R_{f,t} = \alpha_{j,t} + \beta_{j,M} \cdot (R_{M,t} - R_{f,t}) + \beta_{j,SMB} \cdot SMB_t + \beta_{j,HML} \cdot HML_t + \beta_{j,RMW} \cdot RMW_t + \beta_{j,CMA} \cdot CMA_t + \varepsilon_{j,t}$$

Where:

$RMW_t = profitability\ factor\ at\ month\ t$

$\beta_{j,RMW} = sensitivity\ of\ portfolio\ j\ to\ the\ risk\ factor\ RMW$

$CMA_t = investment\ factor\ at\ month\ t$

$\beta_{j,CMA} = sensitivity\ of\ portfolio\ j\ to\ the\ risk\ factor\ CMA$

All further variables have already been described in Equation 4.

The beta factors again represent the slope in the regression measuring the extent to which a security is exposed to the respective risk. They are also estimated using a linear regression (Vorfeld 2008).

Expanding the FF3 with profitability and investment activity factors, the risk factor HML becomes redundant when describing the average return (Fama and French 2015). It no longer provides any additional information, as Fama and French themselves proved for US stocks. The HML factor is nor abdicated, since a globally valid statement could not be provided yet beyond US stocks (Baron 2020).

3.3.4 Fama-French Five-Factor Model + Momentum

Even though the FF5 is well developed and widely accepted in academia (Blitz and van Vliet 2022), it encounters criticism especially in regard to neglecting the momentum risk factor. For

this research, the momentum factor is added as a sixth factor to the FF5 (Dirkx and Peter 2020) to be able to estimate expected returns even more precisely.

The Fama and French (2015) five-factor model combined with the momentum factor of the four-factor model of Carhart (1997) can be represented as follows:

$$(7) \qquad R_{j,t} - R_{f,t} = \alpha_{j,t} + \beta_{j,M} \cdot (R_{M,t} - R_{f,t}) + \beta_{j,SMB} \cdot SMB_t + \beta_{j,HML} \cdot HML_t + \beta_{j,RMW} \cdot RMW_t + \beta_{j,CMA} \cdot CMA_t + \beta_{j,WML} \cdot WML_t + \varepsilon_{j,t}$$

All above-mentioned variables have already been described in Equation 5 and Equation 6.

4 Analysis

The following section describes and evaluates the results of the analysis using the model explained in the previous chapter.

4.1 The Impact of ESG Performance on Stock Returns in the Chemical Industry

The following chapter focuses on the impact of ESG ratings on the stock performance of companies in the global chemical industry. Firstly, a literature overview of ESG in the chemical industry is given. Subsequently, the prepared data set is described, and the results of the regressions performed with the FF3, Carhart, FF5, and FF5 + MOM are presented. Lastly, the analysis results are discussed.

4.1.1 ESG in the Chemical Industry

The chemical industry holds a key position, as its products are widely utilized as feedstock in a variety of downstream sectors, including construction, agriculture, electronics, cosmetics, and textiles (Yang et al. 2022). The high energy demand and widespread usage of fossil raw materials make the sector one of the world's top carbon emitters (Fox 2021). The chemicals sector is responsible for around 6 % of worldwide greenhouse gas emissions (International Energy Agency 2022). According to estimations of the International Energy Agency (2022), the average energy intensity of primary chemical production must decline by 10 % from current levels by 2030 to limit warming to 1.8 °C. Air Liquide, Air Products & Chemicals, and Linde are among the most carbon-intensive industrial gas firms, whereas petrochemicals belong to the less strong emitters (Bloomberg 2022a). Due to their important position in the value chain, chemical firms are therefore under special pressure to innovate. After all, their sustainable innovations and production processes can have a positive impact on third parties (Sommer et al. 2021). ESG-driven innovations in particular are playing an increasingly important role among the most innovative chemical companies (PwC 2022).

Although the chemical sector cannot eliminate carbon emissions, the task of the companies is both to reduce their own emissions by developing new (production) processes and to rely on

sustainable energy sources to keep emissions as low as possible (PwC 2022; Fox 2021). Electrolytic hydrogen and bio-based feedstocks might be used to replace fossil fuels, while carbon capture could serve as both a crucial input and a technique for reducing emissions (Bloomberg 2021). Alongside emission reduction, chemical companies have an opportunity to develop sustainable products that can address issues, including energy, safety, and access to food. Technavio predicts that the global market for green chemicals will increase by USD 50bn, or 10 %, between 2019 and 2023, suggesting significant opportunity for the industry (Technavio 2022). Besides the high environmental impact, the chemical industry also poses risks in social aspects. For example, workers in the chemical industry are exposed to hazardous substances, and the industry faces risks related to worker health and fatalities. Companies that fail to manage their performance in this area face acute impacts, lost revenue, and potential liabilities (Bloomberg 2022a). Also, for instance, operational risk management is critical given the nature of many products. Companies that effectively manage process safety and product transportation are better able to avoid liabilities, regulatory costs, and operational disruptions (Bloomberg 2022a).

Given the widespread use of chemicals in products of all types, quality and safety are critical issues for the industry. Concerns about the effects of certain chemicals on human health and the environment led to the development of industry-specific national and international disclosure requirements and regulations. In this context, the EU developed a regulation on the Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) and the UN developed a standard of the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). In China, for example, national regulations such as "Air Ten", "Soil Ten" and "Water Ten" apply to the chemical industry and impose fines for excessive pollution (Gassmann et al. 2022). But the ESG performance pressure is not only driven by the regulatory side. More and more industrial clients are going above and beyond legal requirements, demanding sustainable solutions from their suppliers to satisfy their own aspiring ESG targets as well as those of

their end users (PwC 2022). Especially in the B2C industry, ESG performance is playing an increasingly important role in purchasing department decisions (Gassmann et al. 2022; PwC 2022). Chemical companies are therefore sandwiched between expanding regulatory requirements and increasing consumer and customer preferences.

Transformation in the chemical sector is necessary and it pays to transform (Sommer et al. 2021). A study by PwC and Strategy& from 2022 shows that chemical businesses that plan ahead of time to fulfill more severe environmental, social, and governance (ESG) criteria will benefit since they are key players in the value chain (Gassmann et al. 2022). Those chemical companies that are less well adapted to sustainable business processes risk falling behind in a competitive comparison. Lower growth rates as well as increasing risks and costs can be the consequences of insufficient ESG adaptation (Sommer et al. 2021; PwC 2022). Therefore, it is interesting to investigate whether chemical companies with a high ESG score are already evaluated by the market and thus can achieve excess returns on the capital market compared to their competitors with a low ESG score.

4.1.2 Dataset Description

The subsequent section describes the base data set and portfolio data set, together with their descriptive statistics. Followed by the validation of the data used in the models.

4.1.2.1 ESG Dataset

To test the before-defined hypothesis, a data set with companies from the chemical industry was designed. As previously described in section 3.1, the data for this analysis was drawn from Bloomberg. Bloomberg subdivides the chemical companies analyzed into three categories, covering "Basic and Diversified Chemicals", "Specialty Chemicals" and "Agricultural Chemicals". "Basic and Diversified" chemical firms are involved in the production of commodity-like chem-

icals that are sold in big quantities. "Specialty Chemicals" companies engage in the manufacturing of chemicals that are produced for their specific performance or function. Companies in the "Agricultural Chemicals" sector are dedicated to the development of a wide range of chemicals used to protect and increase crop growth, such as insecticides, fungicides, and synthetic fertilizers (Bloomberg 2022a).

Prior to data cleaning, the data set consisted of 192 companies in the chemical industry with ESG data available. After cleaning the data, the data set comprises 144 chemical companies. Of these, 59 companies are from the "Basic and Diversified Chemicals" category, 61 companies belong to the "Specialty Chemicals" and 24 companies belong to the "Agricultural Chemicals". The majority of companies in the data set are listed on the capital market in the United States (27 companies; 18,49 %), Japan (23 companies; 15,75 %), and South Korea (17 companies; 11,64 %). The remaining companies are distributed among the capital markets in India, China, Germany, United Kingdom, France, Hong Kong, Netherlands, Australia, Mexico, Switzerland, Taiwan, Belgium, Denmark, Finland, Norway, Pakistan, Russia, Austria, Brazil, Canada, Chile, Israel, Malaysia, Poland, Saudi Arabia, South Africa, Sweden, and Thailand. A detailed description of the country distribution of the chemical companies considered can be found in Appendix H.

	ESG	**Environment**	**Social**	**Governance**	**Market Capitalization (in mio. USD)**
Descriptive Statistics					
Mean	3.36	2.54	1.99	5.56	8,467.42
Median	3.33	2.62	1.69	5.49	4,192.18
Standard Deviation	0.98	1.45	1.17	1.20	12,915.02
Sample Variance	0.96	2.11	1.40	1.44	174,155,461.05
Kurtosis	-0.64	-0.99	2.23	-0.54	20.89
Skewness	0.22	-0.05	1.41	-0.03	3.91
Min	1.07	0.05	0.24	1.11	7.38
Max	6.59	6.89	7.58	8.37	137,893.34
Range	5.53	6.84	7.34	7.26	137,885.96

Table 1: Descriptive statistics on ESG data for the chemical industry

Table 4 summarizes the descriptive statistics of the data set focusing on the ESG score, environment score, social score, governance score, and market capitalization.

The variance in the total ESG rating is lower than in the single pillar scores. This can be attributed to the fact that the ESG score was calculated from the average of the separate pillars. In terms of the three individual ESG pillars, environment has the highest variance and social has the lowest. On average, the companies achieve the highest scores in the governance rating. The average social score severely lacks behind the average environment and governance score. The general distribution of the ESG data exhibits a right skewness (0.22). This means that there are numerous small values in the data. Likewise, there is a lot of small data for the social score (skewness of 1.41), which underlines the poor performance of the companies in terms of social engagement. In contrast, the environment and governance data are skewed to the left, showing many large values. According to the average market capitalization of USD 8.5bn, the companies studied can be classified on average as mid-cap companies. However, the market capitalization shows a vast fluctuation between the lowest (USD 7m) and the highest (USD 137bn) market capitalization. Since market capitalization is a simple and relatively effective means of assessing risk, the chemical companies studied offer investment opportunities for a wide range of investors with different risk preferences.

Looking at the ESG performance of the individual years, a clearly positive development emerges. While the average ESG score of the chemical companies considered was 3.02 in 2015, it rose to 3.72 by 2020. This can be attributed to the increasing implementation of ESG initiatives to achieve their own company sustainability goals, as well as to meet stricter regulatory requirements and more demanding customer requirements.

4.1.2.2 Portfolio Dataset

To analyze the portfolios of the best and worst performing companies, the top and bottom 20 % of the annually re-ranked ESG, environmental, social, and governance scores are considered

and attributed to the eight corresponding portfolios. 20 % of the 144 companies considered translates into 29 companies. This means that the upper (lower) portfolio consists of the 29 companies whose ESG (environment, social, governance) score is among the best (worst) for the respective year.

Looking at the composition of the upper ESG portfolio, one can notice that 13 companies are among the companies with the highest ESG scores every year from 2015 to 2020. In contrast, 96 companies did not make it into the top 20 % of the ESG ranking in any year of the period under review. By absolute portfolio composition, companies from the "Specialty Chemicals" category are the most represented in the upper ESG portfolio in all years. This can be explained by the fact that most companies are assigned to this category in the data set. On a relative basis, however, it is noticeable that based on the number of companies per category, most "Agricultural Chemicals" are listed per year in the upper ESG portfolio. Which can be attributed to the direct use of agrochemical products in industrial agriculture. Whereby direct contact with human and animal food stocks, as well as surrounding ecosystems, exists and therefore higher precautionary measures and customer awareness apply (Bloomberg 2022a). Country-specific analysis of the portfolio composition shows a dominance of companies from the European (47.92 %) and US (35.42 %) markets. This indicates that western companies are clear pioneers when it comes to sustainable innovation and management. In addition, European and American companies are subject to the regulations of the EU Taxonomy resp. the ESG Disclosure Simplification Act, which put additional pressure on the sustainability of a company.

The composition of the lower ESG portfolio includes 12 companies that are ranked among the lowest ESG score companies each year. On the other hand, 97 companies are not listed among the low-ranked companies in any year. Noticeably, for the low ESG scores in both absolute and relative composition, most of the companies included in each year were from the "Specialty Chemicals" category. Specialty Chemicals manufactures products for special customer-specific

applications. As a result, relatively small product volumes are produced in mostly discontinuous production processes (Engel 2021). These non-continuous productions make it difficult to implement long-term predictable, sustainable processes, resulting in the classification of these companies as low ESG performers. Of all the companies listed in the lower ESG portfolio, 80.85 % are based in Asia. The poor ESG scores of companies in these countries stem from the lack of efforts for sustainable innovation, subordinate relevance of sustainability issues, and non-unified - and if present, only very weak - regulations.

The portfolio composition of the upper and lower environment, social, and governance portfolios is similar to the upper and lower ESG portfolios. The respective upper environment, social, and governance portfolio is dominated by companies in the agricultural chemicals sector as well as companies from the European and American markets. The respective lower environment, social, and governance portfolio mainly comprises companies from the specialty chemicals sector and from the Asian region.

Table 5 describes the descriptive statistics of the eight constructed portfolios. All values, except for kurtosis and skewness, are presented in percent. The average monthly return of the LPs is greater than the respective UPs for all sustainability dimensions examined. Meaning that the portfolios with the poorly rated ESG, environment, social, and governance chemical companies on average perform better than the portfolios with the well-rated companies. The minimal sample variance reflects all portfolios' generally consistent performance. The UPs, however, obtain higher extreme values and a wider range of returns. For kurtosis and skewness, no general statement can be made about the UPs or LPs. All portfolios have a high kurtosis value, which characterizes them as a leptokurtic distribution. The skewness is negative for the ESG UP, social UP, social LP, and governance UP, which assigns them many large values and fewer small values. All other portfolios show a right skew, implying many small values in the data.

	ESG Upper Portfolio	ESG Lower Portfolio	Environment Upper Portfolio	Environment Lower Portfolio	Social Upper Portfolio	Social Lower Portfolio	Governance Upper Portfolio	Governance Lower Portfolio
Descriptive Statistics								
Mean	1.00	1.71	1.03	1.40	1.17	1.80	1.10	1.85
Median	0.85	1.60	0.68	1.70	1.37	2.14	1.31	1.87
Standard Deviation	5.14	5.02	5.01	4.83	5.26	4.88	5.05	5.67
Sample Variance	0.26	0.25	0.25	0.23	0.28	0.24	0.25	0.32
Kurtosis	114.17	38.37	119.78	124.68	129.22	46.21	85.30	77.42
Skewness	-12.48	2.48	20.75	23.97	-16.16	-52.84	-16.32	35.66
Min	-14.98	-9.48	-12.17	-9.98	-15.71	-11.21	-14.44	-9.71
Max	15.11	14.56	17.00	15.93	15.99	12.02	13.28	18.00
Range	30.08	24.04	29.18	25.91	31.70	23.23	27.72	27.71

Table 2: Descriptive statistics on monthly portfolio returns for the chemical industry

The assumption that the data is stationary is critical for time series inference. Non-stationary data might result in estimators that are biased or inconsistent (Hashem Pesaran 2015). The Augmented Dickey-Fuller test was used to determine the data's stationarity. The test confirmed that the portfolio data used for the analysis are stationary.

4.1.3 Presentation of Results

The following chapter first validates the regression models used and thereafter presents the results of the regression analyses. A detailed description of the results for the UP and LP considered for ESG, environment, social, and governance scores, together with a significance test, is provided.

4.1.3.1 Validation of Regression Models

To be able to justify the regression model findings, the regression residuals must not fulfill autocorrelation. The Durbin-Watson test was used to look for autocorrelation. The results suggest that there is no problem with autocorrelation in the regression residuals.

To validate the regression models' adequacy, the R^2, Aikake Information Criterion (AIC) and the Bayesian Information Criterion (BIC) values are consulted. The R^2 indicates what percentage of the monthly return can be explained by the factors of the individual model. The R^2 of the ESG UPs ranges between 84.8 % and 85.1 % and ranges between 67.2 % and 67.5 % for the

ESG LPs. The regression results of the other portfolios also show a high R^2, i.e., a high explanatory power (environment UPs: 82.3 % to 82.6%; environment LPs: 65.0 % to 67.6 %; social UPs: 84.9 % to 85.9%; social LPs: 75.4 % to 75.9 %; governance UPs: 83.7 % to 84.3 %; governance LPs: 72.8 % to 74.8 %). An increasing R^2 is also associated with more risk factors considered.

The AIC and BIC are applied to identify the most expressive model for each portfolio. Selecting the model with the lowest AIC value yields the model with the lowest predicted information loss (Aikake 1973). This enhances the overall results by optimizing the explanatory power of the favored model. Cavanaugh (1997) validated Aikake's results for linear regression models and multifactor models, hence it can also be applied to the models utilized here. The same is true for the usage of BIC. Appendix I shows the AIC and BIC values of the portfolios for the specific models used. The FF3 model displays among the lowest AIC and BIC values for all models. Only for the environmental LP is the Carhart model better, and for the social UP and governance LP, the FF5 model is better.

4.1.3.2 Evaluation of the ESG Portfolios

Table 6 shows the results of the FF3, Carhart, FF5, and FF5 + MOM. The corresponding dependent variable is the monthly return of the respective UP or LP sorted by ESG score. Presented are the factor loadings with star markings if the factor is significant, along with the respective standard error in parentheses.

	Dependent variable:							
	Portfolio Returns							
	FF3		Carhart		FF5		FF5 + MOM	
	upper	lower	upper	lower	upper	lower	upper	lower
α	0.0009	0.0085**	0.0009	0.0084**	0.0008	0.0088**	0.0008	0.0088**
	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)
Mkt-RF	1.0832***	0.9310***	1.0720***	0.9446***	1.0506***	0.9344***	1.0451***	0.9482***
	(0.058)	(0.084)	(0.067)	(0.096)	(0.065)	(0.094)	(0.072)	(0.103)
SMB	-0.0182	0.1878	-0.0162	0.1854	-0.0565	0.1371	-0.0543	0.1316
	(0.176)	(0.253)	(0.177)	(0.255)	(0.183)	(0.264)	(0.184)	(0.266)
HML	0.0930	-0.0034	0.0569	0.0401	0.2447	-0.1261	0.2217	-0.0681
	(0.102)	(0.147)	(0.144)	(0.207)	(0.196)	(0.283)	(0.230)	(0.333)
MOM			-0.0456	0.0550			-0.0250	0.0631
			(0.127)	(0.183)			(0.129)	(0.187)
RMW					0.0220	-0.3463	0.0228	-0.3482
					(0.289)	(0.418)	(0.291)	(0.421)
CMA					-0.3766	0.0023	-0.3680	-0.0194
					(0.324)	(0.469)	(0.330)	(0.476)
Observations	72	72	72	72	72	72	72	72
R^2	0.848	0.672	0.848	0.672	0.851	0.675	0.851	0.675
Adjusted R^2	0.841	0.657	0.839	0.653	0.840	0.650	0.838	0.645

Standard errors in parentheses
*p<0.1; **p<0.05; ***p<0.01

Table 3: Regression results of the ESG UP and LP for the chemical industry

As can be seen in the table above the portfolios' alpha is positive for both portfolios in all models. However, the t-statistic and p-value tell that only the alphas for the LPs are statistically significant, with $p < 0.05$. This contradicts the hypothesis, that a good ESG performance has a positive effect on stock returns. The alphas of the LPs vary between 0.0084 % and 0.0088 % per month, or 0.1008 % and 0.1056 % per year, therefore outperforming the market as the regression benchmark, by that amount. For both considered portfolios in all four applied models, the market factor is significant at $p < 0.01$. This means that both portfolios are exposed to market risk. Since the market factor of the UP is > 1 in all models, it moves faster than the market, which is associated with higher volatility. The market factor of the LP is < 1, meaning this portfolio moves slower than the market and has lower volatility. None of the other factors are significant in any of the portfolios considered, hence no conclusions can be drawn regarding

them. The market factor thus has the largest share in explaining the fluctuations in portfolio returns, reducing the applied factor models to just the CAPM.

4.1.3.3 Evaluation of the Environmental Portfolios

Appendix J presents the regression results of the environmental portfolios. The corresponding dependent variable is the monthly return of the respective UP or LP sorted by environmental score.

Similar to the ESG portfolios, only the alphas of the environment LPs are significant positive, with $p < 0.05$ for the FF5 + MOM and $p < 0.1$ for all other models. This implies that the LPs outperform the market by 0.0067 % to 0.0076 % per month or 0.0804 % to 0.0912 % per year. That finding indicates that efforts in the environmental sector are not recognized by the capital market, which contrasts with the hypothesis on environment made before. The market factor is with $p < 0.01$ the only significant factor in all models for both portfolios, which attributes to it the largest share in explaining the return fluctuations. As with the ESG portfolios before, the UP moves faster and more volatile, the LP slower and less volatile than the market.

4.1.3.4 Evaluation of the Social Portfolios

Appendix K presents the regression results of the social portfolios. The corresponding dependent variable is the monthly return of the respective UP or LP sorted by social score.

In the portfolios sorted by social score, the LP, i.e., the portfolio of chemical companies with a poor social score, also performs significantly better than the market. The Social LP outperforms the market by 0.0079 % to 0.0082 % per month or by 0.0948 % to 0.0984 % per year at $p < 0.05$. As no effect on the social UP could be found, this again contradicts with the before defined hypothesis that a good social performance has a positive impact on stock returns. At a significance level of $p < 0.01$ the market factor is significant in all models for both portfolios. Again, the UP moves faster and the LP moves slower than the market. Since none of the risk

factors are significant in any model for the LP, the models for the LP can be reduced to the CAPM. Despite the alpha of the UP models not being significant, statements on the composition of the portfolio can still be made. As the HLM factor for FF3 and FF5 is positive and significant, the social UP consists of value stocks. Value stocks are shares of companies whose so-called intrinsic values are higher than the market price of their share, it is thus an undervalued share (Krupka 2022). Additionally, the CMA factor in the FF5 and FF5 + MOM for the social UP is negative significant. Meaning that the social UP follows an aggressive investment structure, which involves higher risks to maximize possible rewards (Holloway 1983).

4.1.3.5 Evaluation of the Governance Portfolios

Appendix L presents the regression results of the governance portfolios. The corresponding dependent variable is the monthly return of the respective UP or LP sorted by governance score. Similar to the ESG, environment, and social portfolios, only the alphas of the governance LPs are significant positive, with $p < 0.05$ for all models. Generating 0.0090 % to 0.0101 % per month or 0.108 % to 0.1212 % per year on excess returns. Again, this is in contrast to the hypothesis made earlier about the influence of governance on stock performance. At a significance level of $p < 0.01$ the market factor is significant in all models for both portfolios. In this case, the market factors of both portfolios are > 1, which means that they both move faster than the market, but the LP is subject to higher volatility compared to the UP. The RMW factor is significant for the LP in the FF5 and FF5 + MOM. As it is negative, the LP appears to consist of weak firms with low profitability. Since none of the risk factors are significant in any model for the UP, the models for the UP can be reduced to the CAPM.

4.1.4 Discussion of Results

The following chapter concludes by discussing the results presented in this thesis. Summarizing theoretical and practical implications are given.

4.1.4.1 Summary

The results of the multifactor regression models lead to several key findings about the impact of ESG rating on stock returns of globally considered chemical companies. Portfolios classified by high ESG, environmental, social, and governance scores do not exhibit significant abnormal returns, implying a neutral link between good ESG performance and chemical companies' stock returns. Thus, the empirical results are not consistent with the hypothesis that ESG score, and its individual pillars have a positive effect on stock return. This finding is in contrast to the results of Rodionova et al. (2022), Kim et al. (2015) and Yang and Baasandorj (2017). Their studies were able to find significant abnormal returns for the sectors they examined. Several reasons for these differing results are explored next.

One possible explanation for the disparities is that the research listed above investigate the association between ESG performance and stock returns in different time frames and sectors. Between 2015 and 2020, the positive association may not exist in the chemical industry, implying that the results are not convertible to other industries.

In addition, companies with high ESG scores in all chemical UPs are mostly located in Europe and the US. It is widely known that companies in those markets have already made cost intensive investments into abatement efforts, especially in terms of emissions savings and social aspects. This makes them one of the best-in-class companies regarding the ESG score, but also reduces their profit, which leads to lower stock returns. Sood and Tellis (2009) already proved in their research that innovation takes time to become visible in the company's stock returns. So, the positive impact on stock returns of the investments and restructurings made will inevitably be visible in the future, giving these companies an advantage. This is also underlined by the fact that positive excess returns of all UPs are present in the models' results, but they are not significant.

The fact that for the social UP the HML factor is significant positive in FF3 and FF5 also speaks for a not yet correct evaluation of current ESG efforts. The thus confirmed composition of the social UP of value stocks literally expresses that the portfolio consists of undervalued stocks, as their intrinsic values are not correctly reflected in the market price.

Coming back to the comparability with the other studies by Rodionova et al. (2022), Kim et al. (2015) and Yang and Baasandorj (2017), it is important to mention that they looked at sectors less in need of ESG innovation investments. The banking, software, and real estate industries they looked at, have marginal CO_2 emissions compared to the chemical industry. For a better ESG rating, companies in these sectors must therefore undertake lower ESG investments, whereby the positive effect of ESG on performance could already be demonstrated here.

Another finding is that the ESG, environmental, social, and governance LPs significantly outperform the market. Whereby the governance LP achieves the highest excess returns compared to the other LPs. The basis of this finding could be that the companies from the LPs are mostly located in the Asian region. Companies in this region are subordinating expensive abatement costs, due to a lack of regulatory guidelines and a different cultural and mental attitude towards ESG compared to the European and US area. Thus, cost intensive ESG innovation expenditures are omitted by the chemical companies located there. As a result, higher returns can be achieved, leading, for example, to higher dividends being paid out, which ultimately has a positive impact on their stock returns. In the long term, however, these companies will likely not be able to maintain their excess returns. Climate change will inevitably force them to make changes and invest in ESG. Their current lack of ESG investments is therefore only postponed and not removed and will be necessary in the long term. Which will lead to lower stock returns for them in the future.

In conclusion, it can be said that the chemical sector is experiencing a ESG upheaval. Chemical companies that are initiating only few ESG initiatives are for now performing better, but in the

future will be caught up in their stock returns by the ESG-compliant companies. It can thus be said that the capital market does currently not correctly reflect ESG for the chemical industry. At present ESG is not 100 % internalized by the chemical companies. Which, from a macroeconomic perspective, means that the cost savings of firms with low ESG ratings must currently be borne by the environment and society as a whole.

4.1.4.2 Theoretical and Practical Implications

This research can be used in both academics and practice. Despite existing literature on the relationship between ESG and financial performance indicators, especially in the context of banking, hospitality, airline, software, and real estate industry, research on the relationship between ESG and stock performance in the global chemical industry has been left out. This empirical analysis fills the gap of a still non-existing consideration of stock returns based on portfolios of chemical companies with high and low ESG ratings. The additional consideration of the individual pillar scores (environment, social, governance) allows their influence on the ESG rating to be better illuminated. By means of the FF3, Carhart, FF5 and FF5 + MOM, it was possible to evaluate how the portfolios of high and low rated chemical companies perform compared to market as benchmark.

Looking at the resulting practical meaning of this research, an excess return is evident when investors invest in chemical companies with poor ESG ratings. Although significant excess returns for chemical companies with a high ESG rating have not yet been proven, investors with a long-term investment approach should not neglect them. Current economic and regulatory changes, as well as greater stakeholder awareness, indicate that significant excess returns can be achieved in the long term with ESG-compliant chemical companies. When investors invest in chemical companies in the Asian region, they should be aware that these are likely to be companies with a poor ESG score. In contrast, investments in European and US chemical companies are likely to be investments in companies with a high ESG score.

5 Conclusion

The following chapter concludes the overall findings of the impact of ESG performance on stock returns in the automotive, chemical, apparel manufacturers and retailers, and utility industry. The findings are presented in the light of applicable limitations from which ultimately further research recommendations are derived.

5.1 Summary

This thesis analyzes the impact of ESG performance on stock returns in capital markets. Thereby, the focus was placed on four global sectors, the automotive, chemical, apparel manufacturer and retailer, and utility industry. For each industry two portfolios with globally listed companies were built. One consisting of companies with the highest ESG performance of the respective industry and one consisting of companies with the lowest ESG performance. Bloomberg's ESG rating was used to measure the companies' ESG performance within the period from 2015 to 2020. To determine abnormal portfolio returns of the constructed portfolios, the multiple linear regression models FF3, Carhart, FF5, and FF5 + MOM were applied. Ordinary least square regressions in Python were used to obtain the coefficients of the respective factors and intercepts. Using the market as performance benchmark, the models reveal if the market values ESG scores accordingly so that companies with high/low ESG scores can achieve access returns on the capital market. Additionally, the three underlying dimensions of ESG are evaluated individually in the same way as the ESG score for further insights.

Based on theoretical frameworks and previous academic research in this field, a positive relationship between ESG performance and stock returns was expected. However, this thesis finds no significant results for the positive influence of ESG on stock returns for any of the four industries. Furthermore, there is no evidence of a positive relationship between any of the three individual dimensions environment, social, and governance and abnormal stock returns.

Nevertheless, the chemical and apparel manufacturers and retailers industries demonstrate a significant relationship between poor ESG performance and abnormal returns. The same result was also observed in the lower portfolios of the environment, social, and governance pillars.

The analysis on the automotive and utility industry reveals that neither the ESG performance, nor the individual dimensions have any effect on abnormal stock returns.

Although the results do not confirm the initially expected outcome, the highly complex nature of investment decision requires the incorporation of a broader perspective. Due to current economic and regulatory developments and increased stakeholder awareness, ESG is expected to be the next major disruption in the investment context. Therefore, ESG will be inevitable in the future and redefine the investment landscape. Until then, investors need to distinguish short-term and long-term goals and adapt their investment strategy accordingly. “Ultimately, purpose is the engine of long-term profitability” (BlackRock 2020).

5.2 Limitations and Further Research

The overall findings for this study should be interpreted in the light of some fundamental limitations that apply, especially with ESG being a relatively new trend in investment decisions.

First, there are limitations towards the ESG rating scores and their informative value. Several studies show a low convergence in and agreement between different ESG ratings (Abhayawansa and Mooneeapen 2021), with minimal correlation between ESG scores from different rating agencies (Dimson, Marsh, and Staunton 2020). This indicates that the same company with a high rating from one agency could get a middle or low score from another rating provider, with the effect being even higher when just comparing individual dimensions. This can be attributed to problems associated with different dimensionalities and weightings of the sub-categories, as well as validity and reliability problems in measurement frameworks.

Secondly, the size bias should be considered. This originates in rating agency's reliance on publicly disclosed data, towards which larger and multi-national companies have more resources allocated. Therefore, larger companies have higher data availability and increased transparency, ultimately often resulting in better ESG ratings (Drempetic, Klein, and Zwergel 2020).

Furthermore, the scope of the examined industries is limited. All datasets only cover the period from 2015 to 2020, reflecting a relatively short period of six years. In addition, only publicly traded companies that are listed in Bloomberg's ESG rating with complete data series are considered. This creates the risk of an unbalanced overall impression of the sectors, as poorly performing companies, for example, are not included due to missing data points.

To examine the relationship between ESG performance and stock returns in the automotive, chemical, apparel manufacturers and retailers, and utility industry in more detail, further research can be conducted. One can focus on individual markets, since geographically separated capital markets do not value sustainability efforts equally yet. For example, the European and Asian capital market have a different perception and appreciation of sustainability efforts. In addition, the same analyses could be conducted with scores from an alternative rating agency. The limited correlation between ESG rating providers may cause different results. Finally, the use of a different portfolio construction approach could also lead to diverging results. Literature proposes a zero-investment long-short strategy, where companies with a high ESG score take a long position and companies with a low ESG score take a short position.

With the ongoing adoption of ESG, more and more investors will be attracted to ESG aware investing. However, the investment dynamics in this emerging market remain largely unknown. Nevertheless, the results of this thesis raise public awareness of this still largely unexplored field and provide a foundation for further studies.

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Appendix

Appendix A

Score structure of Bloomberg's ESG dimensions

ENVIRONMENTAL	SOCIAL	GOVERNANCE
Air Quality Air Emissions Air Emissions Policies **Climate Exposure** Transition Risk **Ecological Impact** Ecosystem Protection Environmental Fines Environmental Incidents **Energy Management** Energy Consumption Renewable Energy Use **Environmental Supply Chain Management** Sustainable Sourcing **GHG Emissions Management** GHG Emissions GHG Emissions Policies GHG Regulation GHG Target **Sustainable Product** Green Product **Waste Management** Hazardous Waste Generation Hazardous Waste Recycling Waste Generation Waste Recycling **Water Management** Wastewater Water Use Water Use Policies	**Community Rights & Relation** Community & Human Rights Community Relations **Ethics & Compliance** Business Ethics Competitive Behavior Legal & Regulatory Management **Labor & Employment Practices** Labor Actions Organized Labor Training **Occupational Health & Safety Management** Fatalities Health & Safety Fines Health & Safety Polices Safety Incidents **Operational Risk Mangement** Operational Incidents Operational Preparedness **Product Quality Management** Product Quality & Safety **Social Supply Chain Management** Supplier Social Compliance	BOARD COMPOSITION **Director Roles** CEO Roles Chair Roles Board Roles **Diversity** Age Diversity Gender Diversity **Independence** Board Leadership Independence Board Independence **Refreshment** Board Refreshment Chair Refreshment EXECUTIVE COMPENSATION **Incentive Structure** CEO Incentive Plan Design Executive Incentive Plan Design Executive Pay Equity Executive Pay Linkages **Pay Governance** Compensation Board Oversight Gender Diversity Say on Pay Pay Policies **Pay for Performance** Fixed Pay Alignment Variable Pay Performance SHAREHOLDER RIGHTS **Shareholder Policies** Takeover Defense Voting Rights Director Election Policies **Director Voting** Director Terms Director Support

Source: Own representation based on Bloomberg (2022).

Appendix B

Example of Python code for FF3 of UP ESG

```
pip install pandas-datareader

import pandas_datareader.data as reader

import pandas as pd

import numpy as np

import datetime as dt

import statsmodels.api as sm

import matplotlib.pyplot as plt

%matplotlib inline


#time horizon of the research

start = dt.date(2015,1,1)

end = dt.date(2020,12,31)


#importing ESG data from pre-cleaned excel sheet

df = pd.read_excel(r"/Users/patricia/Documents/NOVA SBE/Work Project/ESG-Portfolio upper 20% 201
5-2020.xlsx", sheet_name='ESG_lower_PF')


#Data preperation

df["Date"] = pd.to_datetime(df["Date"])

df["Date"] = df["Date"].dt.to_period("M")

df.set_index('Date')


#getting the farma french 3 factors for the regression via online request

factors = reader.DataReader('Developed_3_Factors', 'famafrench',start,end)[0]
```

```
#look into data structure to make sure that return frame and factors frame have the same size for easy mergi
ng
factors.shape
df.shape

#merging the two data frames
merge = pd.merge(df, factors, on = 'Date')

#set Date as index
merge = merge.set_index("Date")

#divide factors by 100 because they are displayed in percent
merge[['Mkt-RF', 'SMB', 'HML', 'RF']] = merge[['Mkt-RF', 'SMB', 'HML', 'RF']]/100
merge['PF return - RF'] = merge['upper_PF_return']- merge['RF']

#Regression
y = merge['PF return - RF'] #dependent variable
x = merge[['Mkt-RF', 'SMB', 'HML']]
X_sm = sm.add_constant(x) #adding a constant to the model
model = sm.OLS(y,X_sm)
results = model.fit()
print(results.summary())
```

Source: Own code based on Teo (2021) and modified.

Appendix H

Geographical distribution by listing stock exchange of companies in the chemical industry

Country	N	%	Country	N	%
United States	27	18.49%	Finland	2	1.37%
Japan	23	15.75%	Norway	2	1.37%
South Korea	17	11.64%	Pakistan	2	1.37%
India	9	6.16%	Russian Federation	2	1.37%
China	8	5.48%	Austria	1	0.68%
Germany	7	4.79%	Brazil	1	0.68%
United Kingdom	6	4.11%	Canada	1	0.68%
France	5	3.42%	Chile	1	0.68%
Hong Kong	5	3.42%	Israel	1	0.68%
Netherlands	4	2.74%	Malaysia	1	0.68%
Australia	3	2.05%	Poland	1	0.68%
Mexico	3	2.05%	Saudi Arabia	1	0.68%
Switzerland	3	2.05%	South Africa	1	0.68%
Taiwan	3	2.05%	Sweden	1	0.68%
Belgium	2	1.37%	Thailand	1	0.68%
Denmark	2	1.37%			

Source: Own representation

Appendix I

AIC and BIC values for UP and LP of chemical industry in different model configurations

		Portfolio							
Model		**ESG_upper**	**ESG_lower**	**E_upper**	**E_lower**	**S_upper**	**S_lower**	**G_upper**	**G_lower**
FF3									
	AIC	**-351.5**	**-299.3**	**-344.1**	**-300.0**	**-348.4**	**-324.1**	**-349.0**	**-295.0**
	BIC	**-342.4**	**-290.2**	**-335.0**	**290.9**	**-339.3**	**315.0**	**-339.9**	**-285.9**
Carhart									
	AIC	-349.7	-297.4	-342.6	**-300.9**	-346.5	-322.4	-347.0	-293.4
	BIC	-338.3	-286.0	-331.3	**289.5**	-335.1	-311.0	-335.7	-282.0
FF5									
	AIC	-349.0	-296.0	-340.6	-299.1	**-349.7**	-321.1	-347.6	**-296.2**
	BIC	-335.4	-282.3	-327.0	-285.4	**-336.0**	-307.4	-333.9	**-282.5**
FF5 + MOM									
	AIC	-347.1	-294.1	-339.1	-299.6	-347.7	-319.5	-345.6	-294.8
	BIC	-331.1	-278.1	-323.1	-283.7	-331.8	-303.6	-329.6	-278.9

Source: Own representation

Appendix J

Regression results for the environmental UP and LP for the chemical industry

	Dependent variable:							
	Portfolio Returns							
	FF3		Carhart		FF5		FF5 + MOM	
	upper	lower	upper	lower	upper	lower	upper	lower
α	0.0009	0.0067*	0.001	0.0069*	0.0011	0.0073*	0.0012	0.0076**
	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)
Mkt-RF	1.0598***	0.8606***	1.0365***	0.7877***	1.0526***	0.8477***	1.0337***	0.7878***
	(0.062)	(-0.084)	(-0.070)	(-0.094)	(-0.069)	(-0.092)	(-0.076)	(-0.099)
SMB	-0.16	0.2882	-0.156	0.301	-0.1935	0.1661	-0.1860	0.1901
	(-0.185)	(-0.252)	(-0.186)	(-0.249)	(-0.194)	(-0.258)	(-0.195)	(-0.256)
HML	0.0172	0.0996	-0.0571	-0.1333	0.0272	-0.0346	-0.0523	-0.2864
	(0.108)	(0.146)	(0.151)	(0.202)	(0.208)	(0.277)	(0.244)	(0.320)
MOM			-0.0939	-0.2943			-0.0866	-0.2742
			(0.134)	(0.179)			(0.137)	(0.180)
RMW					-0.1499	-0.6393	-0.1473	-0.6312
					(0.306)	(0.409)	(0.308)	(0.405)
CMA					-0.0968	-0.2207	-0.0671	-0.1265
					(0.344)	(0.459)	(0.349)	(0.458)
Observations	72	72	72	72	72	72	72	72
R^2	0.823	0.65	0.825	0.664	0.825	0.665	0.826	0.676
Adjusted R^2	0.816	0.635	0.814	0.644	0.811	0.639	0.810	0.646

Standard errors in parentheses
*p<0.1; **p<0.05; ***p<0.01

Source: Own representation

Appendix K

Regression results for the social UP and LP for the chemical industry

	Dependent variable:							
	Portfolio Returns							
	FF3		Carhart		FF5		FF5 + MOM	
	upper	lower	upper	lower	upper	lower	upper	lower
α	0.0037	0.0082**	0.0038	0.0081**	0.0040	0.0080**	0.0040	0.0079**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Mkt-RF	1.0723***	0.9572***	1.0658***	0.9757***	1.0285***	0.9222***	1.0311***	0.9437***
	(0.060)	(0.071)	(0.068)	(0.081)	(0.065)	(0.079)	(0.071)	(0.087)
SMB	0.1719	0.2779	0.1731	0.2747	0.0588	0.2280	0.0578	0.2194
	(0.180)	(0.213)	(0.181)	(0.214)	(0.182)	(0.222)	(0.184)	(0.223)
HML	0.2551**	-0.1254	0.2342	-0.0662	0.3503*	0.0336	0.3611	0.1240
	(0.105)	(0.124)	(0.147)	(0.174)	(0.195)	(0.238)	(0.229)	(0.279)
MOM			-0.0264	0.0748			0.0118	0.0984
			(0.13)	(0.154)			(0.129)	(0.157)
RMW					-0.3245	0.09451	-0.3248	0.0922
					(0.288)	(0.351)	(0.290)	(0.352)
CMA					-0.5478*	-0.4174	-0.5518*	-0.4512
					(0.323)	(0.394)	(0.328)	(0.399)
Observations	72	72	72	72	72	72	72	72
R^2	0.849	0.754	0.849	0.755	0.859	0.758	0.859	0.759
Adjusted R^2	0.842	0.743	0.840	0.741	0.849	0.739	0.846	0.737

Standard errors in parentheses
*p<0.1; **p<0.05; ***p<0.01

Source: Own representation

Appendix L

Regression results for the governance UP and LP for the chemical industry

	Dependent variable:							
	Portfolio Returns							
	FF3		Carhart		FF5		FF5 + MOM	
	upper	lower	upper	lower	upper	lower	upper	lower
α	0.0020	0.0091**	0.0020	0.0090**	0.0021	0.0101**	0.0021	0.0099**
	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)
Mkt-RF	1.0621***	1.1190***	1.0586***	1.1445***	1.0244***	1.1094***	1.0275***	1.1390***
	(0.059)	(0.087)	(0.068)	(0.099)	(0.066)	(0.094)	(0.072)	(0.103)
SMB	-0.0795	-0.1410	-0.0789	-0.1455	-0.1522	-0.3065	-0.1534	-0.3184
	(0.179)	(0.260)	(0.189)	(0.262)	(0.184)	(0.264)	(0.186)	(0.265)
HML	0.0885	0.0920	0.0772	0.1734	0.2486	-0.0459	0.2615	0.0789
	(0.104)	(0.151)	(0.147)	(0.213)	(0.198)	(0.283)	(0.233)	(0.331)
MOM			-0.0142	0.1029			0.0141	0.1359
			(0.130)	(0.188)			(0.131)	(0.186)
RMW					-0.0777	-0.8067*	-0.0781	-0.8107*
					(0.292)	(0.417)	(0.294)	(0.474)
CMA					-0.4554	-0.2142	-0.4602	-0.2609
					(0.328)	(0.468)	(0.333)	(0.474)
Observations	72	72	72	72	72	72	72	72
R^2	0.837	0.728	0.837	0.729	0.843	0.746	0.843	0.748
Adjusted R^2	0.830	0.716	0.827	0.713	0.831	0.727	0.828	0.725

Standard errors in parentheses
*p<0.1; **p<0.05; ***p<0.01

Source: Own representation