UNIVERSITÉ LIBRE DE BRUXELLES

Solvay Brussels School
Economics & Management

MEMOIRE

Présenté en vue de l'obtention du Master en **Ingénieur de Gestion**, finalité **spécialisée (QTEM)**

The financial impact of Covid-19: a sectoral and geographical event study of the performance and resilience of portfolios composed of European ESG best-in-class stocks

Par Hadrien Venance

Directeur: Professeur Hugues Pirotte
Assesseur: Professeur Kim Oosterlinck

J'autorise la consultation de ce mémoire

The financial impact of COVID-19: a sectoral and geographical event study of the performance and resilience of portfolios composed of European ESG best-in-class stocks

Master thesis submitted by Hadrien Venance in order to be awarded the degree of Master in Business Engineering
Academic year 2022-2023

Executive summary
The increasing interest in Environmental, Social, and Governance (ESG) concerns in financial markets has led to the development of strategies such as ESG best-in-class investing, which uses metrics like ESG scores to assess the performance of sampled firms. These ESG approaches have gained even more prominence in the context of the COVID-19 pandemic, with European countries prioritizing sustainability in their recovery efforts (von der Leyen, 2020) and asset managers integrating ESG considerations into their investment processes (Wu & Juvyns, 2020). The outbreak of the pandemic also led to unprecedented market turmoil and aversion of risk for investors (OEDC, 2020). That is, this period instigates a thorough examination of firms' risk-adjusted performance depending on their ESG scores.

This thesis builds on the existing literature and aims at filling the voids by implementing advanced methodologies to evaluate the resilience and idiosyncratic risk of ESG best-in-class stocks during the pandemic. It conducts a comprehensive examination of the effects of the pandemic throughout European countries. Additionally, it performs an in-depth analysis of the financial performance variations across sectors. Subsequently, this research endeavors to examine the differential performance and resilience of high-scoring ESG firms in comparison to their low-scoring peers during the COVID-19 shock, and to identify the underlying financial factors contributing to these outcomes.

To perform the analyses, a sample of 32 firms listed on European stock exchanges has been gathered. The data encompasses these firms alongside some of their inherent characteristics (e.g. debt-to-equity ratio, market capitalization, etc.) and their ESG combined (ESGC) scores. Thereupon, portfolios were constructed based on these scores, with firms scoring in the top or bottom decile of the sample being classified as *ESG leaders* or *ESG laggards*, respectively.
The first data analysis indicates that *leaders* firms underperformed but exhibited conspicuous tail-risk resilience during the crisis. This statement relies on a wide range of metrics, including

mean returns, skewness, and financial indicators as well as Value at Risk (VaR), Δ VaR, Expected Shortfall (ES), and drawdown features as measures of risk. One suggested reason for the underperformance is the ESG best-in-class approach's flaw of relying on one single score, whereas this strategy could rather blend additional features (Napoletano & Curry, 2021, as cited by Martinez, 2021). On the other side, the portfolio's construction technique is notably a vector of overall performance. In light of the latter, the outperformance of capitalization-weighted portfolios suggests that the European market has supposedly experienced momentum effects during market turmoil linked to the pandemic (Fournier, 2022).

The second analysis examines the impact of the pandemic on the returns of highly and lowly-scored ESG firms at the country level. Two event study regressions have been modeled, namely a market model (MM) and a refined firms' features model. The results of the event study using solely parameters of the market model indicate that the coefficients of each country's market index are statistically significant and suggest that the performance of ESG investments may vary based on geographical location (Müller, 2020). Then, even though the two regressions only partly share the same outcomes, it can be assumed that firms' stock returns have overreacted to the announcement of lockdowns during the pre-event and on-event periods (Maneenop & Kotcharin, 2020) - albeit the total effect for the three analysed periods is statistically insignificant. In Spain and the UK, it appears that *ESG leaders* firms have been able to significantly better cope with lockdown announcements than their non-ESG counterparts, supporting the fact that ESG scores can act as a risk management tool. Moreover, the insurance function of ESG performance has been verified, meaning ESGC scores demonstrate a heightened level of importance during studied events (Engle et al., 2020, as cited by Broadstock et al., 2021).

The third analysis of this thesis focuses on the effects of the pandemic per industry and their underlying sources. The results indicate that while belonging to a specific ESG cluster (i.e. *leaders* or *laggards*) does not have a significant impact on financial performance, firm-specific characteristics such as inorganic growth by acquisition, low leverage, new product launches, diversification, and long-standing partnerships with stakeholders play an important role in helping companies weather the market crisis. In contrast, high levels of debt negatively affected financial performance. However, two industries, namely utilities and industrials, exhibit higher financial ratios for companies actively working towards combating climate change. As a result, it may be worthwhile to create a new industry classification benchmark related to this topic and compare the findings to previous research to determine if these firms can be considered essential firms (Albuquerque et al., 2020) - in other words, if firms belonging to

this new sector show resilience, it might be because they are vital to the stability of the world economy. The synthesis of these findings implies that accounting-based financial ratios and specific corporate strategies hold key significance in explaining a firm's performance during periods of economic stress, rather than adherence to ESG principles or industry classification.

Overall, this study provides a comprehensive approach to analyzing the effectiveness of ESG best-in-class investing in managing risk and maximizing returns during market turmoil. Still, it is noteworthy that the results must be viewed cautiously, as the stringent threshold for best-in-class classification results in limited sample size and is dependent on the chosen ESG data provider - Refinitiv. Furthermore, the event study models' results may be influenced by confounding or hidden variables that have not been taken into account in the specified regressions. To verify these results, further testing on different datasets is recommended.
In the immediate future, this study emphasizes the importance for investors, policy-makers, and financial institutions to reevaluate their approach towards ESG best-in-class investing. The Sustainable Finance Disclosure Regulation (SFDR) in Europe will increase transparency and public reporting of ESG performance, which will further benefit the potential of ESG investments in times of market turmoil. However, solely relying on regulations will not suffice, stakeholders must actively advocate for this type of investment.

Keywords: *Sustainable finance, ESG best-in-class, COVID-19 pandemic, portfolio performance, resilience, drawdowns, statistical analysis for finance, event study, benchmarking analysis*.

Contents

Acknowledgments

The writing of this thesis marks the end of my time at Solvay Brussels School and the end of my time as a student. For the past months, I have spent countless hours studying, gathering information and challenging myself to get this work I am truly proud of. I would like to take this opportunity to thank those who have helped me get to where I am today and who have contributed to my enjoyable years at the Université Libre de Bruxelles.

I wish to thank my family and friends for their undeniable support during these last 5 years and for guiding me to make the best choices even in times of doubt. I would not have achieved so much without their help. I also think in particular of my grandfather who taught me to always look for the best in myself, and of Céline who continually supported me and helped me proofread this work.

I am also grateful to have met other such nice students, at ULB and during my two exchanges, people with whom I was able to grow relationally and intellectually. They became true friends and I am now looking forward to seeing where the future will bring us all.

Lastly, I would like to thank professor Hugues Pirotte for accepting to supervise my thesis and for providing me useful feedback and structure for the ideas I wanted to develop through this work. At the same time, I wanted to thank the ULB and its teachers who allowed me to develop my critical mind and to lay a solid foundation for my future career.

Introduction

The emergence and evolution of Environmental, Social, and Governance (ESG) concerns have recently been a topic of growing interest in the context of financial markets. Over the past decades, investors have experienced a wave of awareness about the impacts they can have, while investing in fields linked to environmental and natural disasters, social inclusion and equality, and governance. That is, their investing preferences have shifted from the sole maximisation of returns to taking into account the negative externalities of their investments and these latter priorities are now steering their investment behaviours. Therefore, stockholders are increasingly looking for companies implementing strong policies in line with ESG issues. It means that they continuously challenge industries to re-invent their sustainability agendas alongside their higher ESG expectations. As a result, portfolio managers do not have any other choice than to directly include sustainability in their investment processes. To overcome this challenge of sustainability in finance, specialists have started shaping new strategies within their processes. Several methods have been developed such as engagement and voting, ESG integration, impact investing, and best-in-class investing. All of these depend on the investor's objective sought. In this thesis, the choice has been made to focus on ESG best-in-class approach. The reasons underlying this choice are, among others, the facilitated availability of metrics (even in companies' annual reports) and lesser burdensome limitations compared to other methods. To enable and smooth the emergence of these new trends, ESG data has greatly expanded since the early years of the 21st century, bringing to the forefront ESG scores as a straightforward and comprehensive approach to assess the ESG performance of invested firms.

The recent outbreak of COVID-19 in 2020 has plunged the world in a global economic recession. The impacts of this new virus have been global, causing deaths and infections of millions of people, triggering social disruption, reducing human activity, and, ultimately, leading to (almost) unprecedented economic and financial market turmoil. This global impact on financial markets has also led to an increasing aversion to risk not seen since the global financial crisis of 2008 according to the OECD (OECD, 2020) - that is, it also further lays foundations for investigating firms' risk-based market performances. In this challenging context, ESG investments have interestingly gained prominence as a result of the drive of politics, investors, and financial institutions. For instance, the European Union (EU) has significantly shown its leadership in ESG compliance by showcasing the *Green Deal*, approved at the beginning of 2020, as one of the main tools for recovery from the pandemic. In its financial component, the European *Green Deal Investment Plan* will activate EU funding and shape a

congruent framework to ease and provide incentives to unlock public and private investments geared towards a more climate-neutral, green, competitive, and inclusive economy. Then, it has also been proven that the investors' awareness is even more salient in the context of global crises (Martinez, 2021) - thus, further shedding the light on ESG investments. Moreover, asset managers have prioritized the integration of ESG drivers into their investment process to stay in line with investors' preferences (Wu & Juvyns, 2020). These bold reactions from distinct backgrounds have placed ESG at the forefront. As a matter of fact, the pandemic has been closely interconnected to the three components of ESG - the environmental dimension was tied to COVID-19's origins, namely an environmental management problem involving animals and humans; the social dimension was undermined by lockdowns as social contacts were restrained to staunch the virus spread; and the governance dimension was involved as corporate management and governments had to act together to support their populations (Hoang, Segbotangni & Lahiani, 2021).

Subsequently, scholars have built on this momentum to investigate firms' stock market performance and resilience with respect to their approach towards sustainability (i.e. the impact of integrating ESG initiatives at firms' core businesses). They found inconclusive results and manifold discrepancies. In this research, the literature will be reviewed by focusing on two main topics. The first strand of the literature refers to the body of research studying the impact of COVID-19 on financial markets. The other strand of the literature encompasses the body of knowledge on the relationship between a firm's sustainability and its underlying risk-adjusted performance. This thesis will examine returns, risks, and wealth changes. It will also study firms' annual reports to uncover the underlying reasons of these results and determine if there is a statistically significant reaction to the pandemic for highly and lowly-rated ESG stocks.

The theoretical background behind this thesis blends these two strands of literature in order to close some of the gaps related to pitfalls in the aforementioned literature. The gaps that will be tackled in this paper are threefold. First, previous event studies analyzing the impact of the pandemic focused solely on specific industries (Maneenop & Kotcharin, 2020), or specific countries (Abedifar et al., 2022; Li, Pan & Sohail, 2022). This has resulted in divergent opinions as impacts were different depending on the type of product or firms analysed (Li et al., 2022). Therefore, no known (event) study has decided to tackle the same scope as this thesis, which is broader from a geographical and a sectoral point of view - i.e. it includes stocks from various industries listed in Europe.
Second, most researchers supplemented their regressions and panel data analyses with fixed-effects for firms' industries to inspect differences in performance (Hoang, Segbotangni &

Lahiani, 2021; Abedifar et al., 2022; Albuquerque et al., 2020) Yet, these scholars did not try to deeply delve into the importance and underlying consequences of belonging to a specific industry and what it implies - no studies clearly differentiated between sectors from a financial analysis performance point of view. In fact, the effect of the COVID-19 pandemic crisis has not been similar for all sectors. Thus, depending on the vulnerability of firms' core businesses, there were different and opposite sectorial impacts (Boldeanu et al., 2022). Overall, this issue will be worth considering in the current work.
Third, while most scholars analyzing the resilience of ESG stocks during the pandemic regarded resilience and idiosyncratic risk by computing volatility, standard deviation, or cumulative flows (Abedifar et al., 2022; Omura, Roca & Nakai, 2021), this thesis will seek to use more advanced techniques such as VaR, ES, and drawdowns to inspect resilience.
Hence, this thesis will contribute to the literature by attempting to respond to the following research question: how did best-in-class ESG scoring firms perform and withstand during the COVID-19 shock compared to their worst-in-class peer groups? And, what are the reasons behind their performance and resilience results?

The first part of this paper lays out the state-of-the-art knowledge on sustainable investments, the impact of a global pandemic on European markets, the resilience and performance fundamentals regarding ESG investments, and the portfolios construction fundamentals. Then, the analysed data is thoroughly explained. Later, the methodology is illustrated in order to answer the research question and bring novelty to this topic. Subsequently, results are discussed and robustly tested in a following section. The last part concludes, gathers the main insights that have been established, and raises and discusess additional perspectives. Overall, the contribution of this thesis to the existing literature is threefold. Performance assessments and risk measurements are compiled by distinguishing between firms scoring the highest and the lowest on ESG initiatives. Besides, the event study methodology is brought in order to assess financial impact of pandemic lockdowns in European countries on which selected stocks were traded. On top of this, in-depth financial analysis per industry is carried out based on firms' annual reports.

Chapter 1

Literature review

This chapter lays out relevant theories related to sustainable investments, in particular the ESG best-in-class investment strategy, to the impact of COVID-19 on European financial markets, and to financial and resilience fundamentals linked to firms' ESG characteristics. It focuses on proven insights and discusses about potential grey fields. The aim of this chapter is to ultimately draw the current state of knowledge in order to determine areas of research which are worth deepening - hence, the research question of this thesis (see preceding Introduction chapter) relies on this.

1.1 Sustainable investments: nomenclature and main differences

This sections outlines an overview of the current state of sustainable investments. It exposes the contemporary nomenclature of these investments in the finance industry and the choice of strategy this thesis will tackle. In fact, it is important to set the scene for this selected investment approach to understand its main characteristics as well as its influence on statistical results during the pandemic.

Nowadays, a rising share of investments and common stocks is not solely geared towards financial results but is also driven by environmental, social, and governance concerns (ESG). According to Bloomberg journalist, Saijel Kishan (2022), this share of ESG assets reached 41 trillion of $ at the end of 2021, meaning that globally one in three dollars is ESG-related and this amount is expected to rise in the future. Yet, financial headlines of this kind are rather imprecise as the ESG wording is mainstream and encompasses various investments with different purposes.

The nomenclature of sustainable investments does not appear to follow a widely accepted framework. After analysing and cross-checking the findings of numerous institutional and trusted sources (Eurosif, Triodos, Harvard Business School (HBS), State Street Global Advisors (SSGA)), it is clear that at the moment there is not one single standard for the classification of responsible investments. Nevertheless, this section will try to provide a summary of known classifications that is as accurate and up-to-date as possible. Therefore, it has been decided to build upon Eurosif classification as it is the leading European association for the promotion and advancement of sustainable and responsible investments across Europe. Eurosif classifies responsible investments in the following seven strategies (Eurosif, 2021):

1. **Best-in-class**
   In this strategy, best-performing investments within a category (i.e. industry, country, etc.) receive a score based on their ESG performance and they are selected if they score well. Thus, companies that score best are selected and altogether they can form a built-in financial portfolio. Most of the time, these ratings come from third-party rating agencies that build specific algorithms and spend substantial resources to get an indicator as relevant as possible.
   The best-in-class methodology is widely accepted as it enables a low tracking error (see Appendix 7.1 for definition and formula) and it adapts quite well to a passive strategy. However, the biggest shortcoming of a best-in-class approach is that it is seen by many ESG analysts as the least sustainable strategy because investors can decide from which threshold they will select investments (Triodos Investement Management, n.d.). To remedy this issue, this paper has decided to choose a significantly high threshold while building portfolios under analysis - see 2.3 for info on sample construction.

2. **Engagement and voting**
   It consists of active ownership through share votes and durable engagement with companies regarding ESG concerns. This lengthy process is intended to influence the behaviour and increase the disclosure and transparency of companies.
   The goal for shareholders is threefold. First, they can influence the way the company acts at large to create long-term value. Then, they can also push to enhance ESG practices and investments across the firm. Finally, they are able to mitigate risks and seek new opportunities. All this is done by supporting or rejecting decisions that have a positive or negative impact on the social community or the environment.

3. **ESG integration**
   ESG integration is the integral inclusion of the risks and opportunities posed by ESG

characteristics in traditional financial analysis from the very beginning to the very end of the investment process. In this way, investors assume that integration ensues significant impact on companies' finances.

This strategy is also more suited to deliver returns because it integrates ESG considerations into the investment process in a less stringent way than positive and negative screenings which set specific requirements.

4. **Exclusions**

   This approach consists of the exclusion of specific investments or categories of investments, such as companies, sectors or countries, based on ESG performance. It is carried out at the outset by determining the exclusion criteria on the basis of an established objective. This last point makes the exclusion also known as ethical or values-based exclusions. Exclusions can be systematic as long as definite sectors and countries are always involved in certain bad categories. For example, criteria often encountered are weapons, pornography, tobacco and animal testing.

5. **Impact investing**

   This ESG investment strategy is considered to be the most in line with the goal of helping the world in a positive way, as it explicitly targets ESG outcomes while seeking financial returns. Investors of such an approach target a range of returns from below-market to market rate. Thus, this strategy differs from philanthropy in that the investor, in addition to owning the asset, also expects a positive financial return. To ensure positive impact on the society, a strict due diligence process is applied before the inclusion of a specific stock and it leads impact investing to produce consistent returns. Examples of such a strategy are microfinance for low-income people, community investment, and social entrepreneurship funds.

6. **Norms based screening**

   This approach involves selecting companies based on their level of compliance with international standards or various combinations of standards associated with ESG factors. These international norms encompass principles originating, among others, from the Organisation for Economic Co-operation and Development (OECD), International Labour Organisation (ILO), and the United Nations (UN).

7. **Sustainability themed**

   This strategy involves investing in indices of companies that address specific or multiple sustainability themes. Most thematic funds focus on climate change, water management and health. Sustainability themed is quite similar to positive screening, but it does not

only select the best performing companies given the fact that an integrated index is also created.

This thesis will follow and investigate the best-in-class investment strategy for the following reasons. Besides being cited as one of the most efficient and less-time consuming ESG strategy to generate positive abnormal returns (Fulton, Kahn & Sharples, 2012), the rationale behind the choice of the *best-in-class* approach also lays in the fact that a threshold is usually set across a peer group (i.e. firms sharing similar characteristics) for stocks to be selected and it brings consistent and robust grounds for analysis. Hence, 2 assertions back up this strategy. First, by removing and including stocks within a peer group, one can secure to keep the filtered investment universe quite close to the initial one. Then, ESG ratings are generally biased by the sector in which a company operates - healthcare companies will most of the time outperform energy ones (de Franco et al., 2020). Thus, it is of the uttermost importance to use relative scores in a statistical analysis as it enables high-scoring companies to be compared to other companies belonging to the same industry or business definition. Otherwise, results will be biased by a firm's industry. These 2 assertions are covered by the choice of the ESG rating methodology - see 2.1 for explanation on Refinitiv's scoring approach.

For the record, it is also important to introduce the ESG factors in this section. As a matter of fact, to better understand the ESG terminology which will be mentioned all along this thesis, it is worth disclosing what each of this factor means (Cote, 2022):

- **E** stands for Environment. It concerns any firm's impact in positive or negative contribution to the environment. For instance, its greenhouse gas emission, its water use, its clean technology usage, its effective management of waste, and its impact on biodiversity.
- **S** stands for Social. It refers to community and employee matter. For example, it looks at a firm's contribution to human rights, workplace safety, non-discrimination, and health standards.
- **G** stands for Governance. It investigates a company's culture and management practices. For instance, anti-corruption policies, transparency, executive remuneration, and shareholder rights.

As explained just above, the assumption that *best-in-class* strategy is the most convenient and efficient one has been made, but the discussion around ESG investments' performance

still remains debatable in this restricted environment. Actually, various outcomes can yet be drawn depending on the selected portfolio construction (i.e. the approach whereby stocks were picked). The literature around portfolios and their underlying contribution to this work can be found in **??**.

1.2 COVID-19 impact on European financial markets

Before jumping to financial performance and resilience fundamentals (see 1.3), it is relevant to unveil the impact of COVID-19 on European firms' stocks in order to assess whether these effects have also affected the investigated sample of data and hence, shape the main analyses' drivers. The choice to study the recent COVID-19 pandemic stems from the fact that this crisis has a direct link with the three elements that make up ESG. It is closely linked to the environmental dimension because its origins are related to an environmental management problem involving animals and humans. COVID-19 has also affected the social dimension because the spread of the virus is linked to social contacts between humans. The latter has brought lockdown measures which created problems and restrictions for the population. Finally, governance has been at stake as governments and corporate management had to act altogether to help populations overcoming this global crisis (Hoang, Segbotangni & Lahiani, 2021). In this respect, the focus is on financial markets, though the society as a whole has been deeply disrupted by the pandemic.

The coronavirus disease has disturbed financial markets through impacting consumption, work, investors' confidence and short-term market profitability, which has lead to an unprecedented crisis in Europe. Particularly, the European financial market has appeared to experience larger stock market volatility than other areas of the world (Boldeanu et al., 2022).

Impact of lower investors' confidence has already been demonstrated even for other economic turmoil. In fact, their loss of faith regarding financial markets has been proved to increase market risks, volatility, and to lead to negative returns (Shaikh, 2020). Furthermore, level of fear and anxiety has been reported as higher than ever, when the VIX[1] historically appeared at 82.69% on March 2020 - which was significantly higher than levels during the global financial crisis of 2008 where it peaked at around 80%. This extremely high level of concern among investors has generated extreme volatility, market instability, and abrupt stock price declines. The outbreak of COVID-19 also gave an opportunity to test the hypothesis raised by Broad-

[1] See Appendix 7.1 for a comprehensive definition of this index.

stock et al. (2020), which explained that the role of firms' ESG performance is mitigated during time of quiet market, but is increasingly important during times of crisis such as the current pandemic. These scholars discovered this pattern on the Chinese market, thus it is relevant to investigate whether this holds on the European financial market as well.

Lastly, COVID-19 acted as an unparalleled and unexpected shock to European markets. It originated out of health concerns and not because of economic turmoil at first. Thus, it has been an exogenous shock which enables to properly study the causal link from ESG to financial performance - the latter is part of the research question raised by this work (see). As a matter of fact, the speed of transmission of this shock has put European firms in an unpleasant situation that constrained their ability to respond to the crisis. In this context, Albuquerque et al. (2020) made that the assumption that stock market prices changed mostly because of firms situation and characteristics (including their ESG ratings) to withstand the pandemic.

1.3 Financial performance and resilience ESG-related fundamentals

After investigating the impact of the coronavirus disease on European markets, it is relevant to look at how this impact has been appraised. Therefore, the current section will aim at considering how ESG scores have played a key positive or negative role in financial performance and resilience of companies. Besides the first studies aforementioned in 1.2 which endeavor to depict ESG influence during the pandemic, some yet limited insights can also be retrieved from papers which targeted another period of time, namely the 2008 global financial crisis (Broadstock et al., 2021) - although these findings are also vulnerable because of less advanced ESG frameworks and approachs at that time.

Direct ESG scores effects

Factors of ESG scores (i.e. environment, social, and governance components) have been widely analysed to understand whether they have influence on firms' performance and resilience. Some scholars analysed the contributions of each factor individually, while others studied it as a whole by means of ESG scores. In this subsection, compilation of theories will focus on the latter.

There has been causal evidence that investors value sustainability, and this evidence is robust as it discards the possibility that investors are indifferent to firms' characteristics or likely to penalize a fund for maintaining a portfolio of sustainable investments (Hartzmark & Sussman, 2019). It induces that most of the market views ESG performance as a positive feature for companies, hence investors have a positive belief that better ESG ratings will predict steady future returns. In the same vein, Ferriani & Natoli (2020) investigated whether ESG scores contribute to explain the significant variations in fund flows observed during the first wave of COVID-19. The results of this study stated that ESG ratings contribute significantly to inflows to equity with larger value when the market goes down and during market's recovery - if a firm exhibits low-ESG risk, this effect significantly increases new spendings into the firm's equity. In other words, investors have significantly taken into account ESG risks during the pandemic crisis. Especially, they have preferred to spend their investments in low-ESG risk funds and to discard the high-risk ones (Ferriani & Natoli, 2020). Consequently, investors tend to focus on low-ESG risk investments. It is proven by higher significant coefficients than before the market crashed for this metric in regressions, leading to a flight-to-safety movement[2]. This flight-to-safety enables stock prices to stay steady and to partly avoid additional losses in terms of returns. Ferriani & Natoli (2020) concluded their study on the following: within a risk-return strategy, low-ESG risk investments happen to perform significantly better than high-risk ones - this result only holds for the new approach of Morningstar's scoring, as opposed to past evidence gathered with the old ESG scores. Overall, it can be said that ESG performance (i.e. high ratings from third-party agency providers) is often a beneficial hedge against times of crises. This edge has also been uncovered in the work of Ferrell et al. (2016, as cited by Cardillo, Bendinelli & Torluccio, 2022). In fact, they suggested that high ESG scores can capture reliable top management and sound ESG business strategies, leading to better performance and resilience thanks to superior firm quality.

Albuquerque et al. (2020) consider firms' ESG activities as profitable on a financial performance perspective. In fact, they look at ESG activities in the context of customer and investor preferences. For illustrative purposes of customers preferences, they present a firm investing in ESG policies as part of their product differentiation strategy and they realize that this firm benefits from more loyal customers and these have lower price-elasticity of demand for its products. Consequently, the firm will create a virtuous circle: it will be able to charge higher prices and have higher profit margins, hence lowering leverage and systematic risk. Overall, it makes this firm more competitive and resilient. The investor preferences' theory is explained by the fact that ESG investors are less sensitive to the performance of their investments than

[2] See 7.1 for the comprehensive definition of this term

their conventional counterparts. In times of market turmoil, these investors will thus sell less easily their positions. By implication, ESG stocks' prices will not decline as much as other conventional stocks and returns will remain.
Hoepner et al. (2021) also obtained positive empirical evidence on ESG engagement. In fact, they found out that adopting ESG policies enables firms to decrease their downside risks and their exposure to underlying risk factors. Their methodology relied on the measurement of the lower partial moment (LPM) of the second order of the distribution (i.e. to capture negative return fluctuations) and on calculation of the value at risk - the latter approach has been implemented in this thesis as well. Plus, this ability of firms engaging in ESG activities is even more relevant for pensions funds which need their assets to match their liabilities and thus need wealth protection against downside risks, or for banks and other financial actors which are constrained by regulatory capital requirements on their equity positions.

Then, even though investors surely value the ESG initiatives of companies, some scholars disapprove that benefits stem from ESG components. Friedman (2007, as cited by Li et al., 2022) was one of the first to disapprove gains from ESG on the basis that is was some money waste due to a misallocation and misappropriation of valuable corporate resources. Other insights about bad performance of firms linked to their ESG policies come from Demers et al. (2021) who stated that strong corporate governance may be counterproductive, in the sense that it creates agency adverse effects. In other words, investments in ESG-related activities may destroy value, provided that executives decide to improve their company's ESG scores at the expense of company's shareholders in order to build their own personal reputations and future endeavours. That is, firms pull away money from creating shareholders' value because of their significant ESG investments.
Moreover, some studies focused on financial statements of companies. That is, researchers investigated whether balance sheets and income statements described by low leverage ratios, high market value, and higher price-to-earnings ratios perform better than smaller, weaker firms (Clark, Mauck & Pruitt, 2021) - in this thesis, this hypothesis will be investigated in part 4.3. These arguments are also sometimes referred to as the traditional economic and financial theory.

Sectoral effects

Although all sectors have been negatively hit by the pandemic with investors in turmoil and firms' stocks prices plummeting, ESG scores have significantly been influential - as it can be read just above, these scores have influenced companies differently and this has been specific to the sectors in which a company was operating. Thus, depending on their sensitivities to

crises, there were different and even opposite sectorial effects (Boldeanu et al., 2022) - yet, literature on industry-related impacts of the pandemic has been scarce until now.

Scholars have already attempted to assess the impact of COVID-19 on specific sectors. Among these, Ramelli & Wagner (2020, as cited by Boldeanu et al., 2022) found out that the transport and energy sectors have experienced negative effects on their stocks' returns or have suffered from considerable profit downturns. It turns out that the poor performance of the energy sector has been the consequence of the riskiness of this specific investment. In fact, its returns are perceived as risky because the energy sector is weather dependent and presents uncertainty regarding the reliability of its supply (Boldeanu et al., 2022). On the other hand, some sectors have exhibited endurance abilities to withstand the pandemic. For instance, the manufacturing, information technology, education, and health industries have responded positively to the pandemic at longer term because of the creation of opportunities within the development of these high-tech fields (He et al., 2020) - though, this result holds for China. Across sectors, it is important to look at the level of disclosure of other companies. The industry affiliation appears to be an important indication of firms' disclosure. For instance, the financial industry displays a low transparency in sustainable disclosure compared to the materials, consumer staples, and utilities sectors. Consequently, the disclosure of sustainable initiatives can offset the misguided perception of an industry by investors and hedge this sector against economic risks (Hoang, Segbotangni & Lahiani, 2021). As a matter of fact, if a company belongs to a sector disclosing comprehensive data on the matter, investors will expect global disclosures of this specific firm. Otherwise, stocks returns will be negatively impacted (Boldeanu et al., 2022) - notably, the ESG score measurement in this thesis also takes into account the extent of this level of disclosure in its computation (see 2.1).
All studies mention the importance of understanding these sectors' affiliations and their inherent characteristics and risk behaviours to prevent future crises' reactions and to identify and reveal possible opportunities.

Geographical effects

Europe has been chosen as the geographical area of analysis for various reasons such as the importance the continent puts on ESG initiatives with investments and new policies (e.g. Green Deal) - these reasons are explained in . However, most of the literature is based on US or Chinese stock markets. Thus, the following paragraphs will aim at testing insights retrieved mainly from these two broad markets and see whether some theories are also valid on the European soil.

In the previous section, some sectors were highlighted to better endure the COVID-19 crisis by scholars. It is important to note that underlying facts are also country-specific (He et al., 2020) - although they only analysed Chinese stocks. As a matter of fact, China's large economy, steady infrastructure and industrial supply chain, and strong supporting capabilities enabled some sectors to stand out. Plus, Chinese public authorities are strongly boosting effective investments, market demand and consumption in these sectors of interest. Therefore, it is relevant to verify if these results also hold in Europe - the geographical scope of this paper.

Another theory called the national-level uncertainty avoidance stipulates that reactions to the pandemic have not been uniform across countries. Ashraf (2020) developed this framework where countries' level of uncertainty sensitiveness moderates stock markets' movements amidst time of crisis - for instance, France and Spain are countries with sensitivity to uncertainty, while Australia, New Zealand and the US clearly exhibit the contrary pattern (Schmeling, 2008). One of the reason explaining these disparate reactions is found in investor sentiment. The latter is defined as the propensity to speculate and it varies across countries, leading to various investors' reactions towards a news announcement. Consequences on stock market returns have been significant, as illustrated by the quite high (low) negative correlation between COVID-19 cases and stock market returns for countries with high (low) uncertainty avoidance. In fact, if a country has a high level of uncertainty aversion, its investors are more likely to be involved in panic selling to offset and avoid uncertainty. It results in higher negative returns than in countries where uncertainty aversion is low and investors stay calm during a period of turmoil (Ashraf, 2020).

In this thesis, the hypothesis of the geographical effect will be tested by means of a thorough event study which will compare firms' reactions to the pandemic with respect to their countries of exchange and their lockdown announcement dates (see 4.2).

1.4 Portfolios construction fundamentals

The distinction between ESG and non-ESG stocks has been drawn by classifying these stocks according to the quantiles of their ESG combined score - further explanation in the upcoming *sample matching* part (see 2.3). The result is two peer groups of stocks encompassing various industries and distinct inherent characteristics. These two groups will be compared by means of statistical analysis, but the first step is to decide how companies belonging to these two clusters will be merged. In fact, it has been established to gather these firms into portfolios

based on equal and capitalization-weighted approaches. This section will outline the reasons for this choice and the current body of knowledge about these portfolios' characteristics with respect to performance, risk, and resilience.

In an equally-weighted strategy, weights' computation is rather straightforward. As a matter of fact, every constituent stock has the same weight, regardless of how great the market capitalization of its company is. It ensues that, in this type of portfolio, diversification is carried out across a broad range of securities and sectors. Thus, this approach enables to reduce concentration risk and to increase exposure to smaller stocks. It is also called a value-based technique given the fact that to keep equal weights, portfolio managers need to buy or sell positions alongside stocks' increases or decreases in value. Contrary to a capitalization-weighted strategy which builds on momentum, this strategy is more like *contrarian investing*, meaning that it will force to buy shares of bad-performing companies and sell shares of high-performing ones (Fournier, 2022).
Capitalization-weighted portfolio encompasses a pool of stocks where companies with the largest market capitalizations have the highest weights in the portfolio. In this context, capitalizations are computed by multiplying the share price and the number of shares outstanding. It is also widely known as the standard manner of constructing portfolios in the industry. During the pandemic, if a sector has performed very positively and weights are concentrated into this specific fruitful industry, the capitalization-weighted strategy can yield significant benefits - for instance, so-called essential firms (i.e. vital to the stability of the economy and society as a whole) which belong, for instance, to the health care or energy sectors are expected to be more resilient and to exhibit higher returns (Albuquerque et al., 2020). This paper will attempt to investigate this effect. Overall, this method undermines diversification and it skews performance to positive or negative results depending on stocks having an influential effect (i.e. significant weights) on the portfolio. Thus, there are momentum effects in this strategy as the portfolio is tilted towards large firms' capitalizations. This momentum can be effective if these highly-weighted stocks perform well on the long-time (Fournier, 2022).

From a risk-adjusted performance point of view, scholars found out that equal-weighted portfolios outperform value (or capitalization)-weighted portfolios in terms of superior alpha[3], Sharpe ratio, and total mean return (Plyakha, Uppal & Vilkov, 2017). From their findings, this outperformance is related to size, price, liquidity and idiosyncratic volatility factors. They outlined that equal weighting performs better when companies are steady and qualitative, namely companies experiencing low failure rates, than when companies exhibit high failure

[3] See glossary 7.1 for a detailed definition of this term.

rates and risks of bankruptcy. However, this type of portfolio bears additional total risk thus it is worth investigating how significantly this additional risk affects financial performance in times of market turmoil such as the COVID-19.

In this thesis, both aforementioned techniques have been implemented to test and verify findings from Plyakha, Uppal & Vilkov (2017) during the pandemic market turmoil - with the notable exception of a new geographical area and a new period of time. Although both techniques are known as passive investment strategies, they are usually carried out with a minimum amount of purchases and sales of shares. Nonetheless, this paper made the assumption of keeping weights exactly the same during the analysed period. The reasons are the easiness of implementation (i.e. no re-balancing and no inclusion of different taxation fees, which are not this paper's purpose) and the greater focus on firms' analyses throughout the whole period rather than the exclusion of some firms after looking at them during only part of the market turmoil under scrutiny.

Chapter 2

Data

In view of shedding the light on the impact of COVID-19 on European stocks which exhibit strong ESG performance and their counterparts which display weak ESG performance, a sample containing both type of companies' stocks was built. First, the data relies upon the ESG score computation made by Refinitiv. Therefore, the first section highlights Refinitiv's methodology and raises its strengths as well as some of its limitations. The next 3 sections lead to the creation of the sample, namely the manner of fetching data from Refinitiv's database and some early filtering steps, the matching of firms to create a robust sample for further analysis, and also the portfolios' construction. In the last 3 sections, the data about the selected companies is explained for descriptive, causality and performance purposes.

2.1 Computation of ESG scores by Refinitiv

Outcomes of this thesis rely mainly on ESG scores and the insights entailed by these. These ESG ratings enable investors to implement best-in-class screens strategies. That is, they are able to define a specific investable environment by excluding and focusing on stocks which reduce influence of reputational risk, performance sensitivity, client concerns, and ethics issues (S&P Global, 2021). The rationale behind the use of ESG ratings over raw data (i.e. companies' annual reports, press releases, detailed financials) is for some obvious reason a time constraint, but also mostly for aligning with investment process in the industry - nonetheless, ESG ratings takes raw data into accout as they are partly built by relying on this. Actually, most of investors are constrained in their resources and favor ratings from third-party - this result has been retrieved from a survey conducted by van Duuren, Plantinga & Scholtens (2016). Scholars have drown different conclusions on ESG stocks' performance and resilience. Some

authors, among which Albuquerque et al. (2020), assume that it depends on the database and the scoring methodology being used for - see 4.4 to have an overview of the different drawbacks entailed by this thesis' analyses. The discrepancy in the literature is also backed up by the low correlation that can be found between ESG ratings for a same company assessed by different rating agencies (J.P.Morgan, n.d.). To the same extent, Dimson, March, and Staunton (2019) unveiled the divergence between financial providers on the basis of low correlation between MSCI, FTSE, and Sustainanalytics. These correlations are relatively low and this fact is even more pronounced for the governance factor.

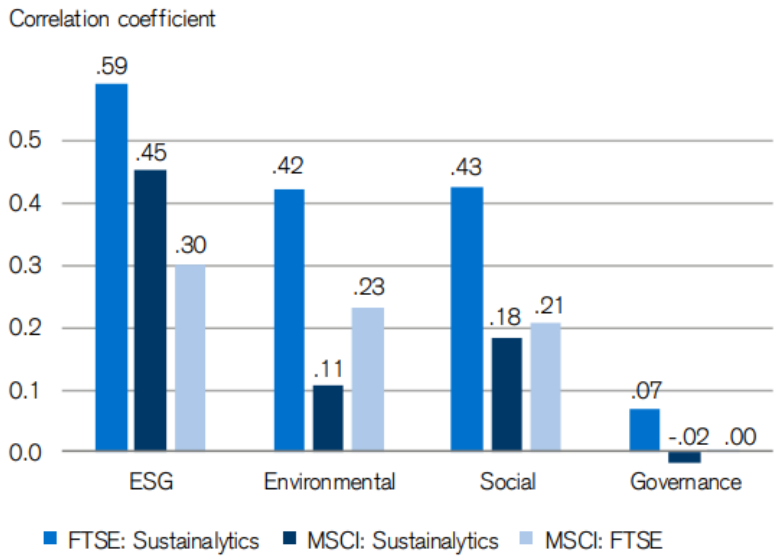


Figure 2.1: Correlations between ratings (source: Data from MSCI, FTSE Russell and Sustainalytics; computations and analysis by Dimson, Marsh and Staunton).

Thomson Reuters' Refinitiv ESG scores have been widely adopted (e.g., Ferrell, Liang & Renneboog 2016, and Dyck et al. 2019). Moreover, if Refinitiv methodology is compared to other major providers of sustainable scores, such as Sustainanalytics or MSCI, it seems to provide a comprehensive overview that other scoring agencies fail to match - see 4.5.1 for further explanations. Therefore, it is worth looking at how Refinitiv computes these scores and investigates what it involves for the results.

Refinitiv which produces the data being used, is a global provider of financial data. Along the ever-increasing share of ESG assets under management, it offers one of the most comprehensive ESG database recognized globally by financial experts. To create its database Refinitiv relies upon more than 500 data points and ratios tied to the ubiquitous big data which enables to provide greater awareness of global business practice. For instance, Refinitiv investigates

companies' compliance with human rights to assess the ESG social component. All this big data is retrieved from annual reports, corporate social responsibility (CSR) reports, company websites and global media sources. As previously said, it has been used widely by researchers in various studies dealing with the performance and the resilience of ESG investments (Albuquerque et al., 2020; Ding et al., 2020; and Demers et al., 2021, among others).

Among the many indicators that Refinitiv build the ESG combined score (ESGC) is the one chosen in this work. The ESGC is a cutting-edge advanced method. It provides an evaluation of a company's ESG performance based on reported information on ESG pillars from a subset of 186 metrics, along with ESG controversies. The latter discounts ESG performance based on negative media stories (e.g. litigations, fines) meaning that if a scandal occurs, the company involved is penalized as it can be seen figure 2.2. Two important features make Refinitiv's methodology particularly insightful. First, it takes into account transparency biases by penalizing firms which do not disclose information on "highly material" points. This inquiry on whether a firm is material or not relies upon the relative level of disclosure in a particular industry group. Second, it also stems from the fact that Refinitiv uses a relative benchmark (- as opposed to an absolute benchmark) in order to set a score for a specific company. It means companies will get a score which is compared to the average of another ESG index. In this context, the ESG index relates to firms belonging to a similar industry and sharing common features. Therefore, there is no need to worry about any bias (- from an industry perspective) on the ESG score because industry effects are already taken into account in the statistical analysis for the calculation of this score. Refinitiv uses a materiality matrix combining different weights for each of the data points used in the computation of ESGC. These loadings determine importance for each factor according to the industry. Moreover, the poor transparency in reporting undermines firms' ESGC similarly to publicly disclosed firms with poor ESG performance (Refinitiv, 2021).

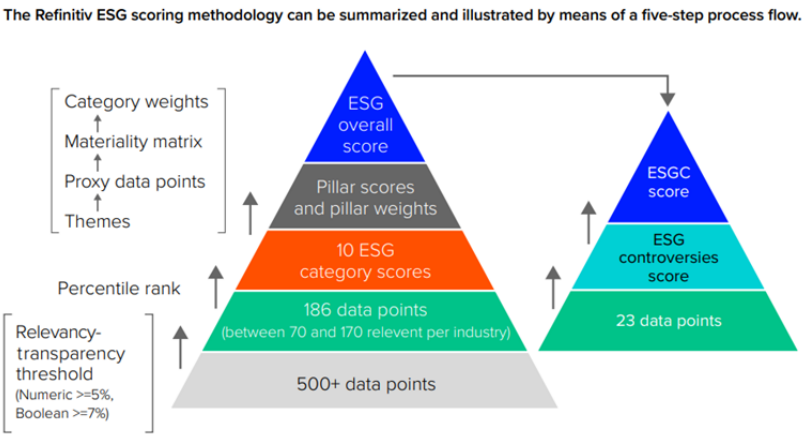


Figure 2.2: Refinitiv ESGC scoring methodology (source: Refinitiv).

To summarize the last points, one can assess ESG performance and controversy involvement by looking at the following grading scale:

- *0-25*: Poor ESG performance and transparency
- *25-50*: Satisfactory ESG performance and transparency
- *50-75*: Good ESG performance and transparency
- *75-100*: Excellent ESG performance and transparency

2.2 Retrieval of sample

The data that is used comes mainly from Refinitiv Eikon and is accessed by an API request run on Python through the Datastream Web Service (DSWS) tool. The data is stored in csv files to allow further use of the statistical analysis tool R. The data encompasses daily, weekly and annual stock returns, Refinitiv ESGC scores, capitalizations, volume traded, country of issuance and industry of European public companies with strong and weak ESG scores and whose stocks are listed and exchanged on European ground. For comparison, the data about STOXX600 is also retrieved in the same manner as Hoang et al. (2021). The rationale behind the use of Refinitiv Eikon data comes from the fact that it has already been widely used by other scholars in numerous studies such as Albuquerque et al. (2020), and Demers et al. (2020) in order to assess the effect of companies' ESG scores on their stock performance and resilience. The data is gathered at a daily frequency as these stocks are traded on a daily basis. Moreover, as the COVID-19 period is analysed it is worth seeing how the data will evolve after

this exogenous shock.

In order to build the dataset used in this analysis, only stocks listed in European countries were kept. The rationale for this European-centric choice relies upon the more mature and regulated European ESG framework (Ground, 2022). In the same vein, the Sustainable Finance Disclosure Regulation (SFDR) was written in March 2021. For the future, this raises the consistent inquiry of whether the European ESG investments will still grow to perhaps become the main hub for ESG or this legal burden will repel sustainable investments from Europe. That being said, one can assume that the quality of ESG investments will be enhanced and it makes Europe worth analyzing.

Following a best-in-class approach that has previously exhibited an ability to capture superior performance (Fulton et al., 2020), two portfolios were formed based on Refinitiv's ESG Combined Score and the data on STOXX600 was retrieved as well. Besides implementing a best-in-class investment approach, the rationale to separate high ESG stocks from low ones is based on the work of de Franco, Geissler, Margot & Monnier, (2020) which state that removing stocks with low ESG ratings within peer groups (- but also within countries in this thesis for more robustness) insures that the final filtered universe remains similar across industries - it will be useful in 4.3 as financial performance will be compared across portfolios and industries. The first portfolio is a pool of investments of public equities of companies whose ESG scores stand in the top 10^{th} percentile of ESG Combined Score. This portfolio is regarded as *(ESG) Leaders* investments. The second portfolio encompasses common stocks of publicly listed companies laying in the bottom 10^{th} percentile. This portfolio is reported as *(ESG) Laggards* investments. This screening strategy seems sensible as Burchi & Wlordaczyk (2020), Ferrat, Daty & Burlacu (2020) have also conducted their study on an ESG best-in-class screen with similar quantiles used. Initially, *(ESG) Leaders* investments and *(ESG) Laggards* investments consisted of 238 stocks respectively. First, it was decided to drop firms with lack of data coverage on price returns due to mergers, delisting or bankruptcy. It is consistent with the work of Hoang, Segbotangni & Lahiani (2021) and Demrs, Hendrikse, Joos & Lev (2020). Second, the so-called penny stocks (i.e. stocks with a maximum high price below 5 €) were removed (Naffa & Fain, 2020). This filter was applied based on stocks' high prices at the end of 2020 in order to avoid any influence of the pandemic on the market. Thus, the remaining sample without low-covered and penny stocks firms consists of 250 firms. It has also been decided not to winsorize the time series as some authors did (Lins, Servae & Tamayo, 2017) because it would have undercut the significance of the COVID-19 shock. Before the peer group formation (see following part 2.3), this mentioned dataset is ultimately made up of 125

firms for *leaders* investments and 125 for *laggards* investments covering a period of 304 data points per firm ranging from 1st November 2019 until the 31st December 2020.

2.3 Sample matching and early-stage exploratory analysis

Before conducting any further statistical or financial analysis, it was essential to create peer groups in order to compare companies that are similar. In other words, for underlying investigations, it is not relevant enough to only look at companies on a standalone basis. Companies must be looked at in comparison to other companies not sharing the same degree of ESG policies to see if these have an added value compared to their peers (Kahil, 2021) - it is enabled by the use of relative score (see 2.1) based on the belonging to a specific industry, which means a high ESG scorer outperforms its industry counterparts. This peer group formation has been enabled thanks to the sample matching approach. Another rationale behind the use of this method is that, by enabling to have a set of similar firms as a benchmark, implicit extrapolation will be avoided in forthcoming regression estimates (Abedifar et al., 2022) - regressions will be carried out in part 4.2.

Consequently, it has been decided to use the 8th March 2020 as the date for forming the 2 ESG *leaders* and *laggards* groups. In this dataset, this date is the day right before the first lockdown announcement date among European countries analysed, hence the matching sample will be created while avoiding most of the major effect from the COVID-19 pandemic - on the 9th March 2020, Italy decided to impose lockdown measures for its citizens and other European countries quickly followed. On the 8th March 2020, firms' stock exchange country, industry, size, and leverage have been retrieved - other data points have also been retrieved for subsequent analyses (see 2.5, 2.6, 2.7), but these are not part of the filter used for peer group formation. The country feature prevents cross-country heterogeneity following regulatory and institutional characteristics that can influence the performance and stability of a firm's returns (Abedifar et al., 2022). Firms' size is proxied by market capitalization as it enables to avoid large discrepancies in respect of diversification, strategies, and profitability between selected firms (Abedifar et al., 2022). The selection of these characteristics is similar to the work of other scholars such as Kahil (2021), de France et al. (2020), and Abedifar et al. (2022). Furthermore, relying on several characteristics enables peer groups to be more robust than if they relied on less features. Besides these fixed-characteristics, peer firms must obviously display a lower ESG score in order to draw practical conclusions from the comparison between firms scoring well and poorly regarding ESG scope.

In conclusion, if industry, country, leverage and size components are neutralized (i.e. to the extent to which high and low-ESG companies are matched respectively) the performance and resilience of ESG investments can seamlessly be assumed to come from the stock picking (i.e. the decision to invest in the *ESG leaders* or *laggards* portfolio) (de Franco et al., 2020).

Controlling for all the aforementioned characteristics, the size of the final dataset has been significantly reduced. As a matter of fact, the final sample contains 9728 data points, which represent 304 trading days for 15 companies of the *ESG leaders* portfolio and 17 companies of the *ESG laggards* portfolio. The further removal of firms has been processed because of the lack of similarity among firms within peer groups. For instance, the *real estate* segment only had three significantly different companies, which was not robust enough to create a peer group. Then, the *basic materials* industry had no firms exchanged on the same market - besides overriding the filter of the peer group, it would have caused major issues in the event study (see 3.2.1). Moreover, the *consumer staples* sector encompassed 4 UK-based companies but with significantly contrasting leverage ratios.

By skimming over firms' countries and industries (these tables are available in Appendix 7.2 and 7.3), it appears that Switzerland and the United Kingdom are the most prominent countries, and consumer discretionary and financials are the most prominent industries. It is worth noting that significant differences are observable between *leaders* and *laggards* investments regarding the industries to which they belong. These differences and their impact will be investigated in 4.
Then, the following tables give an early-stage exploratory analysis by skimming over firms and their sampling characteristics per industry. These list peer groups for the 6 selected industries from Refinitiv. Although there were originally 11 industries in the Industry Classification Benchmark (ICB) used by Refinitiv to compare companies within a same sector, the aforementioned robust screening process discarded five of these industries because it was not possible to find similar and consistent firms among both created portfolios - besides that, the *energy* industry was missing for the *laggards* group (even though five companies appeared in the *leaders* cluster), so this industry has also been discarded.

- **Technology**

Company Name	Stock exchange country	Debt-to-Equity %	Market capitalization (€)
SAP SE	Germany	0.50	1320887750[1]
All for One Group SE	Germany	0.37	213727800
PSI Software AG	Germany	0.29	320226266
SUESS MicroTec SE	Germany	0.28	171084065

Table 2.1: Filtering characteristics for the technology peer group

- **Health Care**

Company Name	Stock exchange country	Debt-to-Equity %	Market capitalization (€)
Roche Holding AG	Switzerland	0.43	2562689270
Lonza Group AG	Switzerland	0.54	2729826445
Coltene Holding AG	Switzerland	0.65	4565166102
Cosmo Pharmaceuticals NV	Switzerland	0.42	1040761912

Table 2.2: Filtering characteristics for the health care peer group

- **Industrials**

Company Name	Stock exchange country	Debt-to-Equity %	Market capitalization (€)
Mondi PLC	United Kingdom	0.52	893131617
Alfa Laval AB	Sweden	0.53	786649385
Judges Scientific PLC	United Kingdom	0.66	358899325
Marlowe PLC	United Kingdom	0.56	237207357
Jetpak Top Holding AB (pulb.)	Sweden	0.37	796205064

Table 2.3: Filtering characteristics for the industrials peer group

- **Financials**

Company Name	Stock exchange country	Debt-to-Equity %	Market capitalization (€)
Assicurazioni Generali SpA	Italy	0.46	687400000
Allianz SE	Germany	0.50	236490000
Zurich Insurance Group AG	Switzerland	0.41	702943280
Tamburi Investment Partners SpA	Italy	0.63	171948302
flatexDEGIRO AG	Germany	0.49	468616000
Swissquote Group Holding SA	Switzerland	0.39	26442488
Private Equity Holding AG	Switzerland	0.27	2970000

Table 2.4: Filtering characteristics for the financials peer group

[1] Despite having an order of magnitude differing by a factor of about, the selected non-ESG companies were the most similar.

- **Utilities**

Company Name	Stock exchange country	Debt-to-Equity %	Market capitalization (€)
Iberdrola SA	Spain	0.87	683758724
Naturgy Energy Group SA	Spain	1.23	972807806
Red Electrica Corporacion SA	Spain	1.50	1979422200
Solaria Energia y Medio Ambiente SA	Spain	1.61	1122683621

Table 2.5: Filtering characteristics for the utilities peer group

- **Consumer discretionary**

Company Name	Stock exchange country	Debt-to-Equity %	Market capitalization (€)
Pearson PLC	United Kingdom	0.49	4915984223
Whitbread PLC	United Kingdom	0.71	5445960954
Elior Group SA	France	0.36	1671291254
L'Oreal SA	France	0.05	91594334908
Trainline PLC	United Kingdom	0.90	2306282764
CVS Group PLC	United Kingdom	0.42	1072412434
Interparfums SA	France	0.06	1488758985
Trigano SA	France	0.27	1282961448

Table 2.6: Filtering characteristics for the consumer discretionary peer group

2.4 Portfolio construction

After matching all firms with respect to their peer groups and classifying them into two categories, it has been decided to build two portfolios on the basis of these two clusters. For each of the latter, two straightforward portfolios construction techniques have been implemented. The rationale behind this choice lays in the willingness to verify whether one approach outperforms the other - thus, confirming or not the hypothesis of capitalization-weighted outperformance, see 1.4 for the current state of the literature around the topic. Moreover, these two are commonplace in the industry. On the one hand, the equally-weighted portfolio allocates the same weight for each of its constituent stocks - for instance, there are 15 stocks in the *leaders* group, so each of them gets a portfolio weight of 6.67 % ($=\frac{100}{15}$)[2]. On the other hand, market capitalizations were used to compute the weights of the capitalization-weighted portfolio. It means that the higher the market capitalization, the higher the allocated weight a firm will

[2] It is worth remembering that firms' allocated weights in portfolios do not vary during the period under analysis - it is also true for capitalization-weighted portfolios.

get.
Below the 4 subsequent portfolios (- one encompassing *ESG leaders* companies, the other gathering *ESG laggards* companies, and these for each of the equally and capitalization-weighted portfolios) are displayed alongside their respective weights for each selected and matched firms:

2.4.1 Equally-weighted strategy

- *ESG leaders portfolio*

Company Name	Allocated weight in portfolio %
Roche Holding AG	6.67
L'Oreal SA	6.67
SAP SE	6.67
Allianz SE	6.67
Iberdrola SA	6.67
Zurich Insurance Group AG	6.67
Lonza Group AG	6.67
Assicurazioni Generali SpA	6.67
Naturgy Energy Group SA	6.67
Red Electrica Corporacion SA	6.67
Mondi PLC	6.67
Alfa Laval AB	6.67
Whitbread PLC	6.67
Pearson PLC	6.67
Elior Group SA	6.67

Table 2.7: ESG leaders companies for the equally-weighted portfolio

- *ESG laggards portfolio*

Company Name	Allocated weight in portfolio %
Trainline PLC	5.88
Interparfums SA	5.88
Trigano SA	5.88
Solaria Energia y Medio Ambiente SA	5.88
Cosmo Pharmaceuticals NV	5.88
Tamburi Investment Partners SpA	5.88
SUESS MicroTec SE	5.88
Swissquote Group Holding SA	5.88
flatexDEGIRO AG	5.88
Coltene Holding AG	5.88
Judges Scientific PLC	5.88
PSI Software AG	5.88
Marlowe PLC	5.88
All for One Group SE	5.88
SUESS MicroTec SE	5.88
Private Equity Holding AG	5.88
Jetpak Top Holding AB (publ)	5.88

Table 2.8: ESG laggards companies for the equally-weighted portfolio

2.4.2 Capitalization-weighted strategy

- *ESG leaders portfolio*

Company Name	Allocated weight in portfolio %
Roche Holding AG	30.57
L'Oreal SA	16.98
SAP SE	15.76
Allianz SE	9.40
Iberdrola SA	8.82
Zurich Insurance Group AG	6.23
Lonza Group AG	3.26
Assicurazioni Generali SpA	2.85
Naturgy Energy Group SA	2.35
Red Electrica Corporacion SA	1.09
Mondi PLC	1.07
Alfa Laval AB	0.94
Whitbread PLC	0.65
Pearson PLC	0.59
Elior Group SA	0.20

Table 2.9: ESG leaders companies for the capitalization-weighted portfolio

- *ESG laggards portfolio*

Company Name	Allocated weight in portfolio %
Trainline PLC	18.58
Interparfums SA	12.00
Trigano SA	10.34
Solaria Energia y Medio Ambiente SA	9.05
Cosmo Pharmaceuticals NV	8.39
Tamburi Investment Partners SpA	7.91
SUESS MicroTec SE	7.03
Swissquote Group Holding SA	6.36
flatexDEGIRO AG	4.41
Coltene Holding AG	3.69
Judges Scientific PLC	2.89
PSI Software AG	2.58
Marlowe PLC	1.91
All for One Group SE	1.72
SUESS MicroTec SE	1.38
Private Equity Holding AG	1.13
Jetpak Top Holding AB (publ)	0.64

Table 2.10: ESG laggards companies for the capitalization-weighted portfolio

2.5 Data for descriptive statistics

This section aims at explaining the chosen ratios and variables for each companies. Most of these ratios were directly retrieved from Refinitiv and some others were computed using *R* statistical software. Altogether, these ratios with different roles and definitions are supposed to give a first comprehensive overview and comparison of different portfolios' behaviours during the pandemic crisis.

- *Mean ESG score:* The mean ESG score is straightforward: it gives the arithmetic mean of companies' ESG combined score. The point of computing it is to ensure scores are significantly different between the 2 types of portfolios and look if opting for one type of portfolio construction or the other (i.e. equally or capitalization-weighted) leads to changes in the mean ESG score of the 2 types of portfolios. As the ESG score has already received extensive explanations (see 2.1), it will not be discussed in this part.
- *Mean return:* This indicator is quite straightforward as it basically takes the arithmetic mean of all retrieved daily simple returns. It gives a first simple view of the estimated benefit or loss an investor can expect from a chosen stock. $Mean = \frac{1}{n}\sum_{i=1}^{N} r_i$ where N corresponds to the amount of daily returns' observations, and r_i is the daily return of a security.

- *Standard deviation:* The standard deviation (std) is also straightforward as it gives the dispersion of the data related to its mean. In finance, it can be used as a measure of relative risk of an asset. To some extent, it can also predict some performance trends. $Std = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \mu)}{N}}$ where x_i is a daily return, μ represents the mean value of all daily returns and N is the number of daily returns' observations.

- *Skewness:* Skewness is a measure of (a)symmetry for returns distribution. Negative values for this metric indicate the data is left-skewed and positive values indicate the data is right-skewed. If the data is left-skewed, it can be expected that the left tail (i.e. where negative returns can be found) is longer than the right tail.
$Skewness = \frac{\sum_{i=1}^{N}(R_i - \overline{R})^3}{(N-1)*\sigma^3}$ where N is the number of data points, R_i is the portfolio's daily returns, $\overline{R}$ represents, the mean of portfolio's daily returns, and σ is the portfolio's standard deviation.

- *Kurtosis:* Kurtosis is a measure of tails of returns distribution. To interpret values of Kurtosis, it is worth noting that the normal distribution has a Kurtosis of 3[3]. As a result, a higher Kurtosis than 3 indicates a "heavy-tailed" (or thicker tails than the normal distribution) distribution and a lower Kurtosis than 3 indicates a "light-tailed" (or thinner tails than the normal distribution) distribution. $Kurtosis = \frac{\sum_{i=1}^{N}(R_i - \bar{R})^4}{(N-1)*\sigma^4}$

- *Sharpe ratio:* The Sharpe ratio has been a trusted financial indicator for decades. It is a measure of an investment's risk-adjusted performance and perhaps the most frequent portfolio management indicator. It determines the expected realized return over the risk-free rate on the grounds of the hypothesis that investors are always able to invest in government-issued bonds, thus to benefit from the risk-free rate of return.
$Sharpe = \frac{(R_p - R_f)}{\sigma_p}$ where R_p are daily portfolio's returns, R_f describes the risk-free rate which was retrieved from Bloomberg terminal[4], and σ_p is the portfolio's standard deviation. Nonetheless, the Sharpe ratio is slightly flawed. Actually, portfolio investment managers can manipulate the history of returns to magnify returns by increasing the measuring range, the portfolio's standard deviation is based on a normal distribution and it is mostly an inaccurate assumption as returns time series tend to be skewed.

- *Information ratio:* The Information ratio is a measure of an investment's risk-adjusted performance. It also determines to what degree excess historical returns (i.e. the ex-

[3] Some authors cite that the normal distribution has a Kurtosis of 0. It is also true but they often forget to mention that 0 corresponds to the measure of **excess** Kurtosis

[4] The access to Bloomberg terminal data has been enabled using the *Kenneth R. French - Data library*, available here: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data$_l ibrary.html$

cess return is computed based on a market benchmark which is the European index *STOXX600*) went along excess volatility. Thus, it is often used as an indicator of a portfolio manager's level of skills to generate excess returns compared to a chosen benchmark. It aims at identifying the consistency of performances by incorporating a tracking error (Murray, 2020). Generally speaking, an information ratio is regarded as good if it fits in the 0.40-0.60 range.
$Information = \frac{R_p - R_{STOXX600}}{Trackingerror}$ where R_p are daily portfolio's returns, $R_{STOXX600}$ represent daily returns of the *STOXX600* benchmark and $Trackingerror$ is the standard deviation of portfolio's excess returns. However, it has some inherent drawbacks. For instance, it is possible for investment managers who seek boosting their track records to manipulate it by increasing measurement intervals, which results in a lower estimate of volatility. Moreover, the comparison to a chosen benchmark can be misleading given the fact that funds may have contrasting securities, asset allocations, and starting dates in their investments.

- *Sortino ratio:* The Sortino ratio overcomes one of the above ratios' weaknesses. Contrary to the Sharpe and Information ratios which assume price movements in either direction are equally risky, the Sortino ratio discards above-average returns to focus solely on downside deviations (i.e. measures of donwnside risk that only look at returns that fall below a minimum threshold) as better proxies for the risk of a portfolio. This indicator is believed to give an enhanced view of a portfolio's risk-adjusted performance since positive volatility is usually seen as a profit and not a loss. $Sortino = \frac{R_p - R_f}{\sigma_d}$ where R_p are daily portfolio's returns, R_f represent daily risk-free rates, and σ_d stands for the standard deviation of the downside.

2.6 Data for event study

The data fetching for the COVID-19 event study relies on Refinitiv database. As explained in 3.2.1, regressions are needed to assess the impact of the pandemic on stock returns. This section lists all independent variables used for regressions' implementation - for both specified regressions and their robustness checks.

- *Market return per country*
  The *market return per country* represents daily market returns per country based on benchmark index prices. It aims at being more specific than by solely relying on the *STOXX600*, as the latter gathers European stocks as a whole. The following benchmark

stock market indexes have been retrieved from Refinitiv database: *CAC40, DAX (DE40), IBEX35, CH20, and FTSE100*. They describe respectively France, Germany, Spain, Switzerland, and the UK.

- *ESG combined score*
  This variable has already been extensively explained in a previous part (see 2.1). Besides being used as the threshold criterion in the best-in-class approach, ESG combined scores also enable to measure the importance of ESG performance in the explanation of stock returns' movements.

- *Post lockdown*
  This dummy variable equals one the day right after a lockdown announcement (- and it still holds for later days) and 0 in previous days. For instance, the first lockdown announcement in France happened on the 12th March 2020 and, from the 13th of March on, this dummy variable has equalled one. The *post lockdown* variable is especially relevant when used with *ESG combined score*, as all together they form an interaction term. The latter allows to test whether ESG investors assign incremental importance to ESG performance in times of crisis (Broadstock et al., 2021).

- *Debt-to-Equity ratio (2019)*
  This variable has been directly retrieved from Refinitiv. It is computed as the ratio of the total debt divided by the total value of shareholders' equity. This ratio is the one of the year before the COVID-19 pandemic (i.e. 2019), as it has been done in the literature (Cardillo, Bendinelli & Torluccio, 2022).

- *Past returns (2019)*
  Past returns incorporate price changes and any relevant dividends. This variable is believed to bear explanatory power in regression settings (Li et al., 2022). It is computed daily through the whole specified period. This average value is the one of the year before the COVID-19 pandemic (i.e. 2019), as it has been done in the literature (Cardillo, Bendinelli & Torluccio, 2022).

- *High Minus Low (HML)*
  This variable corresponds to the value premium in the Fama-French three-Factor model. It is computed by the spread in returns between European companies with the highest book-to-market ratios and European companies with the lowest ratios. Its values have been retrieved from the Data library of Kenneth R. French [5].

[5] These values are available on the following website: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_libr

- *Small Minus Big (SMB)*
  The *Small Minus Big (SMB)* factor proxies the size effect in the Fama-French three-Factor model. It represents the difference between the returns of European firms with high book-to-price ratios (i.e. value stocks) and European firms with low book-to-price ratios (i.e. growth stocks). Its values have also been retrieved from the Data library of Kenneth R. French.

2.7 Data for in-depth performance analysis

The data that is handled for an in-depth performance analysis has also been retrieved from Refinitiv. By crawling the database, several indicators were selected for the purpose of producing a holistic view of firm's performances and financial health. Relying on several measures with different roles enables to obtain a just and fair view of companies' inherent performances and financials. These metrics are computed from January 2020 to December 2020 as it is the calendar period during which COVID-19 hit and has started to affect these indicators. That is, it is possible to directly assess performance of (non-) ESG best-in-class stocks amidst times of global crisis. These measures are believed to be the most relevant ones as they were used in several studies such as Hoang et al., (2021); Li et al., (2022); Abedifar et al., (2022); and Demers et al., (2021).

- *ESG Combined Score:* This indicator is explained in very detailed terms in 2.1. It is of the uttermost importance as main assumptions rely on it - the choice of stocks, the creation of portfolios, and underlying regressions of event study.
- *Total return:* The total return metric gauges how much an investor could have made by keeping a specific firm's stock during the whole period of interest. It incorporates the price change and any relevant dividends. It has been computed for the whole year of 2019 - right before the pandemic hit and undermined the market. The formula states that returns are daily compounded - it explains partly why some companies have such high numbers.
  $R = (1 + (\frac{r}{n}))^{nt}$ where r is a firm's daily interest rate, n represents the number of times the latter interest is compounded per period (i.e. the number of trading days per period - usually it is 252 per year), and t is the number of period (i.e. 1 year in this context).
- *Return-on-Assets:* This indicator gives an insight on the ability for a company to generate profit from its total assets. It is slightly similar to the *Operating margin* with the

difference that the latter is based on revenue and ROA relies on total assets, so it gives additional information. That is, ROA reflects the aptitude of taking care of assets to generate financial performance. Refinitiv computes it in the following way.
$ROA(\%) = \frac{Income\ after\ taxes\ (fiscal\ period)}{Average\ total\ assets\ (beginning + end\ of\ year)}$

- *Return-on-Equity:* This metric gives a firm's ability to generate returns while taking into account the leverage in the computation. The added value of the Return-on-Equity goes alongside the Return-on-Assets as it can be compared to the latter. If the difference between both indicators is high, it means that a firm is significantly more leveraged and risky.
$ROE(\%) = \frac{Net\ Income\ before\ extraordinary\ items\ (fiscal\ period)}{Average\ equity\ (beginning + end\ of\ year)}$

- *Debt-to-Equity:* The Debt-to-Equity ratio indicates to what extent a company funds its operations using borrowed money. It can be used as a comparative tool to compare the leverage of various companies within the same industry. If a company borrows a lot, it can represent a higher risk of investment as this company will have to incur higher fixed-expenses to reimburse the debt and reduce earnings available for shareholders.
$Debt - to - Equity(\%) = \frac{Total\ debt}{Total\ shareholders'\ equity}$

- *Price-Earnings:* The Price-Earnings (PE) ratio is a valuation ratio that uncovers a stock's potential of growth. In other words, it matches how much investors are willing to pay to receive €1 of earnings.
$'PE = \frac{Share\ price}{Earnings\ Per\ Share\ (EPS)}$ where the EPS is the last twelve months EPS from continuing operations.

Chapter 3

Methodology

In this chapter, the three main parts of the conducted statistical analyses are extensively explained. The different sections of this chapter have led to the following pathway. First, after having created the selected sample of data and the two subsequent types of best-in-class portfolios by ensuring firms are comparable (see 2), it has been decided to take a holistic view on these. Therefore, implications on returns have been analysed by looking at risk estimations (i.e. VaR, ES, and maximum drawdown) and wealth evolution. The second part highlights the different steps undertaken to apply an event study on the selected sample of data. Then, the last part builds on the advantage of using a peer group to create the portfolios. In fact, the latter enables to confront companies belonging to a same industry and to get a deeper look on the insights retrieved in the preceding sections. Results and their interpretations are suggested in the following chapter (see 4).

3.1 Portfolios analyses

The goal of the following section is to give an overview of the portfolios' analyses. First, the descriptive statistics part is briefly explained alongside the main rationales of using graphical representations. Then, risk measures are laid out, namely the Value at Risk (VaR), the Expected Shortfall (ES), and the drawdown measures. This section will lay the foundations for using these metrics as tools suitable for measuring the risk[1] of ESG (and non-ESG) companies under analysis. First, it will be noted that the VaR has some drawbacks but given that it is still widely used in finance computing it with various methodologies is meaningful. Then, the

[1] This measurement is also defined more narrowly as the possible loss under "normal market risk" as opposed to all risk. That is, distinction between normal and abnormal risk needs to be carried out (see 4.2 to grasp what is meant by abnormal risk and its results and outcomes).

ES will be briefly discussed as it gives additional information on the risk exposure of firms. After that, drawdown risk measures' methodology is described with some of its underlying computations. Lastly, the wealth evolution analysis is illustrated.

3.1.1 Descriptive statistics

In this subsection, the methodology to get a first exploratory data analysis (EDA) is developed. This EDA builds upon 2 tables and 3 graphical representations encompassing data about *ESG leaders*, *ESG laggards*, and the *STOXX600*. The latter plays the role of benchmark as it represents how the European market overall behaved. The first plot displays returns time-series to give first insights of portfolio's performances, while the second plot exhibits histograms of returns along with their densities. In line with the aforementioned plots, the first table investigates first moments of portfolios' distributions to get deeper insights. It gives an overview of the major features of the distribution of the data by detecting outliers, inspecting tails, and looking at how scattered returns distribution is. The second table is all about key financial ratios that assess the overall performance of a portfolio. In the third plot, it can be inferred from correlations whether similar performances happened at same time or are simply due by coincidence - high correlation would involve portfolios behave similarly in face of similar conditions.

3.1.2 Value at Risk (VaR) methods

VaR is a common metric used to assess the risk which is defined as the potential (maximum) losses for portfolios and specific investments. It is a quantitative and synthetic measure of risk. It has various real-world applications such as setting capital requirements in financial institutions for ensuring their solvency, allocating internal resources or solving optimizations in portfolio selection. In other words, it is a statistic that gives the maximum loss over a target horizon such that there is a low, pre-specified probability (e.g. 5 %) that the actual loss will be larger.

The formal definition of VaR is: if Y_t is a random variable, the value at risk (VaR) of Y_t at a confidence level $(1-\alpha)$ where $0 < \alpha < 1$ is defined as:

$$P[-a' * Y_t > VaR(a, \alpha)] = \alpha \tag{3.1}$$

where a' is a vector encompassing portfolio allocation (i.e. weights assigned to each stock

forming the portfolio) and Y_t is a vector gathering the portfolio's return. What the above formula displays is VaR as a quantile of the loss distribution. Thus, it is a function of the portfolio allocation and the loss probability level.

Albeit this metric is still widely used in the financial sector, it is becoming supplemented by the ES - the latter will be discussed in the following subsection 3.1.3. This shift can be explained as the VaR is not subadditive (i.e. it does not display the positive outcomes of diversification). Moreover, VaR does not tell anything about the size of the potential losses. Instead, VaR gives a single point in the distribution. Nonetheless, to align with the industry VaR computations will be provided. Furthermore, to circumvent some of its drawbacks and provide a coherent and robust risk-analysis tool, this thesis will compute VaR in several ways. Therefore, it will go further than the literature and also compare these VaR results in line with the work of Karahanoglu (2020).

1. **Parametric estimation**

   The parametric methodology is also called the Gaussian case or the variance-covariance method because it assumes a normal distribution of returns. Two parameters need to be estimated for this approach. These two parameters are the expected return and the standard deviation. It means that this estimation depends on parameters - hence, the name of the method. Parametric methodology is valid when distributions are known and reliable. However, it is often untrustworthy when the sample size is small. Moreover, most financial assets do not follow a normal distribution. The fact of the matter is that a normal distribution of returns is mesokurtic (i.e. has a kurtosis of 3 meaning fairly modest significance and extremity of deviations). Therefore, it underestimates the tails of the distribution of returns which often are leptokurtic (i.e. with a kurtosis higher than 3). By assuming a normal distribution, it means that tails are thinner than what they actually are and thus most extreme events are skipped.

   Under the assumption of Gaussian returns one can compute the VaR using an explicit form[2]:

$$VaR(a, \alpha) = -a'\mu + (a'\Sigma)^{1/2} z_{1-\alpha} \tag{3.2}$$

   where $-a'\mu$ is the expected loss return for the portfolio based on the vector of stocks' weights, a' and the vector of stocks' returns, μ). Σ is the covariance matrix of the

[2] This formula holds for VaR at 1 day horizon. Thus, if one needs to compute it for several days (e.g. N days), the formula will be slightly twisted as follows: $VaR(a, \alpha) = -a'\mu * \sqrt{N} + (a'\Sigma)^{1/2} z_{1-\alpha} * \sqrt{N}$.

portfolio's returns, and $z_{1-\alpha}$ is the critical value of the normal distribution (i.e. quantile of the Gaussian distribution at $(1-\alpha)$ level).

2. **Historical estimation**
   Initially, the VaR methodology relied upon the assumption of normal distribution of returns (see 1). However, it is widely known that stock returns do not follow closely a normal distribution. Thus, such an assumption would miss severely the most extreme returns - i.e. returns in the tails of a firm's distribution. In order to break this assumption, historical simulation is based on the histogram of losses and gains. It looks at prior returns and orders them from the deepest losses to the most attractive gains on the grounds of the belief that the past gives all necessary information (Pritsker, 2006 s in Karahanoglu, 2020)[3]:

$$VaR^{\alpha} = Percentile(\{R_{t+1-n}\}_{n=1}^{m}\ ,\ 100 * \alpha) \tag{3.3}$$

   where R is the sorted matrix of returns, α determines the confidence interval for VaR. One of the main drawbacks of this method is logically the strong dependence on the past and the equal importance of each past return observation.

3. **Δ historical VaR estimation**
   The Δ historical VaR estimation relies upon simulations of *historical VaR* at two different time periods, namely the VaR during a period of flat market (i.e. before the pandemic) and the VaR during a period of market turmoil (i.e. during the pandemic). The intended goal is to compare the difference between these two periods to get insights about the resilience of a portfolio. As a matter of fact, a relatively small Δ historical for a portfolio in comparison to another one would ensue that the first portfolio better coped with the economic crisis.

4. **Kernel estimation**
   Kernel estimation methodology is also sometimes called the general case methodology. In fact, this approach does not make any parametric assumption on the distribution of returns. It is a useful technique given that it lets the data and the distribution behave as they really are. As such, a kernel is needed to estimate the VaR non-parametrically - in this thesis, a Gaussian kernel (see 7.1) will be used but other types of kernels could

[3] This formula also holds for VaR at 1 day horizon. Yet, it can easily be adapted to other horizons by the replacement of the R matrix of daily returns with a matrix of returns at different frequency.

have been implemented without significantly altering results.

$$\int_{VaR(a,\alpha}^{+\infty} f(z)\,dz = \frac{1}{T}\sum_{t=1}^{T}\Phi(\frac{z_t - VaR(a,\alpha)}{h}) \tag{3.4}$$

where $f(z)$ is the probability density function of a normal distribution[4], $z_t = -a' * y_t$ is the portfolio's loss data, h is the bandwidth which is the smoothing parameter that determines the number of observations taken into account when estimating the density function at a given data point, and Φ is the cumulative distribution function of a normal distribution. The main advantages of this method are the low bias in the model and the reduction in the number of restrictive assumptions compared to a parametric estimation. However, this approach is also seen as unstable in time and it is difficult to extrapolate to low probability quantiles (Gustin, Van Weverberg & Ducuroir, 2020).

3.1.3 Expected Shortfall (ES) methods

Based on new standards imposed by the Basel Committee on Banking Supervision (2019), a shift has been initiated to supplement and replace the former VaR by the ES, also called the conditional VaR or the tail VaR, to measure the risk of a specific company. The rationale behind this shift is to enable a more relevant capture of companies' tail risks. Thus, ES will set more cautious capital requirements during periods of tremendous financial distress.

Compared to VaR, ES offers two main advantages. First, it offers the mathematical propriety of subadditivity in the risk measure: $ES(a_1 + a_2, \alpha) \leq ES(a_1, \alpha) + ES(a_2, \alpha)$. It means that ES accounts for diversification and, contrary to VaR, it does not give an incentive to split up a large firm into two smaller firms in order to get a lower risk measure (Tasche, 2002). Then, the second advantage is that ES renders the size of the potential losses. It means that it gives the expectation of losses knowing that these losses are above VaR:

$$ES(a,\alpha) = E[-a' * Y_t | - a' * Y_t > VaR(a,\alpha)] \tag{3.5}$$

where $-a' * Y_t$ is a portfolio's loss data, and $VaR(a,\alpha)$ is the VaR computed at the confidence level α of a portfolio with a vector a of weights.

Similarly to the methods implemented to compute the VaR, this thesis will use the 3

[4] This formula also holds for VaR at 1 day horizon. To get estimations at broader horizons, y_t needs to be recomputed at the new horizons, but the formula stays basically the same.

aforementioned techniques to compute the ES, namely the parametric, historical, and kernel estimations.

3.1.4 Drawdown risk measures

In order to complement previously demonstrated risk exposure theories, drawdown risk measures are often used among scholars, and these metrics are receiving increasing attention. Other studies, among whom Geboers, Depaire & Annaert (2022), have implemented drawdown methodology on portfolios to assess their resilience and liquidity. Thus, this section will aim at laying the foundations to compute these drawdowns and understand the conclusions which can be retrieved from them.

First, it is worth noting that, by definition, drawdown measures are based on the peak-to-bottom loss of an investment. They depict cumulative losses following the latest maximum wealth of a portfolio. Therefore, by investigating outcomes of consecutive series of losses, drawdown also measures amplification effects. The latter are noticeable as previous losses usually involve more losses because it is expected that investors will divest and sell these investments' shares. Contrary to VaR and ES, drawdown measures also capture cumulative losses. In other words, drawdown is considered to be path dependent. The latter enables it to take into account conditions like liquidity and maximum loss thresholds while investing. Furthermore, path dependency offers the possibility to integrate psychological components in the analysis - i.e. it allows to evaluate the amount of possible suffering and regret (Geboers et al., 2022).

During market turmoil, such as the one following the onset of the COVID-19, investors have experienced several drawdowns which often bear significant psychological impact on investors. That is, investors, if they fear extreme losses, may decide to sell valuable positions, following large declines in market prices. This whole argument is based on the prospect theory which attempts to understand how individuals make investment choices - and these choices are usually not rational. Actually, one of the explanations is that investors often overestimate their risk tolerance. Amidst times of crises, they can start worrying about the liquidity of their investments if they hold big positions on stocks or if a large part of their disposable income is invested in the market (Mendes & Lavrado, 2017, & Chen et al., 2015; as cited by Geboers et al., 2022) - this behaviour stems from the loss-aversion utility of individuals.

In the *results and discussions* part (see 4), insights from drawndown measurements on the dataset under analysis can be found. Among the two usual approaches, the *max loss approach* and the *loc max vs loc min approach*, to compute drawndowns, it was decided to implement the *max loss* method in this thesis. The choice of this technique relies on easiness of interpretation and computation. The graphical representation of these drawdowns is also sometimes called *underwater graph*, where each new stock's peak value is reset to 0% to focus on new drawdowns (Mladina, Grant & Germani, 2022). Drawdowns have been computed with *R* statistical software, using the following formula (Geboers et al., 2022). Supposing a position on one of the portfolios over a time window $[0, T]$ and a running maximum $M_t = sup_{u \in [0,t]} X_u$ where X is the price series, and sup is the supremum (i.e. the smallest upper bound of the investment set prices - it is different from the maximum which is the largest member of the set), then, the relative drawdown can be defined as:

$$DD_t(X) = (M_t - X_t)/X_t \tag{3.6}$$

Subsequently, the Maximum Drawdown (MDD) of the position is calculated by:

$$MDD(X) = sup_{u \in [0,t]} DD_t(X) \tag{3.7}$$

Thereby, drawdowns are measured as a percentage of the maximum cumulative return (- the cumulative return being computed from price series and thus, corresponding to the relative drawdown, DD) measured from peak equity. In other words, if a new value represents a new high, the drawdown will be zero.

3.1.5 Wealth evolution

This subsection aims at detecting consequences one investment could have brought in terms of wealth. As such, it gauges the hypothetical gain or loss one investor would have grabbed by investing fully 1 unit of money in one of the pre-built portfolios. It is assumed that, in a multi-period context, final wealth is determined by averaging log returns - and not by averaging simple returns.

Therefore, the wealth, after fully investing and holding the same portfolio during the period of analysis, is given by:

$$\log(\frac{V_T}{V_0}) = \sum_{t=1}^{T} \log(1 + R_t) = \sum_{t=1}^{T} r_t \tag{3.8}$$

therefore, setting $V_0 = 1$, and $\bar{r_{1,T}} = \frac{1}{T}\sum_{t=1}^{T} r_t$, $\bar{R_{1,T}} = \frac{1}{T}\sum_{t=1}^{T} R_t$

$$V_T = \exp(T * \bar{r_{1,T}}) \tag{3.9}$$

where V_T is the final wealth, V_0 is the initial wealth, the subscript t stands for the time (i.e. measured by days in this analysis), r_t is the log-return, and R_t the simple return (Giordani, 2021). From this equation, some discussion will arise around the causes of a gain or a loss. Thus, plots of portfolios' wealth will relate to moments of returns distribution, but also to risk assessments (see 4 for further details). For instance, a highly volatile portfolio will produce a more right-skewed distribution of final wealth. The same effect on the wealth distribution can be expected from a longer horizon (Giordani, 2021) - besides, avoiding repercussions of unrelated events or crises.

3.2 Event study of COVID-19

This section outlines the implemented methodology to conduct an event study on the pandemic of COVID-19. The intended goal is to assess the impact of the subsequent market turmoil and to note whether *ESG leaders* or *ESG laggards* stocks have reacted differently. In the first part, the main assumptions deemed to be tested in the event study are explained. The second part will highlight the different necessary steps to conduct the analysis.

3.2.1 Rationale behind the methodology

The efficient market hypothesis (EMH) is the basis of the event study methodology. It states the fundamental view that investors are directly informed of price changes as capital markets are supposed to disclose all publicly available information on a firm's stock prices. Consequently, investors are supposedly not able to persistently achieve abnormal returns. Based on this EMH, the event study approach measures the effects of specific events by computing abnormal returns that are deemed to originate from unexpected stock prices' movements (Ullah et al., 2021). Mostly, the approach looks at impacts on stocks prices as it will be the case in the following sections.

While some scholars have studied the effect of COVID-19 on particular industries like the airlines companies (Maneenop & Kotcharin, 2020) or the global hospitality firms (Clark, Mauck

& Pruitt, 2021) by means of the event study methodology, there has been no such investigation for European firms regarding their distinct ESG characteristics in this event framework. Therefore, this event analysis enables to point out short-term evolvements of stocks regarded as best-in-class ESG compared to their counterparts assessed as worst-in-class ESG. This review is based according to an event study approach developed by D'Espallier et al. (2017) that investigates the impact of an event for an NGO. However, contrary to these scholars' idea of considering yearly data, this thesis applies the event study framework by considering a significantly shorter time period. The rationale behind this additional specification relies on the fact that shorter time periods allow to avoid the impact of unrelated events (Delatre, 2007 as cited in Ullah et al., 2021).

First of all, the rationale behind the use of the event study methodology finds its root in the insights this method provides, namely it captures the effects of a specific event (i.e. consequence of the COVID-19) for some selected variables under consideration (D'Espallier, Goedecke, Hudon & Mersland, 2017). In order to isolate the impact of COVID-19, an expected actual value will be fitted for each dependent variable (i.e. stocks returns per country) under analysis by means of linear regression predictions.
Practically, it is needed to decide on the type of regression that will be used to estimate the parameters of the model. As previously said, the theory of event study relies on linear regressions but the latter assumes various hypotheses under their specifications such as linearity, homoscedasticity, normality of the errors distribution or that the sample is large enough to apply the central limit theorem. To be precise, there are 5 main assumptions that need to be fulfilled for simple linear regression models to perform (Brugger, 2021). These are the following:

1. **Linearity**
   The relationship between independent variables and the mean of of the dependent variable is linear.

2. **Exogeneity**
   Independent variables are not dependent on the dependent variable. In other words, a variable is exogenous to a model if it is not determined by other parameters and variables in this specified model.

3. **Homoskedasticity and non-autocorrelation** The variance of residuals (i.e. the difference between the fitted and the actual values) is the same for any value of independent variables, and the correlation between residuals is not different from 0.

4. **Non-stochasticity of independent variables** The data and its characteristics (i.e. same as the independent variables) must have been randomly sampled from the population

5. **No multicolinearity** The phenomenon of collinearity occurs because independent variables are correlated with each other. Collinearity will result in biased estimation of coefficients.

Therefore, several tests need to be carried out to ensure statistically robust estimations (Watelet, 2021). These inspections follow the reasoning of what has been by explained by HKT skills (2023) in order to decide on the most suitable type of regression for the event study under analysis (see 7.1).
First, a Lagrange Multiplier (LM) test is set up for each of the selected regressions. This statistic enables to test for the presence of **heteroscedasticity** - the null hypothesis (H_0) is that all observations have the same error variance, i.e. errors are homoscedastic. If this hypothesis is rejected, it means that a pooled OLS model needs to be rejected as OLS estimations will be biased (i.e. thus, unreliable), and that a random-effects model is more pertinent (Cornée et al., 2020, as cited by Watelet, 2021).
Following the LM test and assuming that a pooled OLS model has been rejected, one must also consider a second test which is the Durbin Watson test. It belongs to the class of **autocorrelation tests**. It investigates whether the regression residuals are autocorrelated or not, while also assuming that observations are ordered by time - the null hypothesis (H_0) is that there is no autocorrelation in the residuals of an OLS regression model, or in other words, that the model one should opt for is random-effects regressions. This statistic looks to see if there is a correlation between the unique errors and the regressors of the model. If the null hypothesis is rejected, one can assume that the fixed-effects specification is preferred (HKT skills, 2021, as cited by Watelet, 2021).
Afterwards, another test, the Hausman test, enables to compare the parameters of two models, namely the random-effects and the fixed-effects. It also assesses the presence of omitted variables effects (i.e. a variable that is important for explaining the dependent variable is not included in the model) and verifies that there is no presence of **endogeneity** in the regression. Hence, if the null hypothesis of the Hausman test is rejected, it indicates that the fixed-effects model is preferred over the random-effects model, suggesting the presence of omitted variable and endogeneity in the regression.
Ultimately, fitted values for dependent variables of interest are considered as normal values for each stocks in any given days of the estimation window[5]. Then, the abnormal value is found

[5] Fitted and normal values will be used interchangeably in this thesis as they represent the same values.

by taking the difference between the actual value and the fitted value.
Standard event study models follow roughly the same steps and they aim to estimate the fitted values and the abnormal values - by subtracting the ex-post returns. Thus, the model elaborates in this fashion:

$$Y_{i,t}^{abnormal} = Y_{i,t} - E[Y_{i,t}|T_{i,t}] \tag{3.10}$$

where

$$E[Y_{i,t}|T_{i,t}] = \hat{\alpha} + \hat{\beta}X_{i,t} \quad \text{if} \quad T_{i,t} = 0 \tag{3.11}$$

where the overall indices *i* and *t* stand respectively for firms and days characteristics, the vector *X* represents the individual firms characteristics or the market returns in the case of the market model, the coefficient α_i denotes the firms fixed-effects, the coefficient β_i denotes the point estimates for the estimated coefficients of firms characteristics, and $Y_{i,t}$ refers to the ex-post return of a stock, while the specification $T_{i,t} \in \{0, 1\}$ indicates whether the day of the observation lies in the period before or after the lockdown announcement (i.e. t_0). Consequently, $T_{i,t} = 1$ if $t_i > (t_0 + N)$ where N represents half of the event window's length. Thus, this specification enables not to take into account returns outside the estimation and event windows.
The second regression 3.11 that evaluates normal values for returns during the period of interest (i.e. around the lockdown announcement dates) enables to compute the abnormal returns (i.e. $Y_{i,t}^{abnormal}$) by subtracting the ex-post actual returns (i.e. $Y_{i,t}$).

After that, the averages of abnormal returns across all firms is computed in order to assess the impact of the onset of the event. In total, there are two averages as it is needed to distinguish between the firms scoring the best and the worst regarding ESG matters. These average values depict the short-term variations for each type of ESG firms and their comparisons (i.e. of means with paired t-tests and of medians with Wilcoxon matched-pairs signed-rank test) shed light on the impact of the global crisis on the 2 types of firms. Hence, the comparison is made by looking at the 2 following estimations:

$$AV_t^{Leaders,\, abnormal} = \frac{1}{N}\sum_i Y_{i,t}^{abnormal} \quad \text{if} \quad ESG_i = 1 \tag{3.12}$$

$$AV_t^{Laggards,\, abnormal} = \frac{1}{N}\sum_i Y_{i,t}^{abnormal} \quad \text{if} \quad ESG_i = 0 \tag{3.13}$$

where the specification $ESG_i \in \{0, 1\}$ indicates whether a firm belongs to the group of *ESG leaders* firms or to the other cluster of *ESG laggards* firms.

Moreover, as it can be seen, results from the event study critically depend on the fitted normal values. Therefore, the choice and the quality of the selected variables exploited in the underlying regression model are of the uttermost importance. To ensure results are as reliable as possible, several robustness checks are performed. Among these checks, one uses different regression specifications (D'Espallier et al., 2017). The results of these robustness checks are displayed in 4.5.

3.2.2 Implementation of the methodology

The main purpose of the event study methodology is to analyse the effects of stock prices to some pre-identified events - here the so-called event is the announcement dates of COVID-19 lockdowns in Europe. Theoretically (see 3.2.1), this approach answers two questions: the null hypothesis of market efficiency and the influence of studied events on a firm's value. The EMH enables to test the overall impact of the COVID-19 on markets separately and assess whether the pandemic has acted like an exogenous shock on the economy. The influence of lockdowns is the feature of main interest as it will allow to answer one of the research question which is investigating the impact of COVID-19 for ESG stocks from various countries in Europe (see Introduction chapter). To explain the methodology carried out, the following part relies upon the several steps enumerated by Ullah, Zaeferian, Ahmed & Kimani (2021).

1. **Identification of event date**
   The first step of the event study methodology (ESM) is to define an event to investigate and characteristics of firms and European market around this event date. COVID-19 is obviously considered as the central global event impacting the European main capital markets. It is utterly important to identify the right precise date of the event under analysis to avoid flawed estimations. One rule of thumb to overcome flawed computations is to use the first announced date when information is known to have reached the market (Ullah et al., 2021). It is utterly important to identify the right precise date of the event under analysis to avoid flawed estimations. To this extent, the event date has been chosen as it is commonly believed and used among scholars (Hoang, Segbotangni & Lahiani, 2021) for being the date on which markets have been hit the most. For the matter of this thesis, seven event dates have been chosen. As such, it was decided to capture the event dates (t_0) as the announcement dates of lockdowns in countries under analysis - see Appendix 7.4 for tables with announcement dates per country. These announcement dates for sampled countries were retrieved from the article of Hoang et

al. (2021).

2. **Selection of estimation, event, and post-event windows**
   The following figure 3.1 wraps up the three time windows of interest for the ESM. First, the *estimation window* enables to compute the normal returns by fitting them through specified models relying on firms and market characteristics. It was decided to use a period between 20 and 50 days before the event date for trustable and reliable results. By clearly distinguishing between the periods of estimation and event, it also enables to avoid of any confounding effects[6] (Heyden & Heyden, 2021). These estimates are notably daily data. The rationale behind the use of daily data over monthly or yearly data is that daily data enables to work properly on immediate changes after a particular event - on the other hand, using monthly or yearly data would provide insights on long-term trends, focusing less on noises and immediate fluctuations. In this specified period, regressions are implemented blending stock returns with market returns and other explanatory variables - see upcoming subsection 3 for further information on models and variables implemented. Then, the *event window* is determined. For the aim of this study, only event dates reported in 7.4 are taken into account. These are considered as the event date t_0. Lastly, *the post-event window* provides the number of days from which it is looked after the event date. Here, it was decided to look at five days after the event date (i.e. t_1' and t_2). In the same vein, the literature also suggests that a short event window is usually more efficient in order to mitigate the effects of noises related to irrelevant market information on stock prices (Maneenop & Kotcharin, 2020). Overall, it means that the event time window's length is of ten days - ten days is a common standard time span in the industry (Ullah et al.,2021; Patnak & Shah, 2010. Maneenop & Kotcharin, 2020).

[6] See 7.1 to have a detailed definition of this statistical effect.

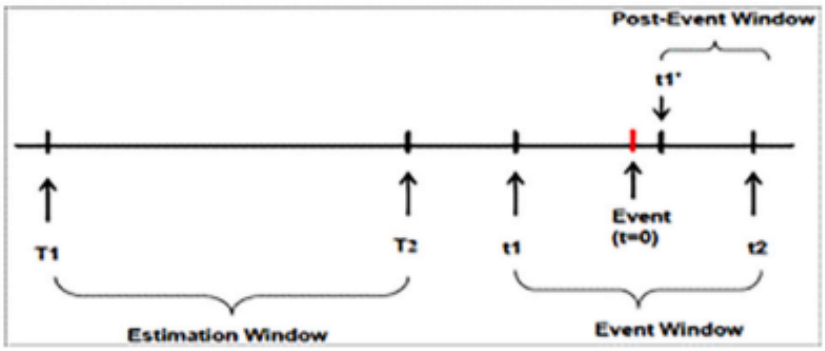


Figure 3.1: Illustration of estimation, event, and post-event windows - source: Ullah et al., 2021

3. **Estimation of parameters**

   After setting the time windows for the ESM, some regressions were run in order to get the expected (i.e. normal) returns during the event period. They are computed for individual companies separately by retrieving firms data from the *estimation window*. Regressions estimate measures for α (i.e. the intercept) and β (i.e. the coefficients of independent explanatory variables). The specifications of regressions and results of these can be seen in section 3.2.1 and section 4.2.1, respectively. Overall, fitted values will allow to compute the *normal* returns and, consequently, the *abnormal* returns as well.

4. **Computation of abnormal and cumulative abnormal returns around the event dates**

   This next step consists of measuring both abnormal and cumulative abnormal stock returns. The abnormal return is computed by subtracting expected return from the ex-post actual return for each day in the event window. Then, to compute the (average) cumulative abnormal returns the (average) sum of each abnormal return is estimated as the latter allows to observe the impact of the event under analysis - for further explanations see 3.2.1.

5. **Implementation of tests - level of significance**

   This last step supports conclusions that can be drawn from the event study. The first test investigates the significance of average abnormal returns for each cluster - i.e. the *leaders* and *laggards* group. The null hypothesis which is tested is the following:

$$\begin{cases} H_0 & \text{if abnormal return for each stock} = 0. \\ H_1 & \text{if abnormal return for at least 1 stock is significantly} \neq 0. \end{cases} \tag{3.14}$$

To reject or not H_0, t-tests need to be computed at different significance levels. Not rejecting H_0 means markets did not perform abnormally as a consequence of the event under analysis. Rejecting the null hypothesis (i.e.H_0) means that cumulative abnormal returns were different from 0 and therefore that the market behaved abnormally in response to a shock stemming from the country lockdown announcement - the latter statement is valid only if the market model is used.

The second test which is conducted aims at determining if the two population means are equal - in this context, the two populations are the *leaders* and *laggards* groups. The H_0 for this t-test is that there is no difference between the means of the two groups being compared, and the alternative hypothesis is that there is a significant difference:

$$\begin{cases} H_0 & \text{There is no difference in the mean between group 1 and group 2.} \\ H_1 & \text{The means of group 1 and group 2 are different.} \end{cases} \tag{3.15}$$

Rejecting the null hypothesis (i.e.H_0) means that, on average, cumulative abnormal returns were different between *leaders* and *laggards* groups. Hence, the two groups exhibit different reactions patterns in front of the announcement of lockdowns.

3.3 In-depth financial performance analysis

The in-depth performance analysis gathers companies by industry to compare them with their closest peers (see 2.3) and it is organized as follows. First, a description of each company belonging to the *ESG leaders* group and the most relevant ones of the *ESG laggards* is established per industry. Then, the returns performances of each firm within an industry are compared to grasp the impact of price changes and how the market reacted to the pandemic. Afterwards, the core part of this financial review lies in the table related to firms' characteristics mentioned in a previous section (see 2.7). Performances of an industry's companies are compared within and between sectors, but also to the median and average of the peer group. Lastly, a brief conclusion of the main findings in the analysed industry is drafted and overall ESG initiatives of companies are confronted with the retrieved insights[7]. As such, the impact of ESG policies within a *leaders* firm can be evaluated. Notably, all annual reports have been skimmed over as well as sustainability reports when these were available.

[7] A subsequent and independent part (see 4.3.2) encompasses cross-industry findings and summarized trends across the analysed data during the pandemic.

Chapter 4

Results and discussions

This chapter outlines the results and subsequent discussions that arose from the several statistical and financial conducted analyses. In the first section, constructed portfolios will be mathematically investigated by means of descriptive statistics, risk assessments, and wealth implications. In the second section, results of the event study will be presented and underlying assumptions will be discussed. In the last section, insights of the two first analyses will be further investigated by looking extensively at financial statements (and sustainable reports) of firms per industry.

4.1 Discussion of portfolios analyses

This section lays out the first step of the analysis, namely what an ESG (or non-ESG) portfolio can bring to an investor. It encompasses a period starting from before the COVID-19 (i.e 1^{st} of December 2019) and finishing the 30^{th} of November 2020, after European markets were hit the most - the chosen period corresponds to the one selected for the upcoming event study (see 3.2.2). It enables to avoid incorporating events unrelated to the COVID-19 while still including the impacts of first waves. It also serves as preliminary findings for subsequent in-depth financial analysis (see 4.1). Overall, this first analysis depicts and assesses how bad the pandemic has affected the market and how this financial place has recovered from it. It is divided in five complementary parts. For each of these parts, one can read that building one type of portfolio or the other (i.e. equal or capitalization weights) significantly influences the outcomes. The first part highlights some basic descriptive statistics by looking at the four first moments of the returns' distribution, the plot of returns time-series, and the correlation between portfolios and their benchmark (i.e. the *STOXX600*). The second part attempts

to mathematically assess the risk of these portfolios by inspecting the VaR using different methodologies. In the third section, results provided by the VaR will be compared to another mathematical approach measuring risk, the ES. This concept has recently gained increasing prominence as being the new standard examined by the Basel Committee on Banking Supervision. The fourth part provides estimations of the drawdowns encountered by the different portfolios. The added value compared to the VaR and ES is its ability to also assess liquidity impacts on top of giving a risk measure. The last section briefly skims over real-world implications for the wealth of an investor if the latter invested in one of the built portfolios.

4.1.1 Descriptive statistics

Equally-weighted portfolio

The first part of the equally-weighted portfolio's analysis concerns insights from plots displaying returns distributions of *ESG leaders*, *ESG laggards*, and *STOXX600* portfolios. At first sight, it can be assumed from the 1st plot that, before COVID-19, the portfolio that mostly outperformed (i.e. had greater returns) was the *laggards* one. However, after mid-April 2020[1], it appears that the *leaders* portfolio performed better and experienced more positive peaks than its non-ESG counterpart. The following plots also exhibit more extreme events for the *STOXX600* and the *leaders* portfolio - both gains and losses.

[1] This point in time is considered as the moment the stock market crash linked to the first wave of the pandemic stopped. From the severe turmoil's levels, stocks globally performed outstandingly high in that month - with their best one-month performance since 1987 (Johnson Investment Council, 2020).

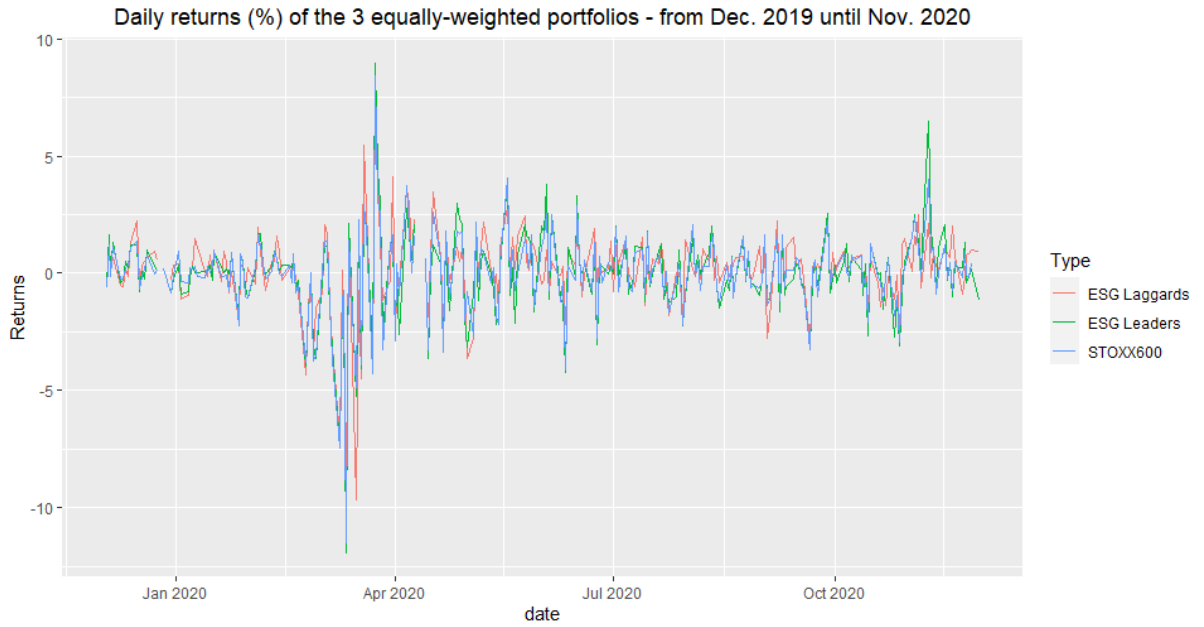


Figure 4.1: Portfolios returns - own computations for the 3 types of equally-weighted portfolios.

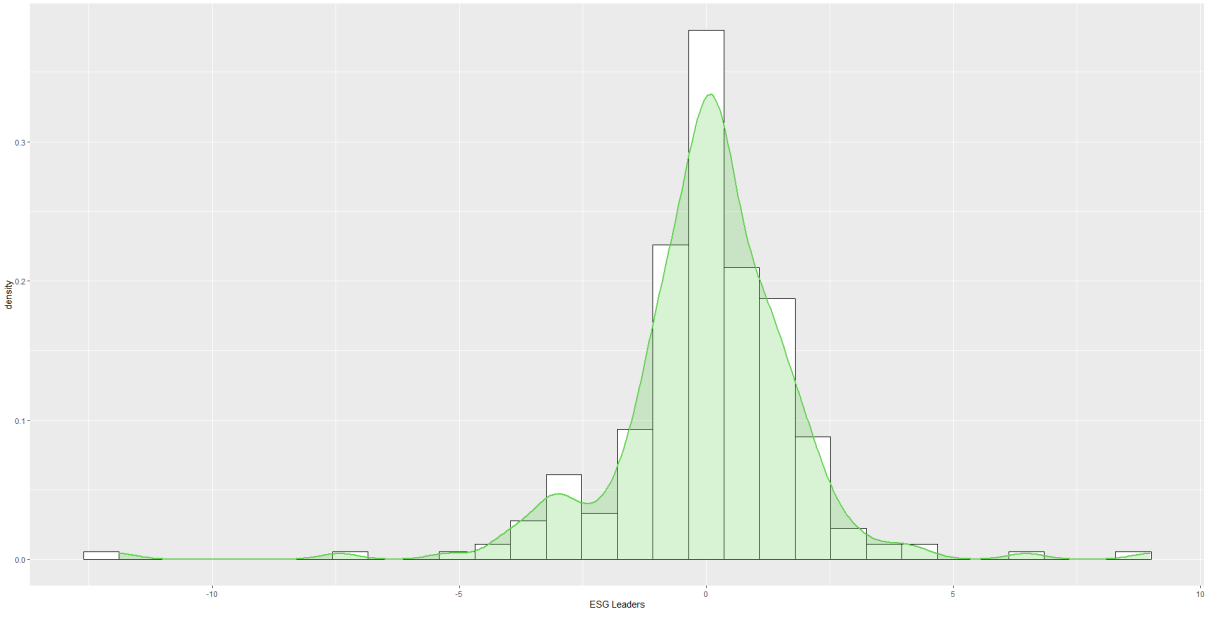


Figure 4.2: Returns distribution - own computations for equally-weighted *ESG Leaders*.

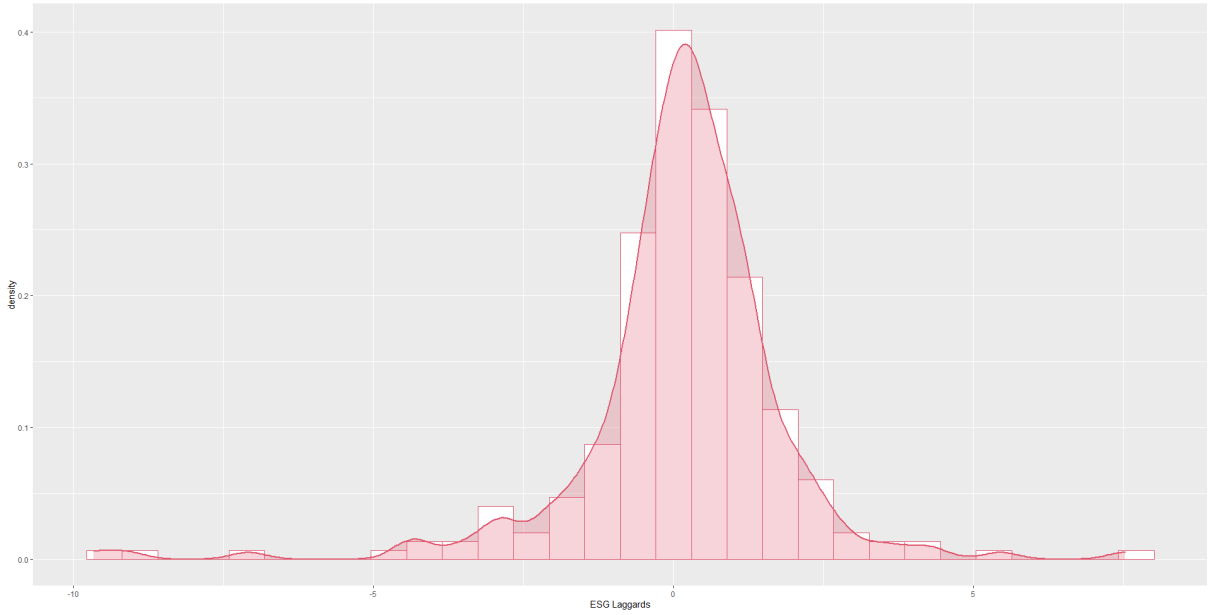


Figure 4.3: Returns distribution - own computations for equally-weighted *ESG Laggards*.

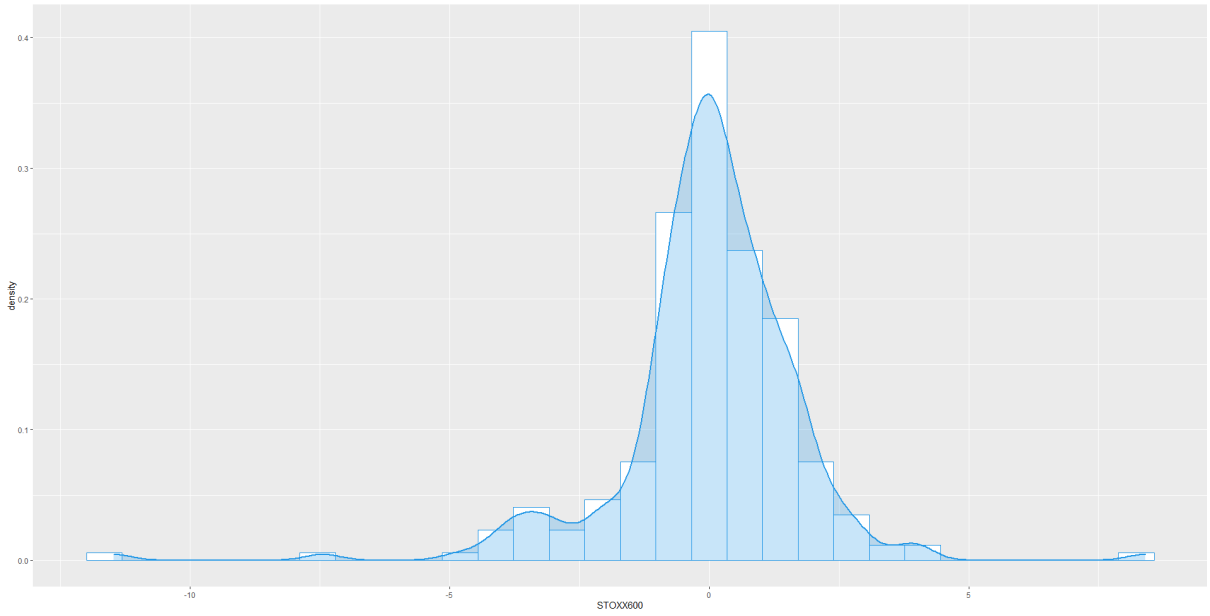


Figure 4.4: Returns distribution - own computations for *STOXX600*.

Looking at the below table, it seems that the *ESG leaders* portfolio is slightly outperformed by its counterpart, the *ESG laggards* portfolio. Hence, the mean of *ESG leaders* over a period starting from the 1st of December 2019 until the 30th of November 2020 is lower, but this result is not significant (i.e. based on a two-sample t-test[2]). Its standard deviation is used

[2] Even though normality of the data cannot be confirmed, the central-limit theorem (CLT) is involved

as a measure of risk and it is superior to its counterpart, meaning that it can be assumed that the ESG portfolio is slightly more spread around its means - as it was expected from the above histogram plots.[3] Regarding the skewness for *leaders*, it is less negative than for *laggards* or for the benchmark *STOXX600*. It implies that the left tail of the distribution is less long. Thus, events involving losses tend to appear less often - in terms of severity. Then, all kurtosis statistics are high, meaning their distributions have fat tails and are more at risk of extreme events - this is in line with previous density plots. From this point forward, further investigation is needed to corroborate these findings.

Type of portfolio	Mean ESG score	Mean return (%)	Standard deviation (%)	Skewness	Kurtosis
ESG Leaders	85.265	0.0021	1.8635	-0.8797	11.9959
ESG Laggards	14.808	0.1443	1.7295	-1.3610	11.9230
STOXX600	NA	0.0078	1.7505	-1.2369	12.6884

Table 4.1: Moments of returns distribution for equally-weighted portfolios

The second table displays some financial ratios which are widely used in the industry to measure portfolios' performances. The *ESG laggards* portfolio consistently scored better than the two other portfolios. First, all Sharpe ratios are negative, meaning that expected returns compared to the risk-free rate were likely to be negative. In other words, an investor able to invest in government bonds to get the risk-free rate of return would have beaten investors having a long-only position on these stocks. The information ratio gives insight on a more active investment strategy[4], considering returns are compared to a benchmark which is the *STOXX600*. *Leaders*' information ratio is really close to 0, but *laggards*' information ratio is outstandingly high and suggest a strong risk-adjusted performance. Regarding the Sortino ratio which only investigates downside deviations (i.e. below the chosen threshold of 0%) in contrast to the 2 previously analysed ratios, all of them are below 1.0. That would suggest suboptimal investments in normal market conditions.

After taking a look at returns plots and having discovered that time series react at the same time (- even though the impact of the response is slightly different), it is logically relevant to assess how strong the co-movements are. Therefore, the following plot exhibits correlations among the three types of portfolio. All computed correlations are above 0.8,

given there are more than 30 observations per group.

[3] Nonetheless, this results is not significant, i.e. based on a F-test to test whether these two population variances are equal or not, we cannot reject H_0 that the two population variances are equal.

[4] However, it is worth remembering that firms' allocated weights in built portfolios do not vary during the period under analysis - it is also true for capitalization-weighted portfolios.

Type of portfolio	Sharpe ratio	Information ratio	Sortino ratio
ESG Leaders	-0.1650	0.0058	0.0047
ESG Laggards	-0.0980	2.5876	0.1083
STOXX600	-0.1720	NaN	0.0033

Table 4.2: Financial ratios of equally-weighted portfolios

which shows strong relations between these type of investments - it could have been expected given the magnitude and systemic aspect of the pandemic crisis[5]. Interestingly, the market portfolio (i.e. the *STOXX600*) is correlated the most with the *leaders* portfolio. Therefore, the equally-weighted *leaders* portfolio is not a steady hedge against market turbulence.

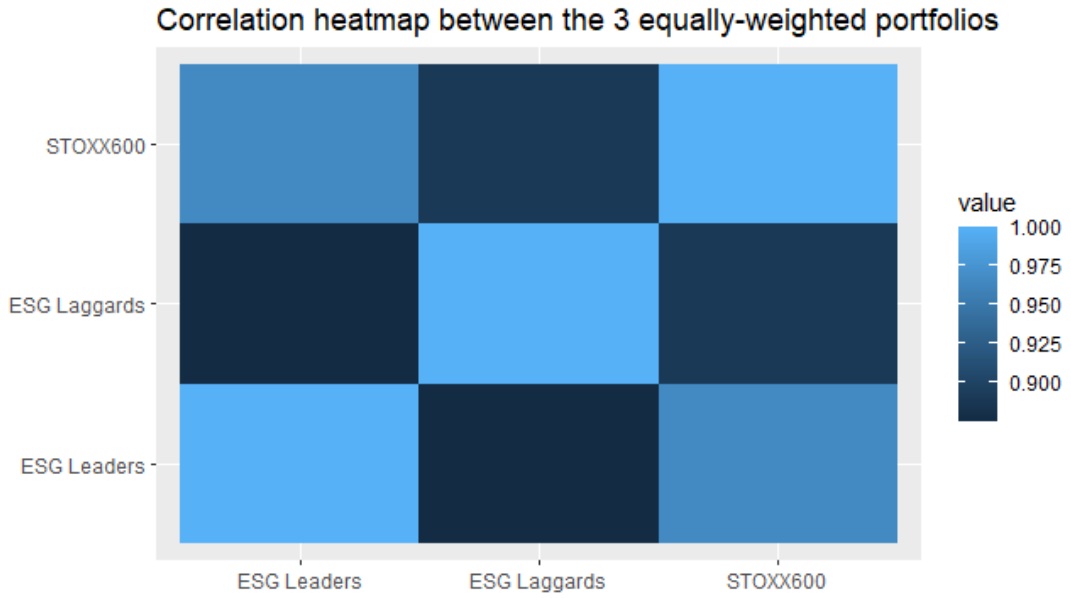


Figure 4.5: Portfolios correlations - own computations for the 3 types of equally-weighted portfolios.

Capitalization-weighted portfolio

First, the capitalization-weighted portfolio is looked at from the returns distribution perspective. It stands out that *laggards* and *STOXX600* are more volatile than *leaders* - at least in the magnitude of their downward movements. Contrary to what has previously been mentioned for equally-weighted portfolios, *ESG laggards* portfolio has concentrated most of its outperformance, in terms of returns, before mid-April[6], and *ESG leaders* group has slightly

[5] Notably, it is also the result of the presence of some stocks in both *STOXX600* and *leaders* or *laggards* portfolios at the same time. Therefore, these correlations results need to be taken cautiously.

[6] April is usually taken as the month during which stock markets rebounded and gained returns after months of severe downturns.

narrowed the gap afterwards.

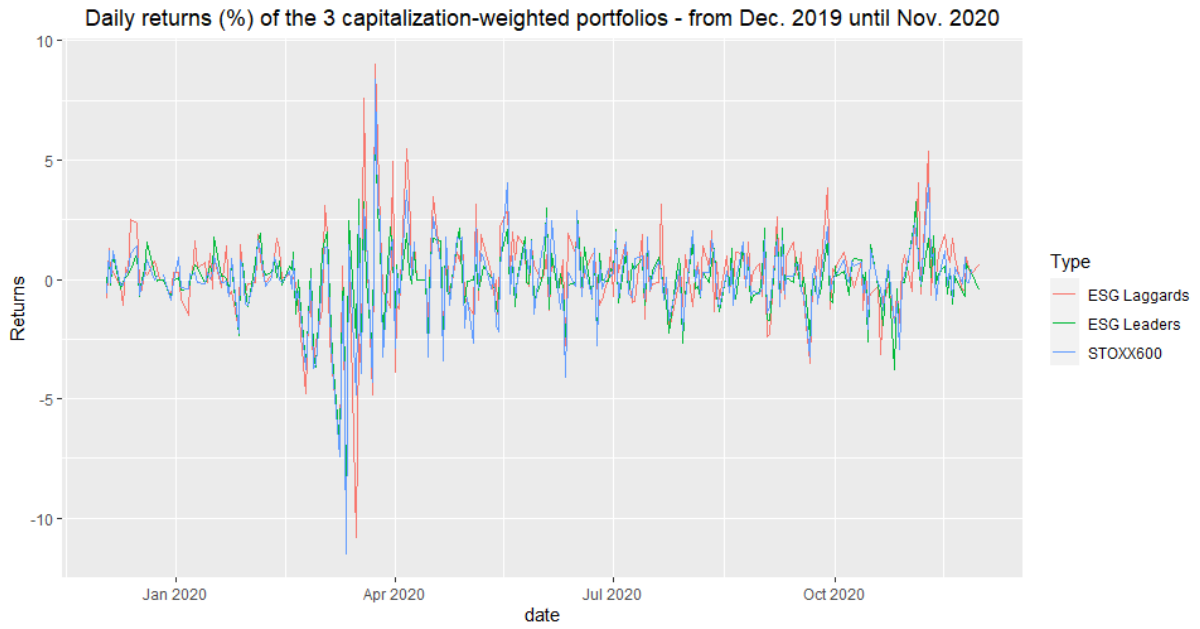


Figure 4.6: Portfolios returns - own computations for the 3 types of capitalization-weighted portfolio.

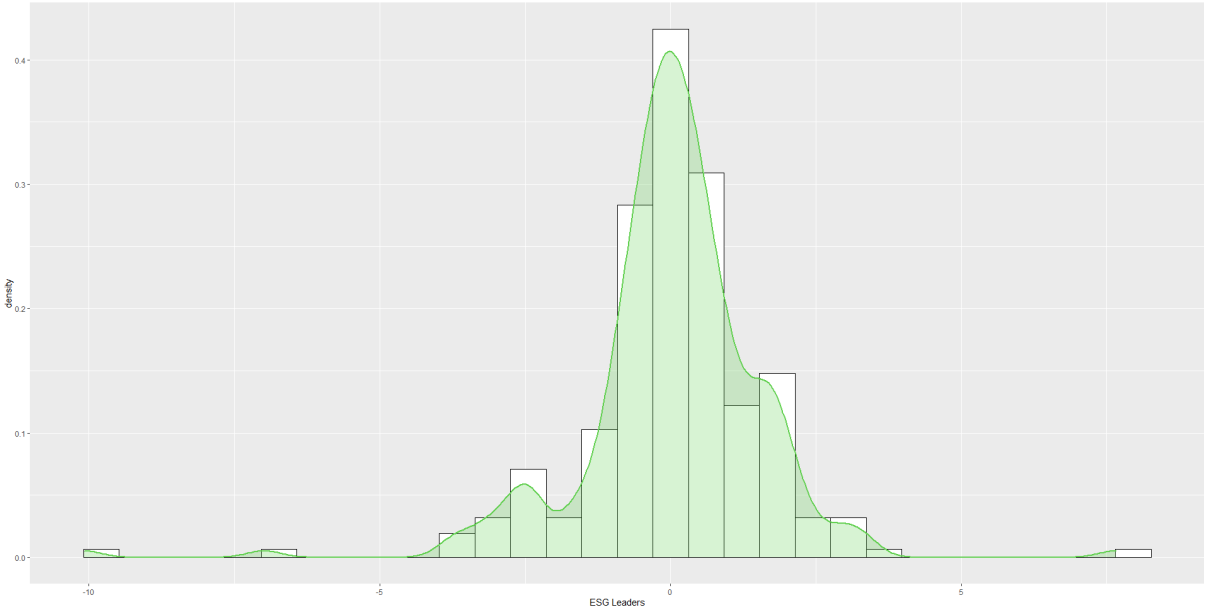


Figure 4.7: Returns distribution - own computations for capitalization-weighted *ESG Leaders*.

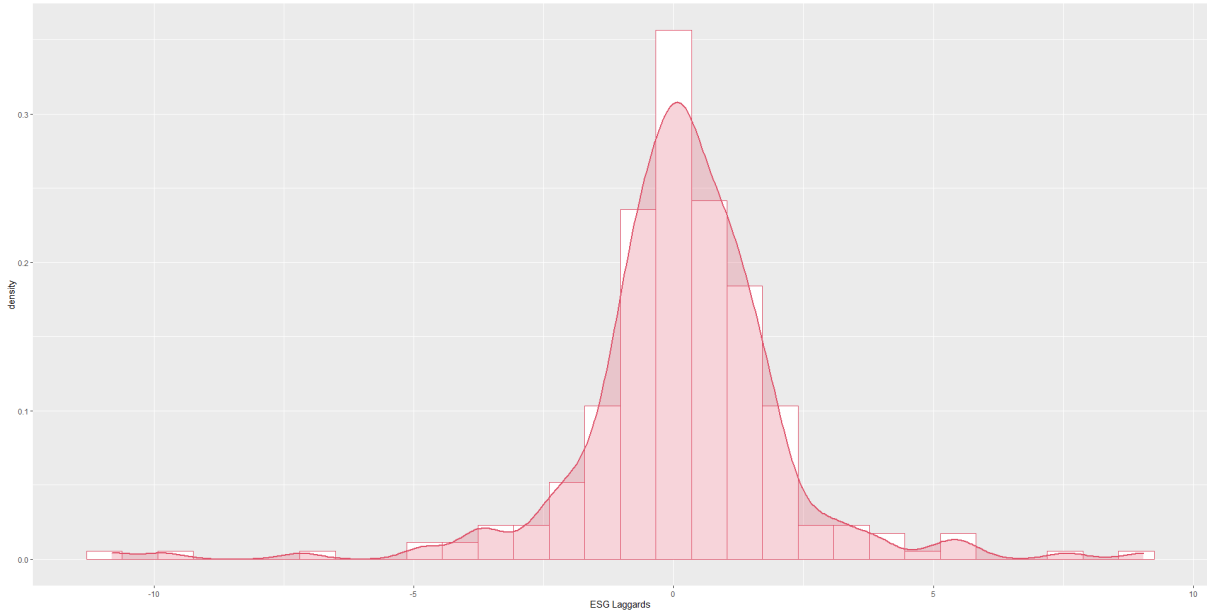


Figure 4.8: Returns distribution - own computations for capitalization-weighted *ESG Laggards*.

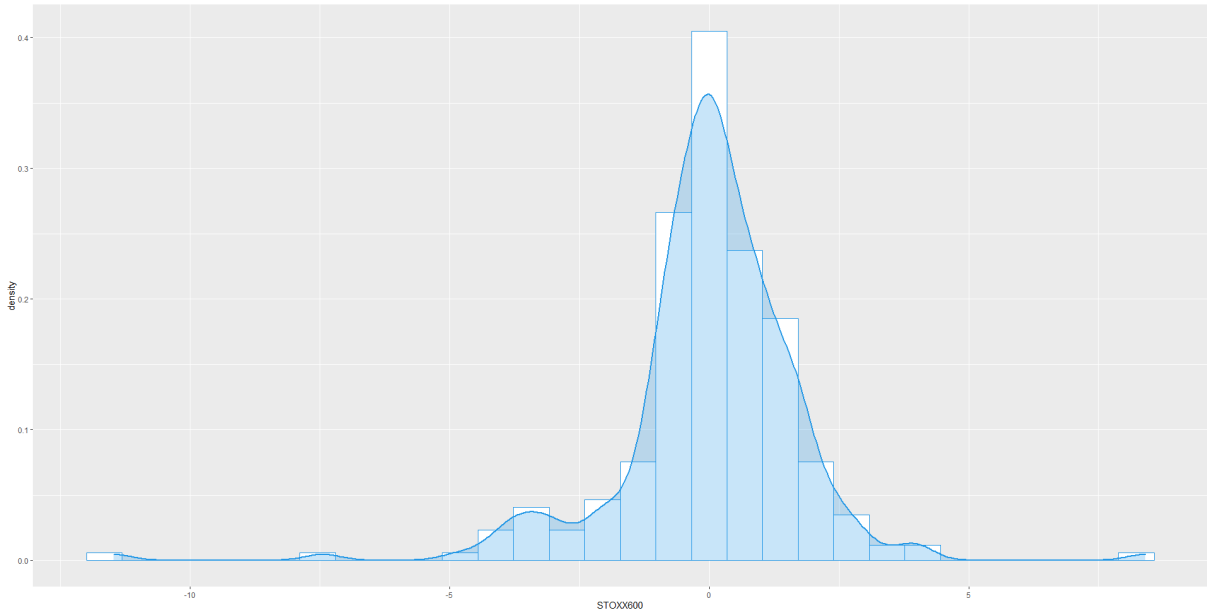


Figure 4.9: Returns distribution (the plot is the same as in previous subsection but it is repeated for visualization purposes) - own computations for *STOXX600*.

The analysis of first moments of returns distribution is investigated in the below table. Main conclusions about the *ESG laggards* portfolio appear to still hold with capitalization-weighted investments. However, the *ESG leaders* portfolio performed relatively better in this

capitalization-weighted setting[7]. It can be explained by the fact that companies which have been more profitable and have performed strongly on the market have a larger allocated weight than in a similar equally-weighted portfolio - for instance, l'Oreal SA, which performed above the portfolio's mean with a return of 18.57%, got a weight of 16.89% in the capitalization setting, instead of only a weight of 6.67% in the previously analysed portfolio. Along with the previously analysed portfolio, the mean return has been higher for the *laggards* group, but once more this result is not significant. However, it is interesting to note that the standard deviation of *leaders* portfolio is significantly different than this of the *laggards* group. Nonetheless, skewness for the latter cluster is less negative, meaning *laggards* have supposedly experienced less extreme losses and its kurtosis is also lower, which involves lower probability of extreme events. Hence, it cannot be concluded that *ESG leaders* exhibited significant lower risk in this capitalization-weighted context.

Type of portfolio	Mean ESG score	Mean return (%)	Standard deviation (%)	Skewness	Kurtosis
ESG Leaders	87.78652	0.0257	***1.5469[8]	-1.1185	12.7092
ESG Laggards	15.69621	0.1655	1.9840	-0.6860	10.9952
STOXX600	NA	0.0078	1.7501	-1.2369	12.6884

Table 4.3: Moments of returns distribution for capitalization-weighted portfolios

Regarding pure portfolio management characteristics, the second table suggests that the *ESG laggards* portfolio consistently outperformed the 2 others, while the *ESG leaders* portfolio consistently scored better than *STOXX600*. Interestingly, if one focuses on the *leaders* row, it can be seen that on all ratios, scores are better off than in the equally-weighted setting. However, any investor in government bonds would have beaten others having a long-only position on one of these portfolios during the period of interest, based on Sharpe ratio. The information ratio considers *leaders* portfolio as a good (i.e. value over 0.5) investment compared to the market and *laggards* portfolio as an investment which is of outstandingly high value. Lastly, the Sortino ratio indicates that all of these investments would have been suboptimal if these results would have hold under normal market conditions.

The last step of this preliminary analysis is to confirm what has been previously raised about the closer relationship between the *STOXX600* and *leaders* portfolio than between this market index and the *laggards* portfolio.

[7] In this context, *ESG leaders* portfolio scored higher on mean return and lower on standard deviation

[8] Test is performed based on a F-test comparing variances between *leaders* and *laggards* clusters

Type of portfolio	Sharpe ratio	Information ratio	Sortino ratio
ESG Leaders	-0.1587	0.5671	0.0238
ESG Laggards	-0.0790	2.5213	0.1182
STOXX600	-0.1720	NaN	0.0057

Table 4.4: Financial ratios of capitalization-weighted portfolios

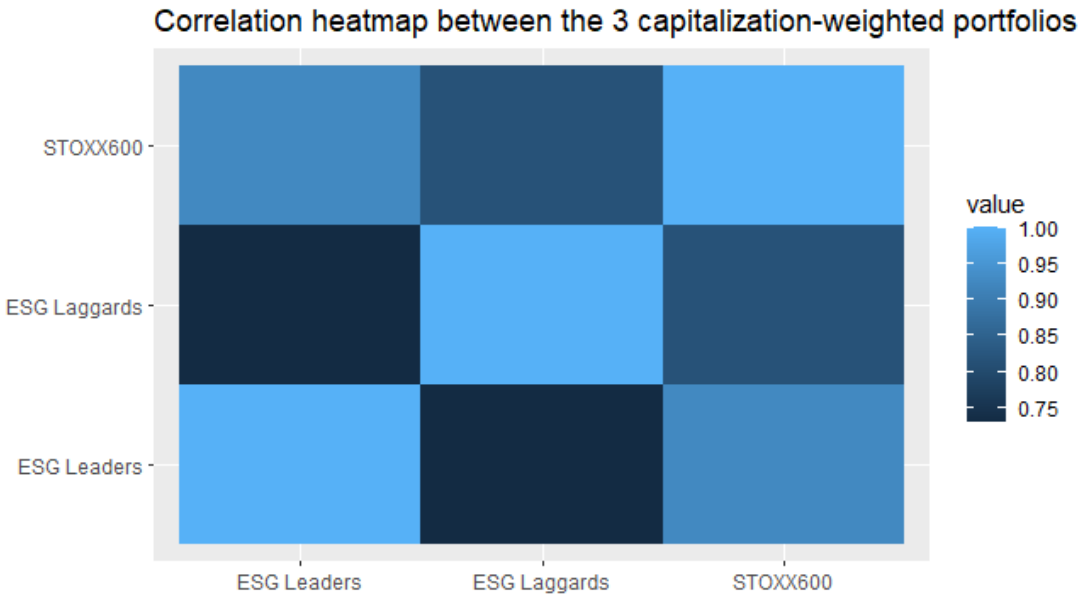


Figure 4.10: Portfolios correlations - own computations for the 3 types of capitalization-weightedportfolio.

4.1.2 Risk assessment - VaR estimations

This subsection aims at assessing the risk of built-in portfolios. Portfolios are naturally exposed to different risks, such as high losses, bankruptcy, legal risks, etc. These risks are usually distinguished between market risk, credit risk, and operational risk. In particular, VaR and ES estimations enable to tackle market risk (Mager, 2012). As a matter of fact, VaR estimations give a statistical measure of the extent of possible financial losses that could occur over a specified period of time - in this analysis, the period of time, also called the value at risk horizon, is 10 days at a confidence interval of 99%[9]. The estimation period is of 260 days. It encompasses almost the whole year of the pandemic - from the 1st of December 2019 until the 30th of November 2020, which is the same timestamp as in 4.1.1, hence it ensures risk analyses and descriptive statistics stay on the same page. This annual period of time also enables to easily compare the VaR of 2019 (i.e. flat market without pandemic, from the 1st of December

[9] The choice of VaR horizon relies on the framework advised by Basel III. It is widely applied across the whole financial industry (Citigroup Inc., 2014).

2018 until the 30th of November 2019) to the VaR of 2020 (i.e. market turmoil in the wake of the pandemic), and their underlying Δ. This measure computes the difference among *ESG leaders* and *ESG laggards* portfolios at a certain point in time - the latter comparison will only be conducted for the historical method. It means that, for each level of confidence, from the value of the 2020 VaR (- which is logically the highest due to a larger risk) is deducted the value of the 2019 VaR. The latter difference is calculated for both portfolios. Then, the discrepancy between Δ gives an insight about the resilience of each portfolio amidst times of crisis.

Equally-weighted portfolio

- **Historical VaR**

	VaR level		
Type of portfolio	95%	97.5%	99%
ESG Leaders	9.791	11.656	14.934
ESG Laggards	8.654	11.284	18.143

Table 4.5: Historical VaR estimations for equally-weighted portfolios

The above table gathers VaR computations for the built portfolios at 3 different levels of significance. It can be noticed that it is definitely relevant to look at various levels of significance to investigate the VaR as it can lead to different results. As a matter of fact, the maximum amount expected to be lost for an investor over 10 days is increasing by targeting a stringent confidence level. At the level of interest (i.e. 99%), the *leaders* portfolio would be preferred as the latter would incur a forecasted loss of 14.934% over a 10 days horizon during the Covid-19 period compared to a higher loss of 18.143% induced by the *ESG laggards* portfolio.

- **Δ historical VaR**

	VaR level		
Type of portfolio	95%	97.5%	99%
ESG Leaders	6.198	7.373	8.811
ESG Laggards	4.038	4.886	10.085

Table 4.6: Δ historical VaR estimations for equally-weighted portfolios

First, it can be noted that delta values increase alongside the level of stringency of the significance threshold. In other words, it suggests that, at the highest levels of potential losses, VaR differences are even more significant. Therefore, portfolios experienced more severe losses in 2020[10]. These delta values also give insights in regards to which investment has been the most resilient during the pandemic. As a matter of fact, a small delta would indicate that only small additional risk would have been added to one portfolio during the crisis. From the above table, it appears that the *laggards* portfolio was more resilient at the 95 and 97.5% level as investors would have experienced an increase in possible losses of, respectively, 4.038% and 4.886% on a 10 days horizon - compared to higher losses of 6.198% and 7.373% for the ESG counterpart investment. However, the *leaders* would be preferred at the highest level of confidence given a lower potential loss. It is also in line with results from the previous subsection of *historical* simulations where *ESG leaders* have occurred to better hedge against the extent of possible losses at the 99% significance level.

- **Parametric VaR**

	VaR level		
Type of portfolio	95%	97.5%	99%
ESG Leaders	9.743	11.612	13.784
ESG Laggards	8.84	10.565	12.569

Table 4.7: Parametric VaR estimations for equally-weighted portfolios

In the above table, results for the parametric VaR are displayed. They appear to be in line with those retrieved from the *historical* simulation part at the levels of 95% and 97.5%, but they are contradictory at the 99% level, which is the level of interest. Actually, *ESG leaders* still has the highest VaR at the most rigorous level in this approach. At this stringent level, it is also striking to see how the *parametric* assumption tends to underestimate the value of VaR - almost 5% less in its estimation. However, these results need to be treated with caution given the fact that this *parametric* simulation makes the assumption of normality of the data and, as it has previously been showed, the data is not normally distributed during this period of time (see 4.1.1).

- **Kernel-based VaR**

[10] For comparison purposes, values of historical VaR for the year before are available in appendix - 7.5.

	VaR level		
Type of portfolio	95%	97.5%	99%
ESG Leaders	9.704	12.513	16.556
ESG Laggards	8.576	10.736	22.424

Table 4.8: Kernel-based VaR estimations for equally-weighted portfolios

Results of the *kernel-based* estimations are systematically in line with results of *historical* estimations as the kernel approach also favours the *ESG leaders* portfolio based on forecasted loss at 99% confidence level - it can be explained by the similarity of these two methods which both rely on the whole sample observations of past data. Interestingly, although the results of these two estimations are really close, the *kernel* method suggests higher potential losses at 99%, being more conservative and precautionary at high levels of confidence.

Capitalization-weighted portfolio

- **Historical VaR**

	VaR level		
Type of portfolio	95%	97.5%	99%
ESG Leaders	8.196	9.968	11.782
ESG Laggards	7.949	12.061	18.320

Table 4.9: Historical VaR estimations for capitalization-weighted portfolios

Results of the above table indicate that the *ESG laggards* portfolio would experience higher possible financial losses, except at the 95% level. Interestingly, these results are in line with those obtained in the equally-weighted setting with the notable exception that the offset to lower losses for the *ESG leaders* portfolio already happens at the 97.5% significance level. Thus, the *ESG leaders* investment would overall incur less losses over a 10 days horizon.

- **Δ historical VaR**

	VaR level		
Type of portfolio	95%	97.5%	99%
ESG Leaders	5.157	5.626	6.123
ESG Laggards	3.341	5.293	9.597

Table 4.10: Δ historical VaR estimations for capitalization-weighted portfolios

The above table suggests that the *ESG laggards* portfolio would be more resilient to the extent of the increase in its VaR values until the 97.5% level. After this threshold, the same inverted pattern as for the equally-weighted portfolios is repeated at 99% of significance, namely the *ESG leaders* portfolio is more secure at the most severe losses. Furthermore, estimations grow consistently higher with the strictness of the significance level. However, delta values increase at a significantly lower rate than for the equally-weighted investments and they are also lower than what can be found above with equal weights. That is, the latter point would also advocate that capitalization-weighted investments have been more resilient. Overall, *leaders* portfolio gives indications of stronger resilience regarding the most severe losses. Indeed, amidst times of COVID-19 and in a calmer period (see Appendix 7.5 to look at values of historical VaR for the year before), its historical VaR has been systematically lower at all levels of significance.

- **Parametric VaR**

	VaR level		
Type of portfolio	95%	97.5%	99%
ESG Leaders	8.269	9.858	11.706
ESG Laggards	10.463	12.501	14.871

Table 4.11: Parametric VaR estimations for capitalization-weighted portfolios

Parametric estimations consistently exhibit lower potential losses for the *ESG leaders* portfolio[11]. It suggests that this portfolio would experience lower level of losses at a 10 days horizon. Moreover, these values are lower than those found for the *historical* approach. Consequently, it is important to remind that these results rely on the assumption of normality of the data and the latter cannot be verified.

[11] These results are completely opposed to the findings under equally-weighted portfolios, suggesting capitalization-weighted portfolios better hedge against extreme losses, in this context at least.

- **Kernel-based VaR**

	VaR level		
Type of portfolio	95%	97.5%	99%
ESG Leaders	8.507	10.238	22.090
ESG Laggards	8.837	12.287	22.663

Table 4.12: Kernel-based VaR estimations for capitalization-weighted portfolios

Results of the *kernel* methodology are in line with previous methods. As a consequence, the *ESG leaders* portfolio would occur less severe losses over a trading horizon of 10 days. Still, this approach brings more cautious assessment of the most extreme losses (i.e. at 99% level) and provides an additional perspective to previous estimations to ensure robust results.

4.1.3 Risk assessment - ES estimations

Equally-weighted portfolio

As previously explained, Basel III tends to put greater emphasis on the computation of ES. The latter is more conservative and, contrary to VaR, it gives an expected value of losses beyond a given confidence level when the returns are above the VaR. As advised and proposed by Basel III accords (as cited by Brie, Genest & Arsac, 2018), ES is computed at a 10 days horizon, on daily data and at a confidence level of 97.5%. One can notice this confidence level is lower than for the VaR. It can be explained by the ES which is continuously greater than the VaR. Thus, keeping the same level of 99% of confidence level would have been overly conservative, leading to (almost) unbearable capital reserves for firms (Brie, Genest & Arsac, 2018). As a result, the ES for the 99% significance level is not retrieved in the following tables. Plus, at that level of confidence, only 3 observations would have been taken into account which is not robust and can potentially harm the estimations.

- **Historical ES**[12]

[12] The number between parentheses next to the *ES level* indicates how many loss returns are taken into account for one ES estimation - it is also effective for all the following tables gathering ES values

	ES level	
Type of portfolio	95% (13)	97.5% (7)
ESG Leaders	12.058	15.311
ESG Laggards	14.716	19.224

Table 4.13: Historical ES estimations for equally-weighted portfolios

ES computations enable to get a more conservative estimation than previous results of VaR. Thus, as expected, estimated values are greater than for the VaR. For instance, at a 97.5% level, the *ESG leaders* portfolio's maximum expected loss is of 11.656% which is given by the VaR, whereas the average loss when this investment exceeds the VaR is of 15.311% which is given by the ES. According to these estimations, the *ESG leaders* portfolio would incur less average losses over a 10 days horizon than its non-ESG counterpart, regardless of the significance level.

- **Parametric ES**

	ES level	
Type of portfolio	95% (13)	97.5% (7)
ESG Leaders	12.221	13.852
ESG Laggards	11.127	12.633

Table 4.14: Parametric ES estimations for equally-weighted portfolios

These results are still in line with the more conservative rule that is imposed by the ES - i.e. these values are higher than these of VaR estimations. However, these estimations put the *ESG laggards* portfolio as the one incurring less losses, which is contradictory to the above finding using *historical* estimations. Given the previously mentioned issue related to the assumption of normality, it has been decided not to further investigate or rely on this approach.

- **Kernel-based ES**

	ES level	
Type of portfolio	95% (13)	97.5% (7)
ESG Leaders	14.424	17.839
ESG Laggards	12.813	20.870

Table 4.15: Kernel-based ES estimations for equally-weighted portfolios

At the level of interest (i.e. 97.5% of significance, as advised by Basel III), *ESG leaders* portfolio would get lower average losses than its non-ESG counterpart. This finding is in line with the conclusion drawn using *historical* simulation. Yet, results are different for the 95% significance level, but these will not be taken into further consideration.

Capitalization-weighted portfolio

- **Historical ES**

	ES level	
Type of portfolio	95% (13)	97.5% (7)
ESG Leaders	9.664	11.820
ESG Laggards	15.243	19.043

Table 4.16: Historical ES estimations for capitalization-weighted portfolios

Results of the ES are significantly more conservative than those of *historical* VaR. That is in line with previous results and the very essence of ES. Then, consistent findings with respect to the VaR comparison between the 2 built-in portfolios are also found. Namely, values of ES are lower in the capitalization-weighted setting than in the equally-weighted. Moreover, *ESG leaders* appear once more to experience lower averaged losses than their non-ESG analogues.

- **Parametric ES**

	ES level	
Type of portfolio	95% (13)	97.5% (7)
ESG Leaders	10.377	11.764
ESG Laggards	13.16568	14.945

Table 4.17: Parametric ES estimations for capitalization-weighted portfolios

Estimations from the above table are in line with findings from the *historical* parameterization for both between portfolios and within portfolios comparison. Thus, *ESG leaders* portfolio has lower average losses exceeding the computed VaR.

- **Kernel-based ES**

	ES level	
Type of portfolio	95% (13)	97.5% (7)
ESG Leaders	12.036	16.553
ESG Laggards	15.481	21.889

Table 4.18: Kernel-based ES estimations for capitalization-weighted portfolios

The above results lead to the same conclusion as for the aforementioned methods, which means this finding is robust and likely valid. That is, the *ESG leaders* portfolio is would consistently experience lower average extreme losses than the *leaders* group. It is also worth noting that the stated contradictory comparison between *ESG leaders* and *laggards* portfolio is not valid anymore.

4.1.4 Maximum drawdowns of portfolios

Following obtained results on portfolios' risk assessment (i.e. VaR and ES estimations), it is also relevant to assess the maximum drawdown of these. Drawdowns give an additional refinement of these portfolios' risks. As a matter of fact, significant maximum drawdowns hurt an investor's liquidity and, ultimately, lead to the selling of one's positions. For an investor, knowing the drawdown metric of a portfolio also helps him to keep major risks in mind. Hence, if one knows he can (cannot) bear the losses, he will proceed (skip) the investment (Thomann, 2021). Following plots will compare subsequent drawdowns of the implemented investment strategies.

Equally-weighted portfolio

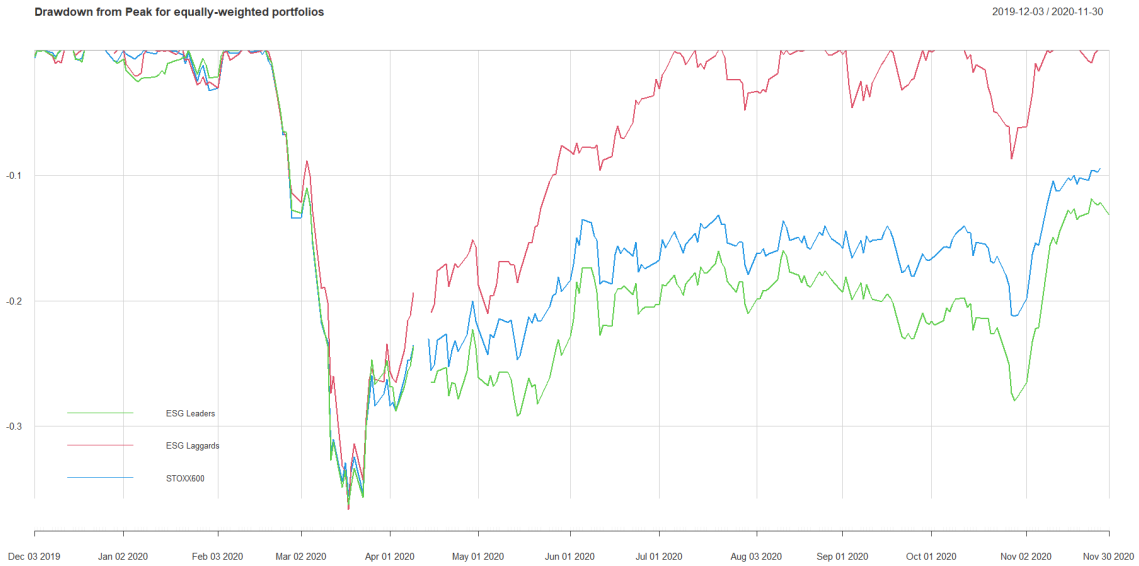


Figure 4.11: Time series chart exhibiting drawdowns from peak equity attained through time - calculated from periodic returns on equally-weighted portfolio.

The above plot displays frequency, size and time windows length of drawdowns and logically it is ideal to have fewer, smaller drawdowns as well as shorter time windows. From the equally-weighted perspective, it appears that the three portfolios experienced similar maximum drawdowns. They all bottomed around mid-March 2020 (- the same time as when European countries announced major lockdown measures) at a value of almost 40% which is worrisome and only reached during high crises such as the global financial crisis of 2008. They also recovered at different pace. The *ESG laggards* recovered faster than any other portfolios as it came back to its original position after roughly four months, while the two other portfolios have never been able to catch up. Interestingly, this measure matches some previous risk measures' conclusions such as VaR and ES estimations at low confidence levels and standard deviations' appraisals. As a matter of fact, the shorter time windows of drawdowns could have been the consequences of lower standard deviation, (slightly) lower kurtosis and lower VaR and ES at low confidence levels involving less frequent losses - at higher levels, these latter measures were larger, so they could also explain why all portfolios bottomed so low. Nonetheless, some measures, such as the Δ VaR which depicted *leaders* as more resilient during the pandemic compared to quieter market periods, or the less negative skewness of *leaders* portfolio which implied shorter negative tail length, would have given rationale for a longer drawdown periods for the *laggards* group. Overall, it highlights the importance of using several measures to get

the most robust and relevant assessments. From this point of view, the *laggards* portfolio appears to be a less risky investment and leads to smaller liquidity issues for investors. In the end, drawdowns are also inherent to investments and it is important for investors to create a plan accordingly. This strategy must be able to handle drawdowns as they occur - for instance, by liquidating assets once a chosen threshold has been topped or by hedging some portfolio's assets with other non-correlated securities.

Capitalization-weighted portfolio

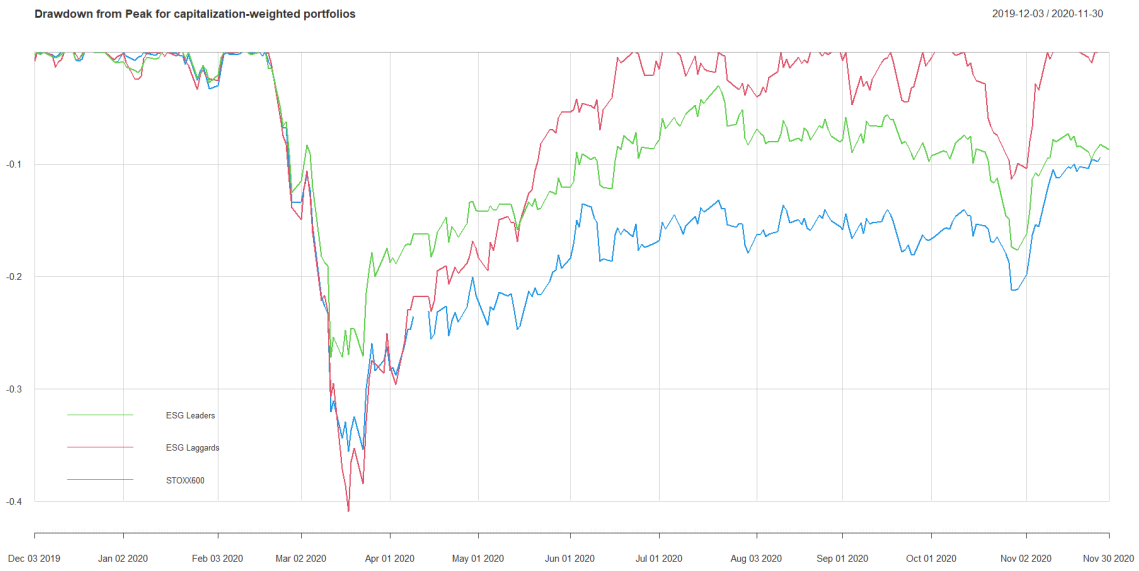


Figure 4.12: Time series chart exhibiting drawdowns from peak equity attained through time - calculated from periodic returns on capitalization-weighted portfolio.

In the capitalization-weighted setting, the *leaders* group occurred to experience a lower maximum drawdown than the two other portfolios. In other words, investing in the *ESG leaders* portfolio enabled to circumvent the large drawdown of more than 40% which can be seen for the *ESG laggards* and *STOXX600* strategy around the first COVID-19 lockdown announcement. Hence, *leaders*' investors would only have to recover around 25% of their investment to overcome this peak loss, while others would have had to recover about 40% loss. Therefore, going long on the *leaders* group is, by nature, a defensive strategy given the fact that it avoids one investor to experience larger losses - i.e. drawdowns (Thomann, 2021). Furthermore, this drawdown plot coincides with findings from earlier analyses. Indeed, it has been shown that the *ESG leaders* portfolio displayed lower standard deviation and especially, lower VaR

and ES at almost all significant levels. Furthermore, the Δ historical VaR measurements always demonstrated that this portfolio was more resilient amidst times of crisis. The latter corroborates findings from drawdown analysis and insights from descriptive statistics and risk assessments. In conclusion, one investor would likely prefer to gear his investment towards the *leaders* or *laggards* portfolio depending on its risk aversion and liquidity constraints. As such, if one has high constraints on liquidity, he would probably pick the *leaders* investment.

4.1.5 Wealth produced by portfolios

This subsection lays out the wealth that one investor could have made by investing fully (i.e., 100% of his disposable money without falling back on leverage) in one of the built best-in-class portfolios. In fact, it is also relevant to have another understanding of what each of the portfolios can bring to one investor and some of the real-world repercussions of these portfolio's characteristics. That is, it brings an additional perspective on these portfolios, which also enables to have a broader view of previously analysed measurements all at once.

Equally-weighted portfolio

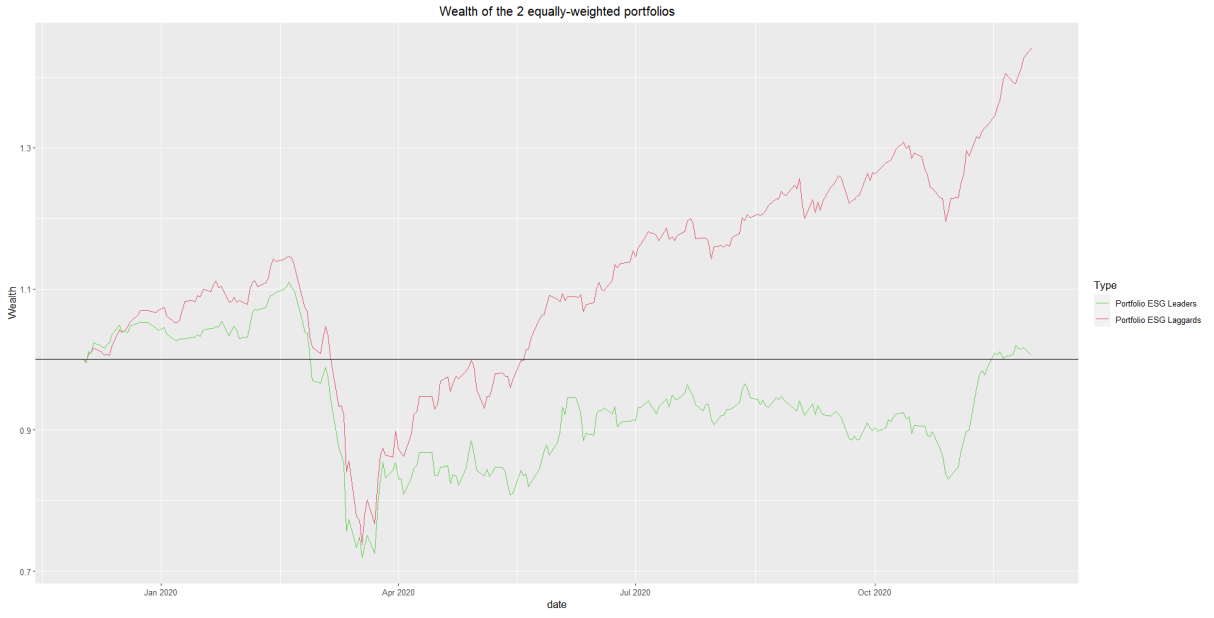


Figure 4.13: Portfolios wealth assuming an initial wealth value of $W_0 = 1$ - own computations for the 2 types of equally-weighted portfolios.

Investors who went long on the *ESG leaders* portfolio would have ultimately ended up with no additional money compared to their initial investment - as it can be seen compared to the horizontal black line. Before, COVID-19 (i.e. until March 2020) the difference between both portfolios appeared narrow. Then, the pandemic hit and both portfolios suffered from significant losses, although the *laggards* portfolio bottomed slightly less low. The latter was expected from the earlier drawdown analysis. After that, the most significant difference between portfolios lies in their recovery after the first COVID-19 wave. As a matter of fact, *ESG laggards* recovered significantly faster and better. This can be due to numerous reasons, among which a higher total mean return, meaning that the most likely outcome is to make money out of this investment (Giordani, 2021). On this plot, the impact of the second measures of lockdowns imposed in Europe around mid and end of October 2020 also greatly undermined investors' wealth - but to a lesser extent than the first lockdown announcements.

Capitalization-weighted portfolio

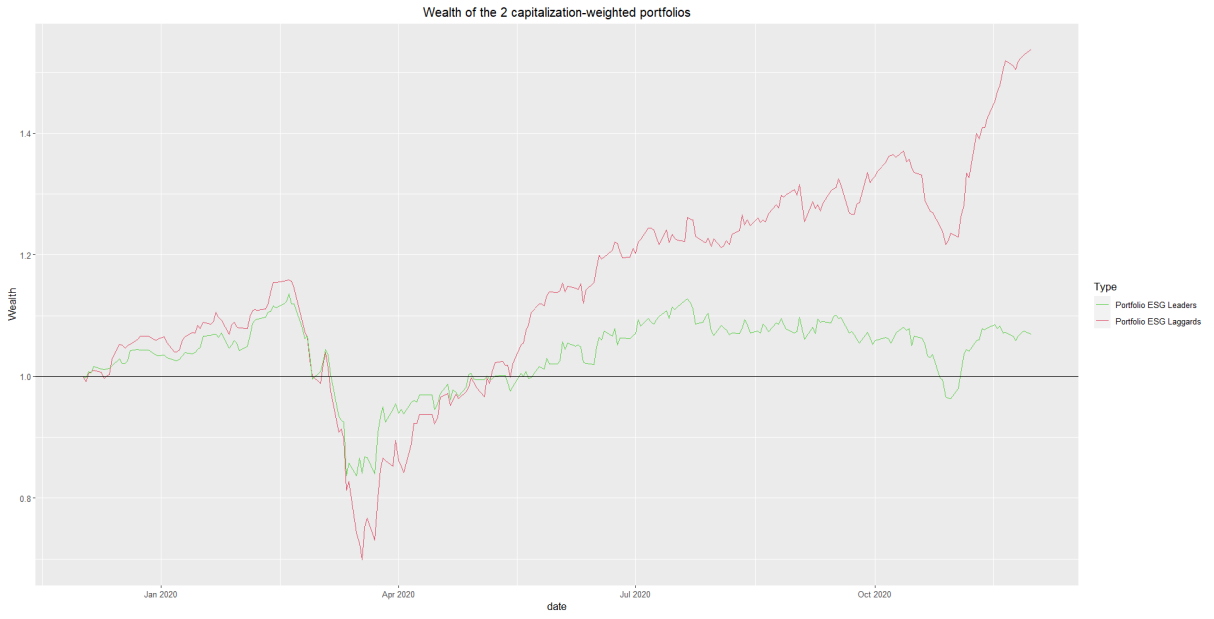


Figure 4.14: Portfolios wealth assuming an initial wealth value of $W_0 = 1$ - own computations for the 2 types of equally-weighted portfolios.

The *ESG laggards* portfolio would have brought more additional wealth for investors owning long positions on it during the analysed time period. However, both portfolios noticeably performed even more similarly before the first wave of the pandemic than in the equally-weighted context. Then, once the pandemic arrived, the *ESG leaders* portfolio appeared to

better withstand the market turmoil, thus, bringing the issue of liquidity for investors of its non-ESG counterpart. As a result, it also turned out that, even two months after COVID-19 hit, the *leaders* group's investors suffered less from the crisis. Overall, the *ESG laggards* portfolio ended up with the highest wealth. This can be the consequence of various assumptions, among which the previously retrieved (see 4.1.1) significant difference in standard deviations between both portfolios. In fact, the *laggards* portfolio statistically displayed higher volatility. As a result, this portfolio's wealth is expected to be more right-skewed (i.e. longer tail of positive returns) and to produce large wealth more rapidly (Giordani, 2021) - even though the risk of ruin is higher. This effect can be seen in the above plot.

In a nutshell, it can be noted that *ESG laggards*' investors would have ended up with the highest wealth - if they had decided to invest all their money in November 2019 and keep it in a long position until November 2020. For illustrative purposes, in the equally-weighted setting, someone having taken a long position on the *ESG leaders* portfolio would have even ended up with almost no additional money from its original investment - on the plot, the green line (for the *leaders* position) ends right above the black line of no additional wealth. Corroborating on previous sections (i.e. descriptives, risk assessments, and drawdowns), one relevant finding is that some retrieved characteristics have direct consequences on the wealth's evolution. Hence, lower maximum drawdowns enabled the *leaders* capitalization-weighted portfolio to suffer from less severe losses in wealth and from less issues about liquidity. To the same extent, the *laggards* capitalization-weighted portfolio has been more volatile (i.e. higher standard deviation). Thus, it has been able to produce large wealth gains more rapidly during the recovery period. The latter has also produced more severe financial losses - which often have ultimately end up in wealth losses (Giordani, 2021).

4.2 Results of event studies

This section outlines implemented event study regressions to investigate previously raised assumptions. That is, the efficient market hypothesis per country to verify if the stock market reacted more promptly and accurately to new information for *leaders* or *laggards* firms, the role of ESG performance during the pandemic, and the role of firms' characteristics amidst times of crisis. To convey the answers to these tested hypotheses, this section is divided in two main parts. First, results of the underlying regressions[13] are displayed with their specifi-

[13] The two regressions outputs written down are estimations for the event time window [-5;5] - though, estimates and the significance of models is exactly the same with other estimated windows as the

cations, goodness-of-fit, and explanatory variables' significance. Second, discussion about the results of the previous part is set, involving the empirical analysis of aforementioned hypotheses.

4.2.1 Results of the underlying regressions

Table 4.19: Market regression output

	France (1)	Germany (2)	Spain (3)	Switzerland (4)	United Kingdom (5)
Market return per country	0.777***	0.918***	0.714***	0.860***	0.783***
	(0.100)	(0.086)	(0.087)	(0.163)	(0.146)
Constant	0.012	0.068	0.128	0.059	0.096**
	(0.068)	(0.059)	(0.102)	(0.041)	(0.034)
Observations	1167	1716	1167	1645	1727
R-squared	0.352	0.337	0.338	0.287	0.278

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As a first step to present the results, the above Table 4.19[14] presents the Market Model (MM) which was used to investigate the general relationship between stocks' returns and market returns per country (Armitage, 1995). This model is clearly built upon statistical rationale - and not true theoretical framework as the Capital Asset Pricing Model (CAPM)[15]. As it can be seen, the chosen type of regression is the pooled OLS specification. This choice relies on an extensive series of test explained in 3.2.1. Noticeably, pooled OLS regressions have been performed with standard-errors clustered at the firm level. That is, it accounts for the correlated errors within clusters, meaning the precision of the estimates and the reliability of the inferences from the model are improved.

These five regressions, one for each European country under analysis, show in general a good fit with the data - all R-squared values lie between 0.278 and 0.352, ensuring results in line with the literature (Heyden & Heyden, 2021; Li et al., 2022; among others). Moreover, all regres-

estimation window stays the same.

[14] Results for Italy and Sweden have been discarded in event study-based regressions as there were only two firms representing these countries in the sample under analysis - one firm in each of the *leaders* and *laggards* groups.

[15] The MM and the CAPM are the most commonly used models for event studies. The MM provides robust and better results than other statistical models (Armitage, 1995). The reasons why the MM was preferred over the CAPM are the easiness of implementation, the similarity in their final estimations, and the sensitivity of the CAPM to its specific restrictions (MacKinlay, 1997).

sions displayed a F-stat (p-value) higher (lower) than the critical value at the 99% confidence level, meaning the null hypothesis that the model had no explanatory power can be rejected. Overall, the main purpose of this model will be to assess whether *leaders* or *laggards* stocks have reacted faster to lockdown announcements and investigate their ability to incorporate new information on the market.

Table 4.20: Firms' features regression output

	France (1)	Germany (2)	Spain (3)	Switzerland (4)	United Kingdom (5)
ESG Combined score	-0.004***	-0.004**	0.000	-0.003	-0.001
	(0.002)	(0.002)	(0.051)	(0.005)	(0.002)
ESG Combined score*Post lockdown	0.016***	0.011	0.002	-0.005	0.018**
	(0.008)	(0.008)	(0.007)	(0.006)	(0.007)
Debt-to-Equity ratio (2019)	0.007	0.004	0.002	-0.002	0.000
	(0.009)	(0.007)	(0.025)	(0.004)	(0.002)
Past returns (2019)	0.006	0.004	0.005	0.004	0.001
	(0.010)	(0.006)	(0.029)	(0.012)	(0.001
Market return per country	0.788***	0.902***	0.716***	0.862***	0.770***
	(0.031)	(0.032)	(0.029)	(0.034)	(0.031)
High-Minus-Low (HML) factor	-0.002***	0.001	-0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
Small-Minus-Big (SMB) factor	-0.001	0.003***	0.001	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.579	-0.049	-0.261	0.201	0.134
	(0.353)	(0.268)	(7.578)	(0.180)	(0.237)
Observations	1167	1716	1167	1645	1727
R-squared	0.363	0.342	0.345	0.289	0.283

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

'Post lockdown' equals to one after a lockdown is announced in a country, and 0 in previous days.

The above Table 4.20 investigates firms stock prices during the COVID-19 pandemic by regressing them with specific firms characteristics, among which the firms' ESG performance, as proxied by their ESG combined scores. All regressions portray R-squared values. These are figures roughly in line with the literature - besides, it is slightly higher than the above MM model. All specified regressions per country also reject the null hypothesis that each model has no explanatory power - by means of F-test of overall significance. As a whole, the aim of this model is to test and understand the role of ESGC scores, firms inherent features and the relative larger importance of one or the other on firms' stock returns. At first sight, the *"Market return per country"* variable is always significant (at the 99% level) through all regressions - this will be discussed in 4.2.2. Furthermore, the *"ESG Combined score"* and *"ESG*

*Combined score*Post lockdown"* variables also convey some explanatory power which will be evaluated in 4.2.2.

Both models have been tested against their main assumptions to ensure robust statistical results. It means that they have passed exogeneity, homoskedasticity, and non-autocorrelation of residuals tests - see 3 for further details on the chosen reasoning to select models' specifications.

Table 4.21: Market regression - Event study measures over different window periods

Market	Window	Actual	Fitted	Mean abnormal	Differences in means (t-test)
Pre-event					
France	[-5,0]	-5.91***	-3.33***	-2.58**	0.977
		-3.87**	-2.87***	-0.96*	
Germany	[-5,0]	-4.15**	-3.37**	-0.78	-0.361
		-4.39***	-2.97***	-1.41	
Spain	[-5,0]	-3.98**	-3.21**	-0.77	-1.948**
		-6.51	-0.21	-6.30*	
Switzerland	[-5,0]	-3.41***	-2.38***	-1.03**	0.249
		-2.57***	-1.81	-0.77	
United Kingdom	[-5,0]	-1.42	-1.29	-0.13	-1.677**
		-4.01**	-0.43	-3.58**	
On-event					
France	[0,0]	-16.06***	-8.61	-7.46	0.554
		-9.84	-7.02***	-2.82	
Germany	[0,0]	-6.20*	-5.56***	-0.64	-1.211
		-11.04**	-4.81**	-6.23*	
Spain	[0,0]	4.73**	3.11	1.63	0.000
		5.68	1.94	3.74	
Switzerland	[0,0]	1.71*	1.34***	0.37	-0.635
		0.56	1.18	-0.62	
United Kingdom	[0,0]	-4.08	-3.99*	-0.09	-1.268
		-9.85**	-1.90	-7.94*	

Post-event					
France	[0,5]	-1.94	-1.90	-0.06	-0.062
		-1.94	-1.75*	-0.19	
Germany	[0,5]	2.15	1.90	0.25	-0.682
		0.49	1.47	-0.99	
Spain	[0,5]	0.74	0.34	0.40	-0.166
		1.11	1.00*	0.11	
Switzerland	[0,5]	0.47	0.89	-0.43	-0.615
		-0.75	0.82	-1.57	
United Kingdom	[0,5]	2.77*	1.50	1.27	-1.215
		0.23	1.09	-0.87	

- Significance of t-tests is represented by *,**, and *** respectively for 10%, 5% and 1% significance level.
- The numbers shown in the parentheses are the number of firms belonging to one group or the other.
- The green highlighted lines represent *ESG leaders* while no highlight embodies *ESG laggards*.

Table 4.22: Firms' features regression - Event study measures over different window periods

Market	**Window**	**Actual**	**Fitted**	**Mean abnormal**	**Differences in means (t-test)**
Pre-event					
France	[-5,0]	-2.83**	-1.87**	-0.97*	0.74
		(-2.27)**	-2.35***	0.07	
Germany	[-5,0]	-4.15**	-3.39**	-0.76	-0.87
		-4.39***	-0.98	-3.41	
Spain	[-5,0]	-3.98**	-2.72*	-1.25	-1.55**
		-6.51	-0.73	-5.78	
Switzerland	[-5,0]	-3.41***	-2.18**	-1.23**	-0.05
		-2.57***	-1.28	-1.29	
United Kingdom	[-5,0]	-1.41	-1.50*	0.08	-1.37*
		-4.01**	-1.09**	-2.92*	
On-event					

France	[0,0]	-16.06***	-9.01*	-7.05	0.31
		-9.84	-5.50***	-4.34	
Germany	[0,0]	-6.20*	-5.50**	-0.71	-1.02
		-11.04**	1.08	-12.12	
Spain	[0,0]	4.73**	5.00***	-0.27	0.21
		5.68	0.24	5.44	
Switzerland	[0,0]	1.71*	2.13	-0.41	-0.91
		0.56	3.15*	-2.59	
United Kingdom	[0,0]	-4.08	-3.21	-0.87	-1.27
		-9.85**	-1.00	-8.64*	
Post-event					
France	[0,5]	-1.96	-1.61	-0.35	0.31
		-1.94	-2.27*	0.33	
Germany	[0,5]	2.15	1.93	0.22	-0.90
		0.49	2.96*	-2.47	
Spain	[0,5]	0.74	0.80	-0.06	0.88
		1.11	-0.48	1.59	
Switzerland	[0,5]	0.47	1.02	-0.56	-0.52
		-0.75	0.79	-1.54	
United Kingdom	[0,5]	2.77*	2.01	0.76	-1.18
		0.23	1.56*	-1.33	

- Significance of t-tests is represented by *,**, and *** respectively for 10%, 5% and 1% significance level.
- The numbers shown in the parentheses are the number of firms belonging to one group or the other.
- The green highlighted lines represent *ESG leaders* while no highlight embodies *ESG laggards*.

Results of the two above tables come from the two implemented event study regressions. They present actual, fitted, and abnormal values per country to compare the impact of COVID-19 on the two groups of firms, namely the *ESG leaders* and the *ESG laggards* groups. In these two table, it has also been decided to take means of values per country during the event window and not to look directly at individual values for each day. This is in line with the paper of Maneenop & Kotcharin (2020) where the authors made their empirical anaylsis in a consistent way to avoid unnecessary noises around specific days. Besides, these daily means have been plotted in 7.8 and 7.8 to analyze and compare general trends around and during the event windows between highly and lowly rated ESG firms. Findings will be discussed and

interpreted in the following section (see 4.2.2).

4.2.2 Discussion of insights from event studies

THE HYPOTHESIS OF THE EMH IN RELATED COUNTRIES

This subsection intends to discuss the results of specified regressions while looking at implications COVID-19 can have on the EMH, hence firms' returns. First, estimates of regression models will be investigated by focusing on the *"Constant"* and the *"Market return per country"* variables. Then, insights from tables gathering the event study measures will be analyzed to understand the impact of the crisis. Alongside the latter, the general pattern of the event study measures will be graphically displayed.

In the estimates of regression models (see Tables 4.19 and 4.20), the constant can be assumed to represent the average reaction of the market to the announcement of lockdowns in respective countries (Heyden & Heyden, 2021). Interestingly, in MM regressions, all *"Constant"* estimates are positive, which would imply that stock markets have calmed down following lockdown announcements. On the other side, in firms' features regressions, *"Constant"* estimates are either positive or negative depending on the country. For instance, France, Germany, and Spain exhibited negative values for their *"Constant"*, which would imply that lockdown measures had no impact to calm these stock markets (Heyden & Heyden, 2021) - this corroborates the hypothesis whereby governments' poor communication prevents the positive intended effects of these policy measures (Müller, 2020). However, it is worth noting that (almost) all ***"Constant"* estimates are not significant**, meaning that if these values are equal to 0 (i.e. the H_0 that cannot be rejected), **stock markets either misjudged the gravity of the situation or had already incorporated the impact of COVID-19 in their stock prices before lockdown announcements**. In the two regression models, the estimates of ***"Market return per country"* are statistically significant and indicate a positive relationship** (i.e. estimates of its coefficients are positive) **with firms' stock returns**. Theoretically, as all of the estimates are below one, it indicates that sampled firms do not move to the exact same extent as the market (- this hypothesis has already been raised in previous section 4.1.1) but they are still sensitive to it.

Event study measures of the MM model (see 4.21) and the firms' features model (see 4.22) indicate that abnormal returns were in most cases negative during the *pre-event* and *on-event* periods. As suggested by Maneenop & Kotcharin (2020), negative average abnormal returns illustrate that stock prices significantly deviated from their intrinsic values and the market experienced an **overreaction phenomenon** of the real effects of the pandemic - which is

not in line with the previous insight from the insignificance of the *"Constant"* term, although previous insight arises from a global look at the three periods altogether. It is also worth noticing that there are significant differences in abnormal means between *ESG leaders* and *ESG laggards*, though only during the *pre-event* period, for Spain and the UK. It entails that the *ESG leaders*' stocks significantly exhibited lower abnormal returns than their non-ESG counterparts - thus, they overreacted less. It means that ***ESG leaders*' stocks can record higher average cumulative abnormal returns, which further supports the fact that ESG performance can act as a risk management tool**. The daily trend of average abnormal returns (see 7.8) also strengthens this statement as *ESG leaders* firms almost consistently show steadier resilience and higher abnormal values. Besides, the daily trend of average actual returns (see 7.8) shows that the two types of portfolios have followed similar patterns - with *ESG leaders* having experienced fewer negative returns. On the other side, measures of the firms' features model (see 4.22) demonstrate consistent findings with the MM model. In the third even window (i.e. the *post-event* period), average actual and abnormal returns are less negative and sometimes even positive. It implies that fitted returns were mostly more pessimistic than what stock markets have experienced. One of the reasons could be, among others, that the event under analysis (i.e. the lockdown announcement) has partly alleviated the market turmoil - although estimates are not significant, meaning results need to be taken cautiously and that **the event has no significant effect on firms' returns**. In other words, abnormal returns for this period are predominantly positive and not statistically significant because **investors have already grasped the information linked to the event during the *pre-event* and *on-event* periods** (Maneenop & Kotcharin, 2020).

THE HYPOTHESIS OF ESGC SCORES' INFLUENCE DURING THE PANDEMIC CRISIS

One of the assumptions supposed to be tested thanks to the event study methodology is whether or not ESGC scores may be used as a valuable signal for consistently avoiding negative returns during the crisis (Li et al., 2022). Empirical evidence has been found on the difference in the performance of highly and lowly-rated ESG stocks during the first wave of the pandemic. First, in the MM and firms' features regressions measures (see Table 4.21 and 4.22), *ESG leaders* usually display higher actual (ex-post) returns than *ESG laggards* firms - except for the case of France. It leads to the belief that ***ESG leaders*' stocks better fared during the pandemic**. Afterwards, if one looks at the estimations of regression coefficients in Table 4.20, it can interestingly be seen that the *ESG Combined score*'s coefficients are always negative, while *ESG Combined score*Post lockdown*'s coefficients are positive. This is

in line with the **hypothesis of the insurance role that high ESG stocks play**, meaning that investors pay an insurance premium in quiet market times but get stronger resilience in market turmoil (Engle et al., 2020, as cited by Broadstock et al., 2021). Though these coefficients are not always significantly different from zero, hence, this insight must be taken with caution.

A refinement of the first hypothesis is related to the hypothetical incremental importance of the ESG score and performance during the crisis (Broadstock et al., 2021). This incremental hypothesis is enabled to be tested thanks to the incorporation of the interaction term *ESG Combined score*Post lockdown*. In fact, its coefficient captures the importance of the ESG score after the lockdown announcement. In Table 4.20, this variable is consistently positive (- except for the case of Switzerland) and significant for France and the UK. It indicates that ESG combined scores are significant to bring positive firms returns in these countries. As such, it rejects the H_0 that returns do not depend on ESG scores after the pandemic (i.e. the coefficient is zero) and, instead, it offers an alternative explanation which is the **additional impact of ESG performance on returns** - it is also talked about additional or **incremental effect** as, before the lockdown announcement (- synonym of crisis in this context), the coefficient of *ESG Combined score* was consistently negative. Overall, this result is in line with the hypothesis that **investors may see ESG performance as an indication of risk mitigation during times of crisis** (Broadstock et al., 2021).

THE HYPOTHESIS OF SPECIFIC FIRMS' FEATURES

In this subpart, results of the refined regression (see Table 4.20) including, among others, ESG considerations and firms' inherent attributes are addressed. It enables to investigate whether some firms' characteristics bring more resilience during times of crisis and importantly it gives insight into the importance of ESG related variables with firms' ratings and the affiliation to one of the pre-specified groups. The latter has been discussed in the above subsection. Besides the already mentioned *"ESGC score"*, *"ESGC score*Post lockdown"*, and *"Market return per country"* variables, no other attribute appears to be significant in the analysed sample. Only the *SMB factor* and the *HML factor* are significant, but they are solely in one country respectively - this lays the ground for further work by, for instance, implementing new models more economically oriented such as the Fama-French Three-Factor model which investigates more deeply this factors.

The **poor (regression) explanatory power of firms' inherent features** leads to the following section 4.3 which will dig deeper in by skimming over firms' financial and sustainability

reports.

4.3 Results of in-depth financial performance analyses

In this section, a financial performance analysis for selected firms is laid out. On top of investigating the impact of ESG scores, one of the main assumptions to be tested in this thesis is whether the ESG strength (i.e. a higher relative score) of a firm within its industry brings performance and whether this outperformance is industry-specific or systemic (i.e. in a market trend perspective). In fact, the literature suggests that industries can play a major role regarding causes of movements in common share prices. Scholars call it the *essential-firm argument* and it states that firms belonging to sectors such as health care or energy were deeply needed and even vital to the stability and of our world (Albuquerque et al., 2020) - in the same vein, some banks were rescued during financial crises as they were too big to fail. As such, the structure of this part covers companies per industry. To convey the insights of this in-depth financial analysis, one table and one plot are displayed per industry. The table gathers ESG scores of a peer group along with five accounting-based figures and ratios from corporate financial statements to get a comprehensive picture of a company's financial health. Then, the plot exhibits time series of returns to give a glimpse of the resilience and returns volatility of a portfolio[16]. All the data has been retrieved for the year 2020. As a matter of fact, it is the year of the pandemic and it matches the time when ESG combined scores were fetched.

4.3.1 Benchmarking analysis - peer review

- **Technology**

  The company belonging to the *ESG Leaders* group in this industry is SAP SE. It is a Germany-based company offering enterprise application softwares. It all comes down to 3 business units which are the applications, technology and services segments. Thus, SAP SE sells its service and helps customers to run the software through its cloud-based collaborative business networks.

[16] These returns time series only rely on stock prices changes and not on dividend of any kind. Therefore, graphical results and total returns' measures, as displayed in the analysis' table, can differ in some instances.

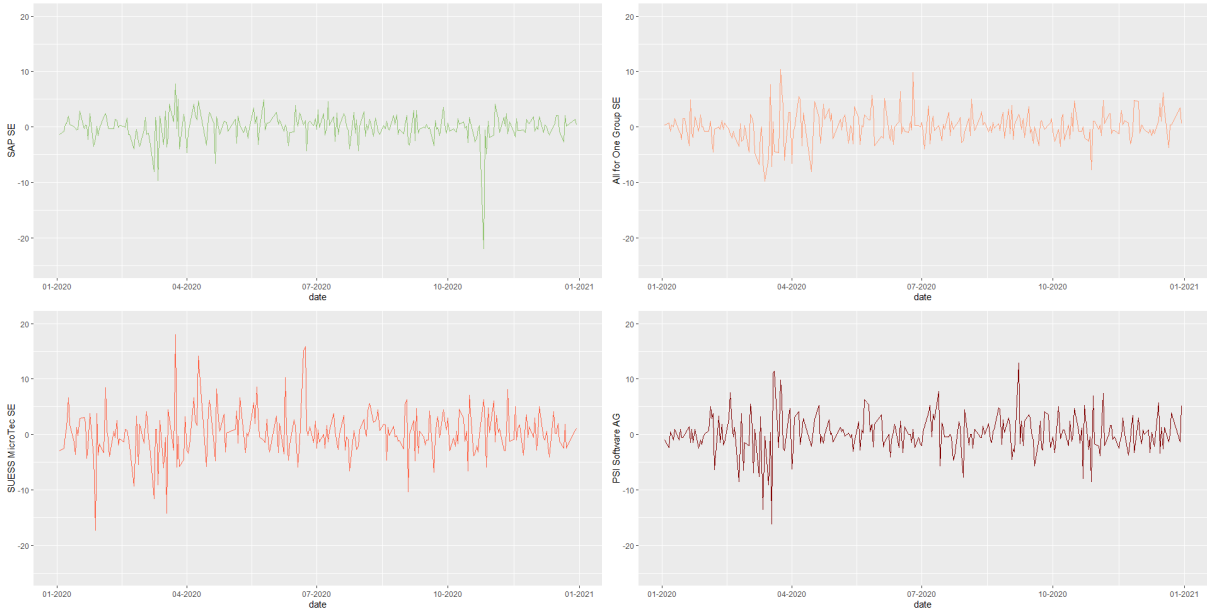


Figure 4.15: Returns time series - own computations for the technology peer group.

From a sustainability aspect, SAP is rated 91.36 on Refinitiv's scale - among the top scorers of the whole chosen sample. SAP strives to promote economic, environmental and social performances and even links it directly to its financial performance by means of regressions analyses. Therefore, SAP can measure these achievements and track them directly from their own data management systems (SAP SE Annual integrated report, 2020). It is also relevant to look at some other characteristics. What is striking, if we look at both plot and table, is that total return on the 2020 period for SAP SE is the only one negative in this sampled industry. It is something that could have been expected as, overall, *ESG leaders* companies performed under their *laggards* counterparts. Even though from a graphical point of view, SAP seemed to have experienced less volatile returns, these did not rocket as much as others after times of instability. SAP's annual report mentions significant decreases of its revenues from software license which is not globally offset. Given the fact that total return is based on price changes and dividend paid, it is relevant to examine both. For the first item, SAP (2020) reports dividend per share has slightly increased compared to previous years. However, this mild increase does not compensate for price changes. Like most companies, SAP experienced strong decline because of the pandemic but it bounced back quickly thanks to comprehensive economic aid packages and benefits from pandemic-driven digitisation trends. In fact, the main reason of decline in prices comes after when, end of the year, it announced an accelerated cloud transition (- whereas companies still tend to prefer on-premises data

centers) and the market reacted badly, leading to a 22% plunge on one day (SAP SE Annual integrated report, 2020). On the other hand, SUESS MicroTec, a firm from the *laggards* portfolio, exhibited outstanding returns. SUESS MicroTec supplies process equipment for micro-structuring in the semiconductor industry. To better understand the reason behind this large return performance, annual reports were skimmed over. One ground for this outperformance was the combination of higher sales and bigger margins. That is, it led to greater earnings per share and the stock price rose in comparison to its market benchmark (SUESS MicroTec Annual report, 2020). The latter was partially the consequence of a fruitful semiconductor market despite COVID-19 - overall sales increased by comprehensive IT investments in the infrastructure for working remotely and by the emergence of new 5G mobile communications standard as well as investments in artificial intelligence and the subsequent demand for servers, processors, and memory elements.

The PE ratio does not seem to bring significant differences among the peer group but SAP scored substantially higher on the ROA and ROE ratios. Regarding the ROE ratio, the higher score of SAP depicts that investors can assume dividends will keep growing similarly to what they have experienced in the last few years. As the ROE ratio also takes into account leverage in its computation, it means that it indicates the return from assets and debt. Being an intermediate (i.e. compared to other similar companies on Refinitiv) leveraged company, SAP has a higher ROE than its ROA - while the difference between both ratios is logically even more striking for All for One Group SE which is highly leveraged.

In conclusion, this analysis shows that, on average, this industry of technology performed quite well amidst times of COVID-19 and SAP's lower return is due to a specific decision (i.e. accelerating cloud transition) which is not linked directly to ESG efforts - even though SAP ambitions to align its cloud service with its defined *Green Cloud*, the main rationale behind this faster transition is top pick up its level of growth. Thus, these figures are more linked to industry trends, but somewhat company idiosyncratic features also come into play over and above ESG scores solely.

Company Name	ESG Combined Score	Total Return %	Debt-to-Equity %	ROE %	ROA Total Assets %	PE
SAP SE	91.36	-9.57	51.67	17.02	8.90	17.04
All for One Group SE	20.93	21.52	97.16	14.83	5.24	NA
PSI Software AG	20.64	17.59	24.78	10.55	4.05	27.94
SUESS MicroTec SE	15.57	57.50	15.01	9.44	5.73	19.93
Mean	37.13	21.76	47.16	12.96	5.98	21.64
Median	20.79	19.56	38.23	12.69	5.49	19.93

Table 4.23: Key financial indicators for the technology industry

- **Health Care**

  Roche Holding AG and Lonza Group AG are the two selected companies of the *ESG leaders* group. They are, respectively, a research-based healthcare company organized into two divisions which are pharmaceuticals and diagnostics to develop medicines for various disease areas, including oncology, immunology, infectious diseases; and a holding company and supplier to the pharmaceutical, healthcare and life science industries. Lonza offers custom development and manufacturing and delivery systems of drugs, as well as development of anti-microbial solutions for commercial application.

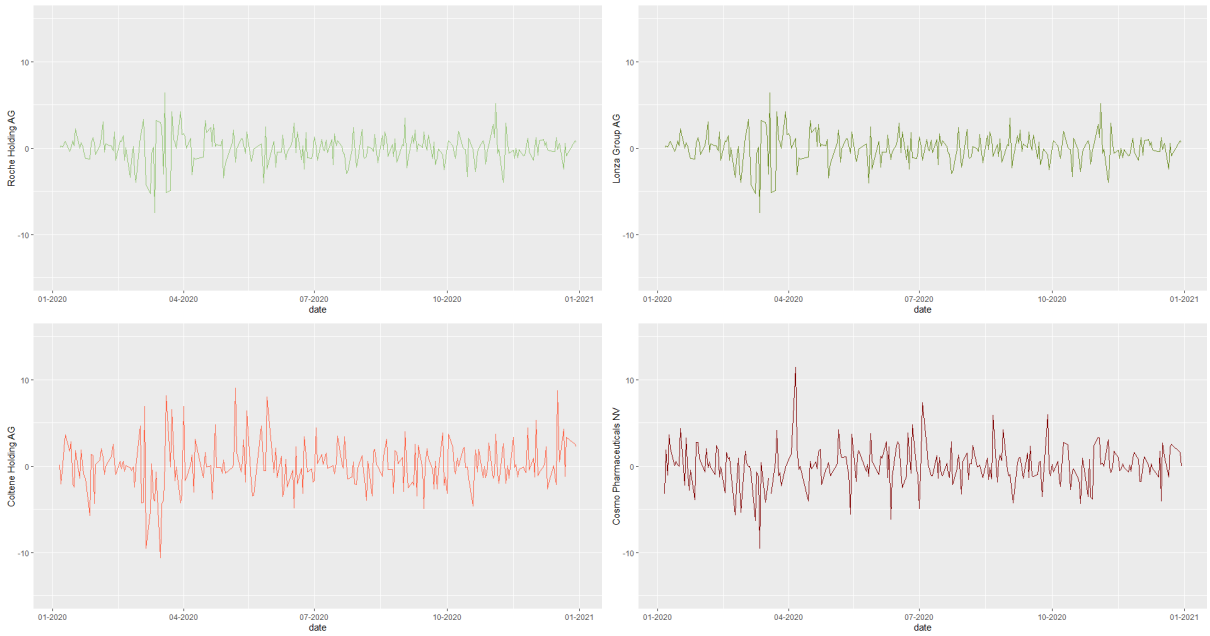


Figure 4.16: Returns time series - own computations for the health care peer group.

Roche and Lonza experienced less volatile returns during 2020 as it can be seen from time series plots. Lonza performed outstandingly well from a total return perspective and Roche also outperformed peers on ROE and ROA ratios with results far above means

and medians. The next few lines will try to understand whether this is due to their high ESG scores showing real efforts or whether it is a company-specific characteristic.

By taking a closer look to Roche's annual report (2020), it seems that expected high competition in biosimilars and the COVID-19 pandemic was not offset enough by its production for SARS-CoV-2 tests, COVID-19-related medicines, and its partnership with Moderna to include a recent antibody test in their ongoing vaccine trials - explaining moderate sales and almost no increase in dividend, thus low returns. Although having experienced a slight decline in total sales, ROE and ROA ratios remained high as net income improved due to lower cost of sales (i.e. lower inventory write-offs, product mix factors, productivity improvements and lower collaboration and profit-sharing expenses) and lower marketing expenses.

Lonza's returns outperformed by far its peers. The main explanation is likely found in its landmark ten-year collaboration agreement with *Moderna Inc.* to manufacture the drug substance for Moderna's COVID-19 vaccine and later in an agreement to manufacture AstraZeneca's COVID-19 long-acting antibody combination from October 2020 on. Lonza collaborated with the vaccine company, Moderna, to enable the manufacturing of 1 billion doses per year. These bold moves enabled Lonza to significantly increase sales. This combined to a lower tax rate and a Swiss Franc appreciation against other currencies brought higher dividends and share prices - resulting in greater returns. Moreover, its long-term environmental target urges it to invest in capital expenditure projects to achieve major improvements in energy efficiency and other areas. The latter led to decrease in environmental and process safety accidents but also in cut in carbon emissions. However, Lonza's ESG strategy does not seem to be the reason why its stock's return was so high - rather the root of its outperformance lies in its collaboration with Moderna and AstraZeneca.

Overall, the health care industry itself did not outperform other sectors but interestingly it displayed high PE ratios. That is, these firms were assessed as high potential companies for growth in their future earnings. This fact is quite straightforward as these firms were spotlighted during the pandemic and developments of vaccines and drugs boomed creating a real momentum for the health care industry.

Company Name	ESG Combined Score	Total Return %	Debt-to-Equity %	ROE %	ROA Total Assets %	PE
Roche Holding AG	92.57	1.28	38.75	41.38	17.81	15.00
Lonza Group AG	87.57	62.01	70.75	11.41	4.66	22.34
Coltene Holding AG	19.81	-0.89	66.87	9.07	4.36	42.46
Cosmo Pharmaceuticals NV	14.80	10.82	42.02	-1.99	-1.34	NA
Mean	53.69	18.31	54.60	14.97	6.37	26.60
Median	53.69	6.05	54.45	10.24	4.51	22.34

Table 4.24: Key financial indicators for the health care industry

- **Industrials**

  The following industry to deal with is the industrial sector. 2 companies from the *leaders* group were selected in this industry, namely Mondi PLC and Alfa Laval AB. Mondi is a UK-based packaging and paper company. This company's business is integrated across the whole value chain from managing forests and producing pulp, paper and films, to developing and manufacturing effective industrial and consumer packaging solutions. Alfa Laval AB is a Sweden-based company engaged in the development, manufacture and marketing of products and solutions for heat transfer, separation and fluid handling. This company's products are used in various industries, including the production of chemicals, paper, metals, sugar and ethanol. For comparison purposes, it is relevant to investigate characteristics from Jetpak Top Holding AB which is a company from the *laggards* portfolio. Jetpak Top Holding is a Sweden-based holding company of the Jetpak Group, a logistics and delivery provider. The company provides time-critical express deliveries mainly in the Nordic region. It specializes in flight-based, door-to-door, long-distance deliveries aimed primarily at the business to business (B2B) sector. This firm takes advantage of its IT platform JENA to find optimal transport routes, combining air and road transport (Refinitiv Datastream, n.d.). Although this firm scored the lowest in terms of ESG combined score among all sampled industries, it has succeeded to get above average ratios for its total return. As such, it is a relevant case to better grasp the hypothetical positive impact of not adopting ESG policies during the COVID-19 period.

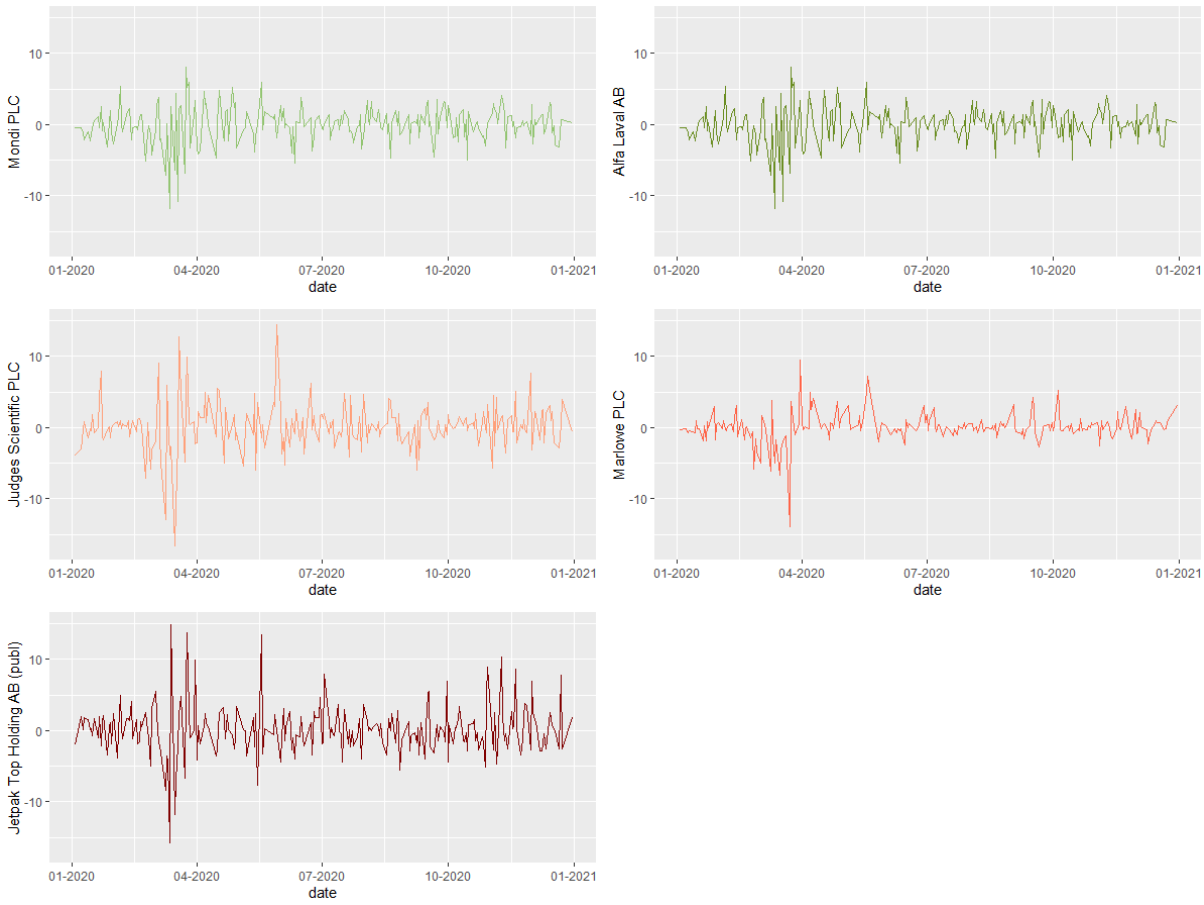


Figure 4.17: Returns time series - own computations for the industrials peer group.

The first thing that springs to attention is both *leaders* companies exhibit (almost) negative returns and far below mean or median values. Thus, it is relevant to skim over their annual reports to understand if their ESG strategies are the reason why they performed so poorly in comparison to their non-ESG counterparts. According to Mondi's report (2020), its sustainability approach is wide and encompasses all ESG aspects - climate change with shift from fossil fuels to more biomass energy, support of local communities, diversity and inclusion, etc. Therefore, its high ESG score is well-founded. Poor total returns can be explained by a lower dividend per share that stems from the fact that Mondi had to withdraw from paying a planned dividend in 2020 due to COVID-19. The latter was also badly perceived and led to share price decline. However, Mondi scored better (i.e. above mean) on ROE and ROA than its non-ESG counterparts. This cannot be demonstrated by a high leverage - thus, a riskier position than other firms as its *debt-to-equity* ratio is average. Actually, Mondi generated a great and robust amount of cash despite the pandemic. To answer this global turmoil, Mondi took

decisive actions to deliver value accretive growth while putting sustainability at core. That is, it implemented continuous improvement initiatives, optimisation of its plant network. Some of these underlying investments enabled Mondi to enhance standards and operational performance by reducing costs and waste (Mondi Group, 2020). Overall, part of the firm's performance can be attributed to the necessity of Mondi's products (- some of their customers deliver essential food, health and hygiene products to society and their businesses needed to be kept running), but putting sustainability at its core business has involved new investments which also benefited its reliability and performance.

Alfa Laval states in its annual report (2020) that poor (negative) total returns come from large decline in share prices and a withdrawal of the previously proposed dividend due to COVID-19 - besides, Alfa Laval was beaten by both Swedish firms of similar industries and its market. Like the previously analysed company, Alfa Laval scored well on ROE ratio. Actually, despite lower volumes (- partially offset by a strong growth in new energy-efficient solutions segment) its profitability remained on a high level thanks to a diversified portfolio and aftersales exposure, but also a cost savings program focusing on short-term savings. Alfa Laval also displayed a strong PE ratio. This meant that investors believed this stock has potential for growth in the future. It can reasonably be expected as Alfa Laval's two flagship products are a division's heat transfer technology and a thermal energy storage solution. These are, respectively, critical in driving energy efficiency and improving energy storage solutions for renewable energy.

First, Jetpak's low ESG combined score is straightforward given their ESG activities are only mentioning a *whistle-blower* program and a future CO2 neutral business model without clear steps to reach it - these policies clearly do not offset the impact of thousands daily flight departures and a comprehensive distribution network of several hundreds delivery vehicles. Then, their steady results are explained by an increase in revenues, an extraordinary capacity surcharge's utilization (- introduced in April for all air based products, in order to compensate for a sharp reduction in air traffic supply) and stringent decreases in expenses following massive lay-offs (Jetpak Top Holding AB (publ.) - Year-End report, 2020). Even though they experienced negative organic growth as a result of the pandemic, their total growth was positive thanks to the acquisition of a Danish company. Overall, Jetpak's performance on selected ratios is quite not explained by its industry's trend, but rather by its strong decisions, a new acquisition, and not taking care of ESG efforts seem not to have influenced results.

In conclusion, it appears that *laggards* companies generated stronger returns during

the pandemic. It is mainly the consequence of inherent bold decisions that involved acquisitions and massive lay-offs, thus, for the latter, a bad governance from an ESG point of view. An interesting point that stemmed from *leaders* companies is they scored high on ROE and ROA ratios meaning they were able to generate cash from their businesses. That was made possible by a greater diversity in companies' portfolios, a real need for their products sold, and significant investments - it can readily be assumed that ESG efforts played a role in the latter.

Company Name	ESG Combined Score	Total Return %	Debt-to-Equity %	ROE %	ROA Total Assets %	PE
Mondi PLC	88.71	0.02	49.70	14.22	14.22	12.96
Alfa Laval AB	88.37	-4.07	40.02	12.56	5.72	23.18
Judges Scientific PLC	13.64	14.06	79.80	27.37	11.33	42.10
Marlowe PLC	7.36	28.67	7.56	-0.94	-0.57	17.13
Jetpak Top Holding AB (publ)	1.95	11.94	40.83	14.42	8.56	19.65
Mean	40.01	10.12	43.58	13.53	7.85	23.00
Median	13.64	11.94	40.83	14.22	8.56	19.65

Table 4.25: Key financial indicators for the industrials industry

- **Financials**

  The financial sector encompasses companies active in savings, loans, security investments and related activities like financial data and information providers. Three companies constitute the *leaders* group. First, Assicurazioni Generali SpA is an Italy-based company engaged in the insurance and financial businesses. It operates around 3 segments which are: saving and protection products; insurance products related to casualty, accident, health, and company plans; and non insurance assets, mostly banking and asset management activities. Then, Allianz SE is a German-based financial service company. This firm is the holding company of the Allianz Group. Allianz is shaped around the following segments, namely property-casualty, life/health, asset management, and corporate and other. The last firm of the *leaders* portfolio is Zurich Insurance Group AG. It is also a holding company and it provides insurance products and related services. Among the four firms belonging to the ESG *laggards* portfolio, two companies are under the spotlight for outstanding performance in terms of total returns and PE ratio. The first one is flatexDEGIRO AG, a German online broker. It operates under the brands flatex and DEGIRO and conducts proprietary securities trading platforms and services for retail customers in 18 European countries. The second one is named Tamburi Investment Partners SpA and it is an Italian company engaged in the financial sector. It provides services of investment banking and advisory in corporate finance transactions. This firm is also active in the investment activity, including acquisitions

of minority equity interests in listed and unlisted companies (Refinitiv Datastream, n.d.).

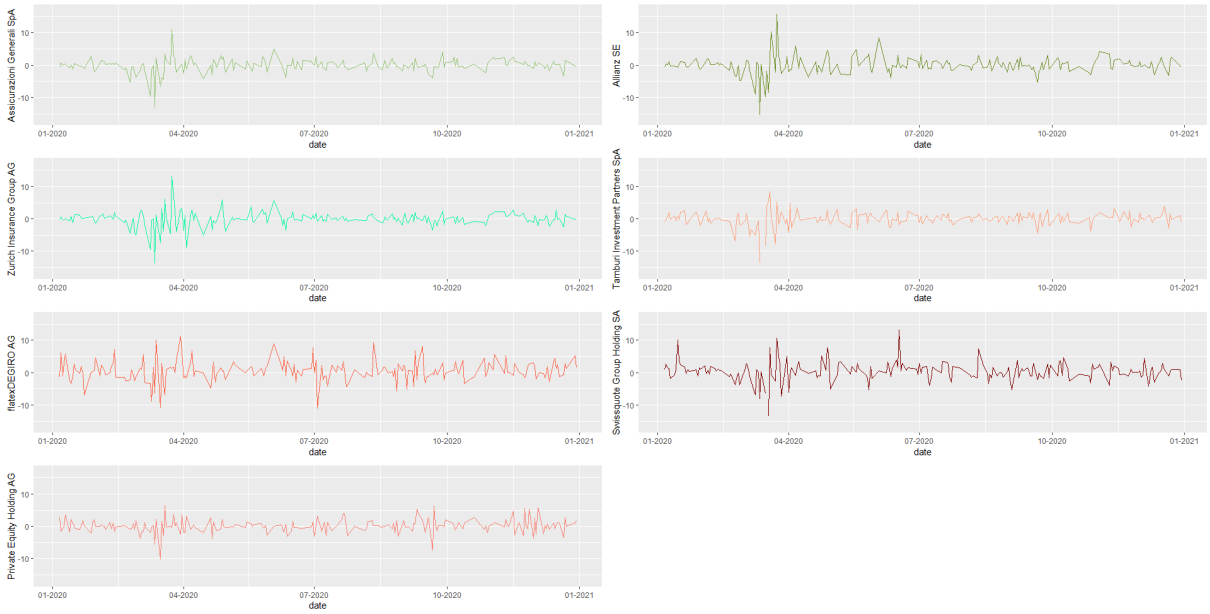


Figure 4.18: Returns time series - own computations for the financials peer group.

Similarly to the industrial sector which was investigated above, ESG *leaders* companies display negative, below mean and median returns. To investigate whether this is, to some extent, related to ESG policies, Assicurazioni Generali's annual report is examined. This report (2020) states that Generali invested more in social and environmental products (- that amounted to almost one quarter of their gross premium on investments) and they aimed to allocate €4.5 billion to new green and sustainable investments, while striving to decarbonise their general account investment portfolio. To explain its low total return, Generali brought to the fore the lower result of the period which decreased the dividend distributed, and led to one of the lowest share price for its stock since 10 years. Overall, ESG initiatives did not bring underperformance as premiums from these types of investments increased and appeared more profitable than these counterparts. However, their ESG strategy has not been sufficient to significantly curb negative impact of COVID-19.

On the other hand, flatexDEGIRO exhibited outstanding total returns for the year 2020. One direct explanation of this outstanding results stemmed from the acquisition of DEGIRO in July 2020 to become the largest retail online brokers in Europe. As such, this acquisition boosted the number of transactions executed - more than double what had been achieved in 2019. While increasing the number of shares by less than 40 %,

flatexDEGIRO generated two times the previous year earnings per share entailing a rise in stock price and, ultimately, greater stock returns. Regarding ESG, flatexDEGIRO did not emphasize any ESG intiatives - they barely mentioned a new add-in function to search for products that conform with ESG for their clients and their objective of reducing energy consumption at all of its sites. Thus, it is hard to define the impact of their low ESG-related actions, but clearly, what made them perform so well was the acquisition of DEGIRO.

Then, Tamburi Investment Partners stands out by its outstanding PE ratio. This far above mean and median PE ratio means that investors see Tamburi's stock as a potential for growth. According to its annual report (2021), Tamburi distributed far less dividend for 2020 than for previous years - which partially explains its low total return. However, its share price increased outstandingly. That is one of the reasons why the PE rocketed. Another rationale might lay in an expectation of high growth rates or an hypothetical overpricing of the company's stock.[17]

To sum up, ESG investments were slightly profitable in the finance industry (e.g. Generali) but it was not enough to be considered as a resilient factor amidst the global pandemic. However, non-organic growth made by acquisition generated strong total returns and Tamburi's outstanding PE appeared to be the results of overpricing of its trading share. Therefore, ESG initiatives do not bring additional value, nor resilience in this industry.

Company Name	ESG Combined Score	Total Return %	Debt-to-Equity %	ROE %	ROA Total Assets %	PE
Assicurazioni Generali SpA	91.36	-19.36	42.22	NA	0.42	11.16
Allianz SE	89.30	-2.49	48.10	NA	0.69	10.86
Zurich Insurance Group AG	87.70	0.26	42.04	NA	0.96	22.82
Tamburi Investment Partners SpA	8.12	2.57	49.05	0.02	0.13	168.84
flatexDEGIRO AG	14.22	159.18	28.21	15.92	2.44	16.74
Swissquote Group Holding SA	20.48	79.79	59.51	22.34	1.31	21.52
Private Equity Holding AG	5.38	3.16	19.64	30.73	25.27	NA
Mean	45.22	37.40	41.25	17.25	4.46	41.99
Median	20.48	3.16	42.22	19.13	0.96	19.13

Table 4.26: Key financial indicators for the financials industry

- **Utilities**

  The industry of utilities encompasses mostly companies that provide electric, gas, and water, but also waste, recycle, and related environmental services. Consequently, these

[17] The latter hypothesis (i.e.overpricing) is confirmed with data from Refinitiv Datastream - expectation of high growth in earnings is refuted according to this same data base.

firms are heavily affected by government regulations. The three selected companies that belong to the *leaders* portfolio are: IBERDROLA SA which is engaged in carrying out electricity and gas activities in Spain and abroad (e.g., in the UK, the US and Brazil) - Iberdrola takes care of energy transmission and distribution, other regulated activity, electricity generation and sales businesses, and activities related to renewable energies; Naturgy Energy Group SA, another Spanish energy company, its activities include renewable businesses, gas supply, marketing and logistics of liquefied natural gas worldwide, but also gas and electricity network businesses in Spain and the Maghreb gas pipelines, in the Latin America South Zone, and in the Latin America North Zone (Mexico and Panama); and Red Electrica Corporacion SA which is a Spanish company also engaged in the energy sector, it focuses on the management of the Spanish high-voltage transmission grid, and is responsible for its development, maintenance and improvement of the network's installations. Besides, it operates through its subsidiaries in a number of other countries, such as Spain, the Netherlands, Peru and France. In the utilities industry, the only company of the *laggards* group is Solaria Energia y Medio Ambiente SA (Solaria), also a Spain-based company, engaged in the renewable energy sector. Its activities comprise the design and installation of solar, thermal, photovoltaic and wind energy plants (Refinitiv Datastram, n.d.).

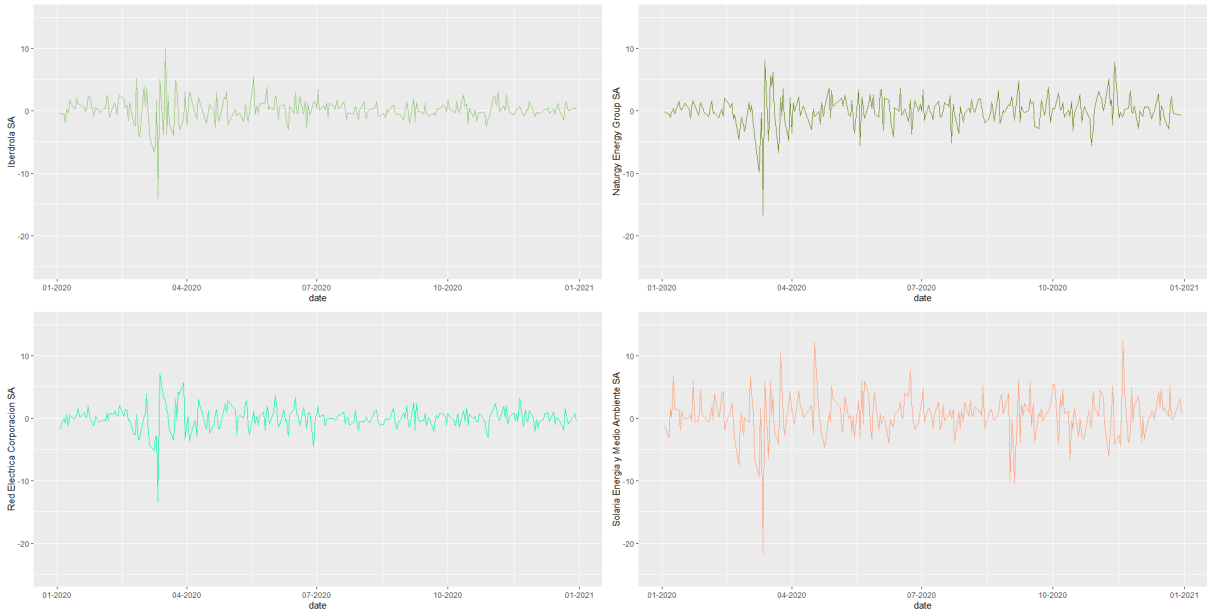


Figure 4.19: Returns time series - own computations for the utilities peer group.

First, Iberdrola has performed far above its counterpart of the *leaders* group in terms of

total return. Besides this figure, the main difference lied in its debt-to-equity ratio which is half the ratio of other firms of this industry. Therefore, it is relevant to assess whether outperformance (in terms of total returns) came from its financial health (i.e. less debt) or from specific ESG initiatives. According to its annual report (2020), Iberdrola follows a sustainable energy model (i.e. its so-called *ESG+F* plan), meaning it only grows through green finance - which involves projects and investments preferably in regulated businesses or renewable assets and a geographical diversification aiming at becoming a leader in the operating countries. Despite the turmoil caused by the global pandemic, Iberdrola succeeded to distribute an increasing dividend and its share price ended at a higher level than in December 2019. It has been made possible thanks to higher net profit resulting from more consumers and a higher total net output (- in GWh). Alongside this, Iberdrola maintained a strong financial position (i.e. steady solvency ratios) to successfully face potential market turbulence and to be set to exploit fresh growth opportunities.

By investigating Solaria Energia's annual report (2020), it appears surprising that the firm is not part of the *leaders* group and that it does not score significantly higher in terms of ESG combined score[18] as this firm is active in the fight against climate change and promotes emission-free energy. A possible explanation surely states in the fact that until end of 2020 they were not completely transparent - their first non financial information report has been published in December 2020. Iberdrola also scored outstandingly great on its total return. As such, despite a high volatility depicted in above plot, Solaria ended the year 2020 with its highest share price of the recent years. Plus, the firm generated an increasing dividend enabled by a great rise in energy production and a focus on minimum IRR (see 7.1) for new projects.

In conclusion, strong total returns of these companies shed the light on the importance of this utilities industry. In the current context of fight against climate change which is one of the most pressing challenges globally, electricity from renewable sources is put at the epicentre of decarbonisation. Belonging to this industry ensures steady results and it is worth noting that it is specific to this sector and not inherent to firms' characteristics. Therefore, this part of the industry has been growing and ESG initiatives have shaped companies' strategies. Moreover, strong financial health, such as the one exhibited by Iberdrola, ensured strong performance and growth opportunities in an industry mostly

[18] After complementary checkup, it appears that Solaria caught up other companies of its industry by scoring 59.54 on ESG combined score, which is significantly higher than its previous score of 17.26 retrieved during the year COVID-19 began.

regulated.

Company Name	ESG Combined Score	Total Return %	Debt-to-Equity %	ROE %	ROA Total Assets %	PE
Iberdrola SA	82.53	37.65	85.05	9.93	3.24	18.19
Naturgy Energy Group SA	79.86	-8.02	154.10	-3.99	-0.14	22.50
Red Electrica Corporacion SA	77.10	-0.49	158.16	17.88	4.79	11.38
Solaria Energia y Medio Ambiente SA	17.26	247.65	188.94	14.63	4.62	65.82
Mean	64.19	69.20	146.56	9.61	3.13	29.47
Median	78.48	18.58	156.13	12.28	3.93	20.35

Table 4.27: Key financial indicators for the utilities industry

- **Consumer discretionary**

  The consumer discretionary sector gathers companies that provide products and services directly to the consumers whose purchasing habits are cyclical in nature (hence, discretionary) - it is clearly differentiated from consumer staples companies which offer essential everyday products, whose sales are typically not impacted by the economic environment, in the ICB classification (Vass, 2019). Therefore, consumer discretionary stocks tend to be more volatile. In the *leaders* group, there are four companies which were selected. First, Pearson PLC is a provider of educational materials and learning technologies. It provides test development, processing and scoring services to governments, educational institutions, professional bodies. Its activities are global as it operates in the United Kingdom, Europe, United States, Canada, and Asia Pacific. Then, Whitbread PLC is a British company which handles hotels and restaurants, located in the United Kingdom and internationally - as such, it also provides services related to accommodation, food, and beverage. The third selected company is Elior Group SA, a France-based company, which operates as an operator in the contracted food and support services industry. It caters to a number of sectors in the domains of business, education, as well as healthcare, among others. Its business model relies on three main activities: contract catering, concession catering and support services. The last chosen firm is the well-known L'Oreal SA, a French cosmetics company, that owns a wide range of brands organized into four division: consumer products, L'Oreal luxe, professionals products, and active cosmetics (Refinitiv Datastream, n.d.).

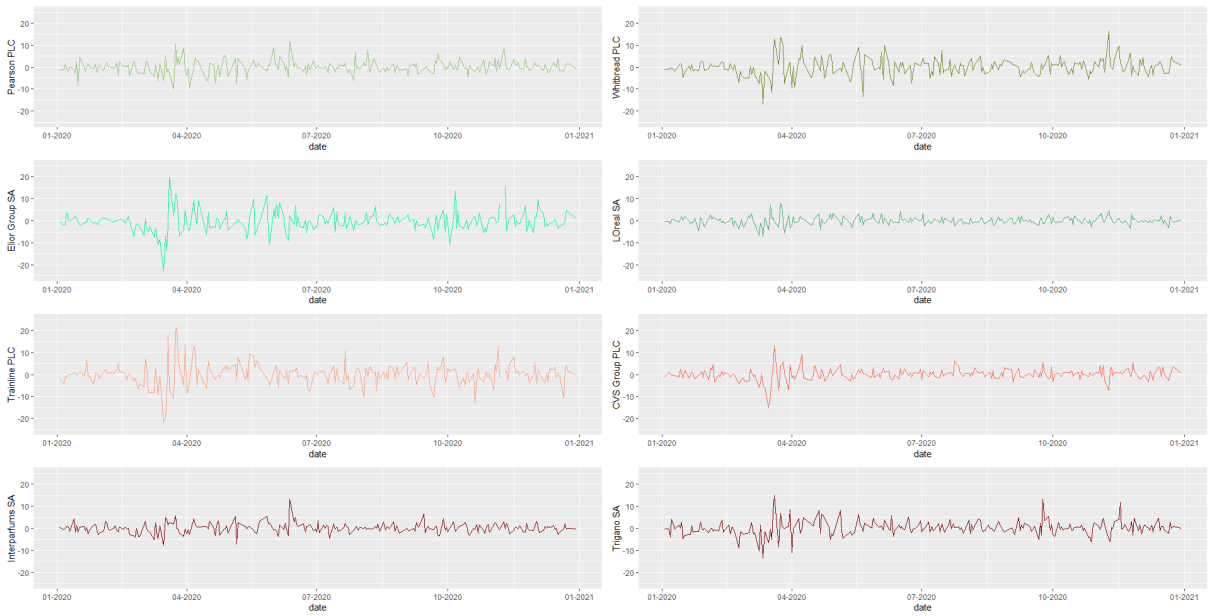


Figure 4.20: Returns time series - own computations for the consumer discretionary peer group.

Preliminary findings from the below table demonstrate that companies belonging to the *leaders* cluster score poorly in terms of total returns if they are highly leveraged - namely, Elior Group and Whitbread. Furthermore, these same companies are far more volatile than the two other less risky firms, if one looks at the above plot. Thus, first analysis will attempt to assess this negative effect of debt on Elior Group's return. Elior's annual report (2020) mentions that sustainability plays a central role in its daily actions and missions and creates acknowledged long-term value. Therefore, its high sustainability score is well-founded. Then, large negative returns happened mainly due to a large decline (- more than 50% decrease) in Elior's share price and no distributed dividend for the year 2020. It also increased tremendously its debt-to-equity ratio following a big increase in debt and a lower equity. In its risk management report, Elior stated that, in the aftermath of COVID-19, it has had to take extra-care of financing and debt servicing. Its indebtedness had adverse effects as a new significant amount of its operating cash-flow had to serve the reimbursement of its debt, which involved possible slowdowns in its business (Elior, 2020) - during the pandemic, Elior also had to sell a subsidiary, Areas, in order to get a solid enough financial basis to face this turmoil. Overall, it undermined its profit because of the service of debt and ESG initiatives did not prevent these adverse consequences.

In the *laggards* group, Interparfums SA almost always scores above means and medians for all indicators - and outstandingly high for the PE ratio. Interparfums is a French

company engaged in the design, manufacturing and marketing of fragrances. The company designs, produces and distributes perfumes and cosmetics under brands such as Burberry, Montblanc, and Paul Smith (Refinitiv Datastream, n.d.). By skimming over its annual report (2020), it will be assessed whether its low ESG combined score and low debt-to-equity ratio can explain its strong performance - especially, its outstanding PE ratio. Interparfurms achieved steady (i.e. above mean and median) returns mainly thanks to a distributed dividend which had not been given the year before. Most of its good performance came from new product launches of its fragrances divisions. Even though it experienced declining profit, Interparfurms managed to increase its reserve of cash and lower its debt-to-equity ratio by cutting down both current and non-current borrowings, which led it to a strong financial health. On the whole, they handled good results thanks to long-term partnerships with suppliers, subcontractors and other vendors to maintain performance and resilience. Thus, their great PE ratio has also not happened because of overpricing of their shares, but because of a right forecast on their future earnings' growth [19]. Nonetheless, they did not clearly engage on ESG initiatives - even though they implemented some policies in favor of the well-being and diversity of their workforce.

To sum up, companies of the consumer discretionary sector seem to be significantly affected by their level of leverage regarding their financial performance. Other factors influencing results are new product launches and diversification, but also long-standing partnerships in this historic industry. However, there were no real impact of ESG policies on performances during the pandemic for selected firms in this industry.

Company Name	ESG Combined Score	Total Return %	Debt-to-Equity %	ROE %	ROA Total Assets %	PE
Pearson PLC	83.38	10.65	39.94	7.35	4.11	30.53
Whitbread PLC	79.29	-25.54	118.26	-23.91	-10.91	NA
Elior Group SA	80.65	-55.87	111.13	-10.33	-3.39	NA
L'Oreal SA	79.23	19.29	8.78	12.20	8.16	42.63
Trainline PLC	12.27	-8.48	95.20	-27.63	-14.01	NA
CVS Group PLC	20.04	31.18	95.60	10.79	4.07	24.69
Interparfums SA	23.64	27.69	4.05	6.43	5.02	91.66
Trigano SA	13.08	57.05	21.12	20.53	11.16	8.61
Mean	48.95	7.00	61.76	-0.57	0.53	39.62
Median	51.44	14.97	67.57	6.89	4.09	30.53

Table 4.28: Key financial indicators for the consumer discretionary industry

[19] According to Refinitiv's data for the year following the conducted analysis (i.e. 2021).

4.3.2 Discussion of insights from industry analyses

This subsection aims at gathering main insights from the above subsection to assess if industries displayed specific patterns or if these patterns were shared across all industries and thus, were more systemic. As expected, most of the financial impact on companies stemmed from the pandemic and most of them suffered from severe setbacks. However, some firms exhibited steady results and, in certain infrequent situations, some firms have had their best results ever. The next paragraphs will highlight the reasons behind these specific yet impactful cases.

First, it appears that, when a company settles an ***acquisition***, it straightaway made a significant impact on short-term returns - no matter the industry. For instance, flatexDEGIRO and Jetpak Top Holding both acquired companies in 2020 and their total returns boomed right after - at least on the analysed panel. This raises the question of how relevant total return is for being a reliable measure in the long term. In a related development with returns computation, share price variations significantly contributed to this. Yet market's expectations can be wrongly forecasted. As such, even though investors benefited from the acquisition in the short-term, additional research could lead scholars to further investigate and confirm or refute whether these short-term benefits held persistently on such panel data.

Afterwards, it appears that if a company is ***active in climate-related businesses***, the ROE, ROA, and PE ratios are significantly high. This statement has been verified by companies active in the fight against climate change and appertaining to industries of utilities and industrials. It would mean that investors gauge these companies as having efficient use of their resources and high potential to grow - this can reasonably be expected given current mega-trends. That is, it could cast awareness around the creation of a *climate* industry classification to gather all these similar firms and more conveniently assess them.

Furthermore, several firms turn out to be significantly affected by their level of ***leverage*** in terms of their financial performance. To put it another way, a higher debt-to-equity shrinks firms' returns as it leads them to pay interest on debt and it restrains their ability to be more resilient in a time of crises. This insight is covered by firms belonging to several industries like utilities (Iberdrola) and consumer discretionary.

Then, it is also worth noting that the industrial sector exhibited differences between firms part of the ESG *leaders* or *laggards* portfolio. The first mentioned was able to generate a

significant amount of cash, hence ensuring healthy financials. On their sides, ESG *laggards* firms generated steady returns during the pandemic due to the undermining of the workforce (e.g. massive lay-offs).

Lastly, some ambitious strategies appeared fruitful by skimming through annual reports. As such, ***new product launches and diversification***, but also ***long-standing partnerships*** give strong positive results for companies that undertake them - this held for various industries such as consumer discretionary and industrials.

In conclusion, inherent accounting-based financial ratios blended with idiosyncratic bold strategies regarding COVID-19 appeared to better explain the financial performance of firms than their ESG scores or their belonging to specific industries - except for utilities and technology industries which substantially performed steadily during the pandemic. In other words, neither ESG strategies nor industry belonging suggests bearing strong benefits in the short-term and resilience abilities - apart from improving efficiency in some sectors.

4.4 Limitations of the methodology

Even though the analyses were conducted as carefully and as specifically as possible, there remain some drawbacks which will partly be offset in the upcoming section - see 4.5. As a first step, the current section aims at listing and explaining all these pitfalls.

The **sensitivity of ratings in the computation by only one provider of data scores** involves that the selection of best-in-class companies relies on the sole use of data provided by Refinitiv. That is, this financial data provider could have misclassified some companies. Plus, no cross-checking of information was done as no other data provider was contacted to compare some companies' scores. Another pitfall related to Refinitiv is that it only scores firms' ESG performance once a year. Therefore, the ratings could be outdated and one company that was considered as best or worst-in-class might not maintain the same position throughout the years.

The **very essence of ESG scores** remains debatable. Nowadays, there are always more scandals about ESG greenwashing involving big corporations or financial institutions - the latest instance is the Michelin scandal in November 2022 whereby Michelin issued *green bonds* to ultimately use the money raised for deforestation instead of devoting it to support local communities and to protect sustainable natural rubber production as initially planned

(Barbiroglio & Valentino, 2022). Some argue that investors are misled because ESG score providers do not reflect accurately the firms' ESG statuses. Others assert that companies themselves can decide to hide unwanted characteristics and hence inflate unethically scores. All of this explains why some investors are still reluctant to this type of investment strategy. However, this debate is still ongoing and should devote significantly more time, research, and global policies. So, this thesis does not attempt to try to solve it.

The **analysis is historical and not forward-looking**. Indeed, statistical analyses were based on historical data and the purpose was not to implement advanced forecasts as it would have been out of context for this work. Moreover, the very core of the event study methodology relies on past data. It means that an event must have happened to use this approach - however, the same approach can be used to analyse other new upcoming waves of COVID-19 or other pandemics. Finally, comparisons between countries and industries might differ in the future. The latter point is especially true as ESG regulation is an evolving topic and countries, as well as industries, will have to comply. That is, resilient or profitable segments can still change.

The **size of the sample is relatively narrow**. In fact, only 32 companies were selected overall for the building of the two initial portfolios. Overall, this seems close and relevant as picking between 20 and 30 stocks is a standard in the industry for portfolio construction. However, it means that for panel data analysis (i.e. the event study and in-depth performance parts) there can be as few as five companies involved in the investigation. To support this statement, if we take a closer look, for instance, at the performance of the *utility* industry (see 4.3), it can be seen that the firm *Solaria Energia* exhibited outstandingly high returns (i.e. 247% on a yearly basis) the year COVID-19 emerged. As this company has relatively high importance in equally-weighted (i.e. weight of 7%) and capitalization-weighted (i.e. weight of 9%) portfolios, it played a role in the overall performance and its removal from both portfolios would have a significant impact. All things considered, this can question the robustness of the methods but the main point of this thesis is to focus on a tight best-in-class screening and the comparison to a relevant peer group. Thus, it had to come with some trade-off between quality and number of firms.

The **sensitivity of event study time windows has not been extensively tested**. In fact, other estimation time windows could have led to new estimations of regressions' coefficients and divergent conclusions. The same applies to shorter or longer event time windows which could have amplified or reduced the stock markets' reactions. To further test the robustness of retrieved results, it could be relevant to investigate the sensitivity of results to these new

specifications and infer whether this event was the most relevant to catch most of the market turmoil linked. However, it is not the main purpose of this thesis and other research has already dedicated resources to answer this (e.g. Hoang, Segbotangni Lahiani, 2021).

4.5 Robustness checks

In this part, the aim is to challenge some of the previously mentioned pitfalls that were raised by analyses conducted in this thesis. It is divided into three parts encompassing the main areas of implemented improvements, namely the ESGC score, the small sample size, and the underlying regressions.

4.5.1 Robustness of ESG scores

The choice of a data score provider is of the uttermost importance although this choice was far from being unambiguous given the manifold organisations active in the financial market. In order to make the right choice of the data provider, the decision relies upon the following discussion.

First, the **quality of data** has been assessed. The data needs to be complete in the sense of geographical, metrics, and materiality points of views. Furthermore, the data must be transparent. It suggests that solely reporting on a selection of ESG data that a firm assumes to have on hand is no longer sufficient - firms that try (and perhaps succeed) to hide ESG issues must suffer damage. In the current context, transparency relates to the quality of the data disclosed. Refinitiv is well-known for providing globally among the best and most up-to-date material information on companies. To ensure it, their methodology encompasses various steps such as the data entry (more than 500 data points), the pre-estimation, the post-production (automated quality check), and the independent auditors' analysis and reviews. Refinitiv also takes care of firms' poor transparency by penalizing them directly on their assigned ESG scores.

Then, an ESG rating agency usually decides on a set of **benchmark** companies for comparative purposes. In the current context, the meaning benchmark refers to the set of companies on which a data provider will base its scoring methodology. As a matter of fact, a score is used for comparative purposes and hence it has to be in line with other companies assessments. There are mainly two types of benchmarking choices: a relative or a global

benchmark. The first indicates that scoring will be set according to the average of other firms belonging to a similar industry or sharing common characteristics, while the second refers to the average of the global set of companies. This thesis makes the assumption that the relative benchmark choice is the most relevant one because it reflects the genuine position of a company compared to other similar ones facing the same market challenges. Refinitiv bases its scores on a business classification per industry.

Finally, the **coverage and frequency** of information have been examined. Refinitiv has one of the widest coverage like Bloomberg and Sustainanalytics, with more than 10.000 companies being tracked. Noticeably, Refinitiv does not provide real-time data but only daily or weekly updates - even though ESG scores are only updated once a year. Nonetheless, it is in line with what other providers offer.

4.5.2 Robustness of small sample size

The number of selected companies is not high, thus it logically makes a small sample. It is worth noting that sample size requirements are different regarding the two different kinds of analyses conducted. Actually, the standalone analysis (i.e. discussion of portfolio analyses - 4.1 and the results of the in-depth financial analysis - 4.3) do not require a large sample but regression-based analyses tend to work more efficiently with numerous observations (results of event study - 4.2). However, other scholars such as Ullah et al. (2021) and Boldeanu et al. (2022) decided to use a sample of a similar range in their event study analyses. This point is also supported by Brown & Warner (1985, as cited by Ullah et al., 2021) who stated that, if after data cleaning and preparation procedures, the subsequent sample size is inadequate, one can avoid possible statistical issues by using daily returns instead of annual or monthly ones. As a matter of fact, the size of the panel data (i.e. the number of data points) is noticeably increased. Moreover, the reasons why it was decided to stay with a limited number of firms are threefold. To begin with, it is believed that the larger the sample size the smaller the probability is to detect an effect. It means that, even though statistical reliance can be improved upon bigger samples, the results of the study could be undermined. Therefore, a study should only be undertaken if it can realistically be expected to yield some relevant information. Then, the selection of companies is based on multiple screening criteria (i.e. size, country, and industry factors) that have coherently decreased the sample size. Nevertheless, this stringent screening ensures that no other events fall within the time period under scrutiny. Lastly, the quality of data from the rating agency has been enhanced by only selecting the top (or bottom)

10% of ESG scoring firms. It results in a smaller sample size but also better quality data points.

4.5.3 Robustness of underlying regressions

Considering the quality of each regression is dependent on its specifications, newly trained regressions should be undertaken in future research. As a matter of fact, new findings can arise from making use of other explanatory variables, other time-related specifications, or other types of regressions than the one specified in the first two aforementioned regressions. For the sake of this thesis, only the type of regressions has been questioned and tested. The rationale behind this is to investigate whether changing the type of regressions can improve the models' explanatory power and unveil fresh patterns - additionally, the LM and Hausman tests for the Spain MM indicate that the fixed-effects model is more suitable for the data than the pooled OLS (see below 4.21 and 4.22).

```
. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

        Firms_Return[id,t] = Xb + u[id] + e[id,t]

        Estimated results:
                         |       Var     SD = sqrt(Var)
                ---------+-----------------------------
                Firms_R~n|   5.988725       2.447187
                       e|   3.947367       1.986798
                       u|    .036694       .1915568

        Test: Var(u) = 0
                                 chibar2(01) =     3.28
                              Prob > chibar2 =   0.0350
```

Figure 4.21: LM test for Spain's market model - favors random-effects model over pooled OLS.

First, the above LM test discards the hypothesis that the pooled OLS is the correct model at a 5% significance level. It means that two options for the type of model are remaining, namely the random and the fixed-effects model. Then, the below Hausman test discards the random-effects model, which supports the hypothesis of the fixed-effects specification.

```
. hausman POOL FE

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     POOL           FE       Difference          Std. err.
-------------+------------------------------------------------------------
Market_Ret~y |   .7768896     .7139948        .0628947        .0100136
------------------------------------------------------------------------------
                b = Consistent under H0 and Ha; obtained from regress.
    B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

    chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =  39.45
Prob > chi2 = 0.0000
```

Figure 4.22: Hausman test for Spain's market model - favors fixed-effects model over random-effects model.

It has also been decided to only report the fixed-effects specification of the first model (i.e. the MM) as, for the second model, estimations removed some variables (e.g. *Debt-to-Equity ratio*, *Past returns*, and *ESG Combined score*) for multicollinearity issues[20]. All other countries' MM models with fixed-effects specifications have also been estimated for comparison purposes with the case of Spain.

[20] In fact, fixed-effects add dummy variables for each company of the subsample and these individual dummies are perfectly correlated with the aforementioned time-invariant variables. Noticeably, fixed-effects have been implemented at the individual level but, some of these had already been taken care of by the very essence of the sample and model constructions. As a matter of fact, it was controlled for the geographical scope as the analysis already distinguishes between countries.

Table 4.29: Market regression output - alternative specification

	France (1)	Germany (2)	Spain (3)	Switzerland (4)	United Kingdom (5)
Market return per country	0.777***	0.918***	0.714***	0.860***	0.783***
	(0.031)	(0.033)	(0.029)	(0.033)	(0.030)
Constant	0.012	0.068	0.128**	0.059	0.010*
	(0.059)	(0.060)	(0.058)	(0.047)	(0.058)
ρ	0.005	0.003	0.090	0.003	0.001
Panel fixed effects	Yes	Yes	Yes	Yes	Yes
Within R-squared	0.353	0.338	0.340	0.288	0.278

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The above table depicts the relationship between firms' returns and market returns per country. This new specification leads to new results which are compared with the initial baseline regressions in 4.2. It can be noticed that the (within)[21] R-squared and estimates of the *"Market return per country"* are almost the same. The two main differences lie, firstly, in the *"Constant"* estimate of the UK - though estimations are similar for other countries. However, the positivity and significance of this variable stay alike. Secondly, the ρ of the Spain's regression is substantially higher than for other countries, meaning that almost 10% of the variance is due to differences across panels (i.e. individuals). Overall, the fixed-effects and pooled OLS models exhibit similar patterns and insights.

[21] In contrast to the usual R-squared, the within R-squared is relevant in the context of fixed-effects regression as it takes into account the average level of fit for each group in the regression (D'Espallier et al. 2017).

Chapter 5

Conclusion

This thesis has aimed at evaluating the sectoral and geographical impact of the COVID-19 pandemic on the performance and resilience of European ESG best-in-class stocks. This work tackled some grey zones of the literature in order to provide a refinement of the divergent body of knowledge on this topic. Discussed pitfalls are related to restrained geographical and sectorial scope, sparse data on the effects of financials, and simplified (i.e. not advanced) techniques to assess resilience and risks. It has also offered a new comprehensive approach to analyse ESG best-in-class investments. This method is designed to be reproducible in other new contexts by adapting either the analysed strand of sustainable strategies (i.e. the best-in-class alongside ESGC scores), the geographical scope (i.e. a focus on Europe), or the distinction between sectors (i.e. the approved ICB classification). This enables the extraction of a clear framework and shapes the analysis according to the three main hypotheses to be tested. These assumptions are the effectiveness of ESG scores inside a best-in-class strategy on performance and resilience during market turmoil, the impact of the pandemic on (non-) ESG stocks' returns per country employing an event study, and the effects of the COVID-19 on *leaders* and *laggards* firms per industry by skimming over their financial, annual, and sustainability reports.

To test the first hypothesis, portfolios under analysis have been built based on their ESGC scores. Firms recording high ESGC scores have underperformed during the crisis. They have consistently exhibited distributions of returns with negative skewness, lower mean returns as well as poor portfolio indicators. This can be due to numerous reasons, among which the flaws of ESG best-in-class investing entailed by solely relying on one indicator. Hence, the best-in-class approach should not only focus on companies exclusively managing the three ESG factors but rather blend other features (e.g. dynamic tracking, missing information, market sentiment arising from ESG news, etc.) in its strategy (Napoletano & Curry, 2021, as

cited by Martinez, 2021). On the contrary, the portfolio's construction technique substantially determines the general performance. The outperformance of capitalization-weighted portfolios suggests that the European market has supposedly experienced momentum effects during market turmoil linked to the pandemic (Fournier, 2022). Although the performance of the *ESG leaders*' portfolio was not as strong, it demonstrated significant resilience to tail-risk. As a matter of fact, it has exhibited lower VaR and ES values (- at least, for quantiles advised by Basel III) during the analysed period. Plus, in the capitalization-weighted approach, this ESG portfolio has suffered from lower drawdowns (i.e. 25% as compared to 30% for *laggards* stocks) and decreases in wealth (i.e. 15% of the initial wealth, instead of 30% for the *ESG laggards* portfolio). It has also exhibited stronger resilience to the crisis as measured by a Δ VaR of 6.1% compared to a Δ VaR of 9.6% for the *ESG laggards*' portfolio.

The second hypothesis has been investigated by looking at how the pandemic has impacted companies with varying ESG scores at the national level. Two regressions have been modelled, namely a market and a refined firms' features model (see 4.2.1). Both statistical representations similarly perform in terms of the model's overall significance (i.e. F-test) and R-squared score. The two implemented regressions concluded that, by investigating the two first studied event windows (i.e. *pre-event* and *on-event*), the European markets have first overreacted to lockdown announcements. In this respect, *ESG leaders* have noticeably been able to better cope with lockdown announcements in Spain and the UK than their non-ESG counterparts. This is also supported by the daily trend of average abnormal returns (see 7.8). Afterwards, lockdown announcement events have partly calmed down market turmoil, which questions the choice of this event as the one when markets were hit the most - as believed from the work of Hoang et al. (2021). This choice relied on the literature but it was still an arbitrary choice. Thus, further investigation can extend the analysis to other events and hypothetically find better predictive models. Moreover, the influence of ESGC scores has also been assessed with regard to firms' returns. It has been found that around (i.e. pre, on, and after-event) lockdown announcements, *ESG leaders* firms experienced lower negative (ex-post or actual) returns than *ESG leaders* companies because of their high ESGC scores. To the same extent, the insurance function of ESG performance has been verified thanks to the incorporation of an interaction term in the firms' feature model (Engle et al., 2020, as cited by Broadstock et al., 2021). That is, ESGC scores bear incremental importance during studied events.

For the third hypothesis, in-depth analyses per industry confirm previous insights whereby belonging to one ESG cluster or the other does not add significant grounds for financial perfor-

mance. Financial ratios and indicators are noticeably affected by firm-specific characteristics which have helped these companies to hold out against the market crisis. Important drivers are inorganic growth by acquisition, low leverage, new product launches, diversification, and long-standing partnerships with stakeholders. Nonetheless, two industries, namely the utilities and industrials, depict high ROE, ROA, and PE ratios for companies active in the fight against climate change. Consequently, it may be interesting to include a new ICB related to this topic. If such a measure was to be introduced, it would be relevant to assess companies from this new industry and compare original evidence with previous findings to gauge whether these firms can be considered as *essential firms* (Albuquerque et al., 2020).

Overall, the observations must be nuanced by mainly two elements. First, the best-in-class threshold used to construct the two groups under analysis is stringent. As a result, the sample size is small and heavily depends on this threshold and the selected ESG data provider. Second, the results of the event study model are potentially caused by confounding or hidden variables which have not been taken into account in the specified regressions. Consequently, regressions might have been misspecified and conclusions might be erroneous. In order to control whether results can be generalized, the analyses should be tested on different datasets. This new data could include ESG scores provided by other third-party rating agencies, new portfolio construction techniques, other firms' characteristics under scrutiny, and, to a larger extent, different areas of the world.

To sum up, the findings of this work provide a real opportunity for investors, policy-makers, and financial institutions to reconsider ESG best-in-class investing strategy more cautiously. In the future, the development of the Sustainable Finance Disclosure Regulation (SFDR) in Europe will give more global transparency, and, ultimately, a public reporting of ESG performance, which will benefit ESG investments in times of forthcoming market turmoil (Li et al., 2022). In particular, ESG scores will have the opportunity to be recomputed by relying on additional data points, common standardization, new regulations, and real-time data thanks to Artificial Intelligence (AI) and Natural Language Processing (NLP). Yet, regulations will not be enough and stakeholders need to push directly in favor of this type of investment.

Chapter 6

Bibliography

[1] Abedifar, P., Bouslah, K., Neumann, C., & Tarazi, A. (2022). Resilience of Environmental and Social Stocks under Stress: Lessons from the COVID-19 Pandemic. *Financial Markets, Institutions & Instruments*. https://doi.org/10.1111/fmii.12166

[2] Albuquerque, R., Koskinen, Y., Yang, S., & Zhang, C. (2020). resilience of Environmental and Social Stocks: An Analysis of the Exogenous COVID-19 Market Crash. *The Review of Corporate Finance Studies, 9(3)*, 593–621. https://doi.org/10.1093/rcfs/cfaa011

[3] Armitage. (1995). EVENT STUDY METHODS AND EVIDENCE ON THEIR PERFORMANCE. *Journal of Economic Surveys, 9(1)*, 25–52. https://doi.org/10.1111/j.1467-6419.1995.tb00109.x

[4] Ashraf, B. N. (2020). Stock markets reaction to COVID-19: Moderating role of national culture. *Finance Research Letters, 41*, 101857. https://doi.org/10.2139/ssrn.3608323

[5] Baele, L., Bekeart, G., Inghelbrecht, K., & Wei, M. (2012). *Flights-to-Safety*. NBB Conference on Endogenous Risks.

[6] Baier, P., Berninger, M., & Kiesel, F. (2020). Environmental, social and governance reporting in annual reports: A textual analysis. *Financial Markets, Institutions & Instruments, 29*, 93–118. https://doi.org/10.1111/fmii.12132

[7] Barbiroglio, E., & Valentino S. (2022). *How Michelin and its Indonesian partner sidestepped the rules for green bonds*. Retrieved January 5, 2023, from https://voxeurop.eu/en/greenwashing-how-michelin-indonesian-partner-sidestepped-rules-green-bonds/

[8] Basel Committee on Banking Supervision. (2019). *Minimum capital requirements for market risk*. BANK FOR INTERNATIONAL SETTLEMENTS (BIS). Retrieved November 8, 2022, from https://www.bis.org/bcbs/publ/d457.pdf

[9] Bennani, L., Le Guenedal, T., Lepetit, F., Ly, L., Mortier, V., Roncalli, T., & Sekine, T. (2018). *How ESG Investing Has Impacted the Asset Pricing in the Equity Market* (SSRN Scholarly Paper ID 3316862). Social Science Research Network. https://doi.org/10.2139/ssrn.3316862

[10] Binder. (1998). The event study methodology since 1969. *Review of Quantitative Finance and Accounting, 11(2)*, 111–137. https://doi.org/10.1023/A:1008295500105

[11] Boldeanu, F. T., Clemente-Almendros, J. A., Tache, I., & Seguí-Amortegui, L. A. (2022). Is ESG Relevant to Electricity Companies during Pandemics? A Case Study on European Firms during COVID-19. *Sustainability (Basel, Switzerland), 14(2)*, 852–. https://doi.org/10.3390/su14020852

[12] Brie, L., Benoit Genest, B., & Arsac, M. (2018). *Back-testing of Expected Shortfall: Main*

challenges and methodologies. Retrieved December 28, 2022, from https://chappuishalder.com/wp-content/uploads/2020/02/Whitepaper-ES-BT-GRA-Vdef-20180402-LON-.pdf
[13] Broadstock, D. C., Chan, K., Cheng, L. T. W., & Wang, X. (2021). The role of ESG performance during times of financial crisis: Evidence from COVID-19 in China. *Finance Research Letters, 38*. https://doi.org/10.1016/j.frl.2020.101716
[14] Brugger, B. (2021). *A Guide to Panel Data Regression: Theoretics and Implementation with Python*. Retrieved December 6, from https://towardsdatascience.com/a-guide-to-panel-data-regression-theoretics-and-implementation-with-python-4c84c5055cf8
[15] Cardillo, G., Bendinelli, E., & Torluccio, G. (2022). COVID-19, ESG investing, and the resilience of more sustainable stocks: Evidence from European firms. *Business Strategy and the Environment*. https://doi.org/10.1002/bse.3163
[16] Clark, Mauck, N., & Pruitt, S. W. (2021). The financial impact of COVID-19: Evidence from an event study of global hospitality firms. *Research in International Business and Finance, 58*, 101452–. https://doi.org/10.1016/j.ribaf.2021.101452
[17] Cornell, B. (2021). ESG preferences, risk and return. *European Financial Management, 27(1)*, 12–19. https://doi.org/10.1111/eufm.12295
[18] Cote, C. (2022). *7 ESG investment strategies to consider*. Business Insights Blog. Retrieved October 24, 2022, from https://online.hbs.edu/blog/post/esg-investment-strategies
[19] D'Espallier, Goedecke, J., Hudon, M., & Mersland, R. (2017). From NGOs to banks: Does institutional transformation alter the business model of microfinance institutions? *World Development, 89*, 19-33. https://doi.org/10.1016/j.worlddev.2016.06.021
[20] Demers, E., Hendrikse, J., Joos, P., & Lev, B. (2021). ESG did not immunize stocks during the COVID-19 crisis, but investments in intangible assets did. *Journal of Business Finance & Accounting, 48(3-4)*, 433-462. https://doi.org/10.2139/ssrn.3675920
[21] de Franco, C., Geissler, C., Margot, V., & Monnier, B. (2020). ESG investments: Filtering versus machine learning approaches. *Cornell University*. https://doi.org/10.48550/arXiv.2002.07477
[22] Dimson, E., Marsh,P., Staunton,M. (2020). *Credit Suisse Global Investment Returns Yearbook 2020*. Credit Suisse Research.
[23] Eurosif. (n.d.). *Infographic on Sustainable finance disclosure requirements*. EUROSIF. Retrieved October 17, 2022, from https://www.eurosif.org/news/infographic-on-sustainable-finance-disclosure-requirements/
[24] Eurosif. (2021). *Responsible Investment Strategies*. EUROSIF 2021. Retrieved October 21, 2022, from https://www.eurosif.org/responsible-investment-strategies/
[25] Ferrat, Y., Daty, F., & Burlacu, R. (2022). Does a sustainability risk premium exist where it matters the most?. *Emerging Markets Review, 100943*. https://doi.org/10.1016/j.ememar.2022.100943
[26] Ferriani, F., & Natoli, F. (2021). ESG risks in times of COVID-19. *Applied Economics Letters, 28(18),* 1537–1541. https://doi.org/10.1080/13504851.2020.1830932
[27] Fulton, M., Kahn, B., & Sharples, C. (2012). Sustainable Investing: Establishing Long-Term Value and Performance. *Climate Change Investment Research, 18-30*. https://doi.org/10.2139/ssrn.2222740
[28] Geboers, H., Depaire, B., & Annaert, J. (n.d.). A review on drawdown risk measures and their implications for risk management. *Journal of Economic Surveys, n/a(n/a)*. https://doi.org/10.1111/joes.12520
[29] Giordani, P. (2021). *Applications of normal, log-normal, central limit theorems, emergence of fat tails*. Syllabus, BI Norwegian Business School, Olso.
[30] Ground, J. (2022). *ESG Global Study 2022*. The Harvard Law School Forum on Corporate Governance.

Retrieved October 6, 2022, from https://corpgov.law.harvard.edu/2022/06/17/esg-global-study-2022/
[31] Gustin, A., Van Weverberg, C, & Ducuroir F. (2020). Deriving distributions from time series using Kernel Density Estimation - With an application for the estimation of the volatile balance of Non-Maturing Deposits. *Reacfin White Paper. Vol 2.* Retrieved November 12, 2022, from
https://www.reacfin.com/index.php/2020/05/19/application-of-kernel-density-estimation-in-finance/
[32] Hartzmark, S. M., & Sussman, A. B. (2019). Do Investors Value Sustainability? A Natural Experiment Examining Ranking and Fund Flows. *The Journal of Finance (New York), 74(6)*, 2789–2837. https://doi.org/10.1111/jofi.12841
[33] Hernaus, A. I. (2019). Exploring the strategic variety of socially responsible investment: Financial performance insights about SRI strategy portfolios. *Sustainability Accounting, Management and Policy Journal*. Retrieved October 14, 2022, from https://www.emerald.com/insight/content/doi/10.1108/SAMPJ-07-2018-0182/full/html
[34] Heyden, K. J., & Heyden, T. (2021). Market reactions to the arrival and containment of COVID-19: An event study. *Finance Research Letters, 38*, 101745. https://doi.org/10.1016/j.frl.2020.101745
[35] HKT Skills. (2023). *Choosing Fixed-Effects, Random-Effects or Pooled OLS Models in Panel Data Analysis using Stata*. [Video]. Retrieved from https://www.youtube.com/watch?v=frh9WMuXXpU&ab_channel=HKTStata
[36] Hoang, T.-H.-V., Segbotangni, E. A., & Lahiani, A. (2021). *ESG Performance and COVID-19 Pandemic: An Empirical Analysis of European Listed Firms (SSRN Scholarly Paper ID 3855360)*. Social Science Research Network. https://doi.org/10.2139/ssrn.3855360
[37] Hua, Peng, L., Schwartz, R. A., & Alan, N. S. (2020). resilience and Stock Returns. *The Review of Financial Studies, 33(2)*, 747–782. https://doi.org/10.1093/rfs/hhz048
[38] J.P.Morgan. (n.d.).*The evolution of the ESG investment landscape*. Retrieved October 24, 2022, from https://am.jpmorgan.com/be/en/asset-management/adv/investment-themes/sustainable-investing/esg-investment-landscape/
[39] Kahil, G. (2021). *Performance study of best-in-class ESG-listed companies*. (Master's thesis). Université Libre de Bruxelles, Bruxelles.
[40] Karahanoglu, I. (2020). The VaR comparison of the fresh investment tool-BITCOIN with other conventional investment tools, gold, stock exchange (BIST100) and foreign currencies (EUR/USD VS TRL). *Eastern Journal of European Studies, 11(2)*, 160-181.
[41] Kempf, A., & Osthoff, P. (2008). SRI Funds, Nomen est Omen. *Journal of Business, Finance & Accounting, 35*, 1276–1294.
[42] Kishan, S. (2022). *ESG by the Numbers: Sustainable Investing Set Records in 2021*. Bloomberg. Retrieved September 27, 2022, from
https://www.bloomberg.com/news/articles/2022-02-03/esg-by-the-numbers-sustainable-investing-set-records-in-2021
[43] Kohers, N., & Kohers, T. (2000). The Value Creation Potential of High-Tech Mergers. *Financial Analysts Journal, 56(3)*, 40–50. https://doi.org/10.2469/faj.v56.n3.2359
[44] Kotsantonis, S., Pinney, C., & Serafeim, G. (2016). ESG Integration in Investment Management: Myths and Realities. *Journal of Applied Corporate Finance, 28(2)*, 10–16. https://doi.org/10.1111/jacf.12169
[45] Kumar, R., Dayaramani, N., & Rocha, J. D. (2018). *Understanding & Comparing ESG Terminology*. Retrieved October 25, 2022, from
https://www.ssga.com/investment-topics/environmental-social-governance/2018/10/esg-terminology.pdf

[46] Laforêt, O. (2018). *Risk measurements applied to Basel III and Solvency II*. (Master's thesis). Université Catholique de Louvain - Louvain School of Management, Louvain-la-Neuve.
[47] Li, Z., Feng, L., Pan, Z., & Sohail, H. M. (2022). ESG performance and stock prices: Evidence from the COVID-19 outbreak in China. *Humanities and Social Sciences Communications, 9(1)*, Article 1. https://doi.org/10.1057/s41599-022-01259-5
[48] Lins, K. V., Servaes, H., & Tamayo, A. (2017). Social Capital, Trust, and Firm Performance: The Value of Corporate Social Responsibility during the Financial Crisis. *The Journal of Finance, 72(4)*, 1785–1824. https://doi.org/10.1111/jofi.12505
[49] MacKinlay. (1997). Event Studies in Economics and Finance. *Journal of Economic Literature, 35(1)*, 13–39.
[50] Mager, J. (2012). *value at risk Estimation in the Basel III Framework*. Technische Universitat Munchen. Department of Mathematics.
[51] Maneenop, S., & Kotcharin, S. (2020). The impacts of COVID-19 on the global airline industry: An event study approach. *Journal of Air Transport Management, 89*, 101920. https://doi.org/10.1016/j.jairtraman.2020.101920
[52] Mathieu E., Ritchie H., Rodés-Guirao L., Appel C., Giattino C., Hasell J., Macdonald B., Dattani S., Beltekian D., Ortiz-Ospina E., & Roser? M. (2020). *Coronavirus Pandemic (COVID-19)*. Retrieved, November 24, 2022, from https://ourworldindata.org/coronavirus
[53] Mladina, P., Grant, C., Germani, S. (2022). A History of Drawdowns - A study of the historical "peak-to-trough" declines of stocks and bonds. *Wealth Management Portfolio Research*. Retrieved December 24, 2022, from https://www.northerntrust.com/africa/insights-research/2022/wealth-management/a-history-of-drawdowns
[54] Mondi Group. (2020). *Integrated report and financial statements 2020*. Retrieved December 19, 2022, from https://www.mondigroup.com/media/13645/mondi-integrated-report-2020.pdf
[55] Murphy, C. (2020). *Information Ratio (IR) Definition, Formula, vs. Sharpe Ratio*. Retrieved December 5, 2022, from https://www.investopedia.com/terms/i/informationratio
[56] Naffa, H., & Fain, M. (2020). Performance measurement of ESG-themed megatrend investments in global equity markets using pure factor portfolios methodology. *PLOS ONE, 15(12)*, e0244225. https://doi.org/10.1371/journal.pone.0244225
[57] Omura, A., Roca, E., & Nakai, M. (2021). Does responsible investing pay during economic downturns: Evidence from the COVID-19 pandemic. *Finance Research Letters, 42*. https://doi.org/10.1016/j.frl.2020.101914
[58] Patnaik I, Shah A (2010). Does the currency regime shape unhedged currency exposure?. *Journal of International Money and Finance, 29(5)*, 760–769.
[59] Refinitiv. (2021). *Environmental, social and governance (ESG) scores from Refinitiv*. Refinitiv. Retrieved September 29, 2021, from https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf
[60] Statista. (n.d.). *Topic: ESG investing*. Statista. Retrieved September 27, 2022, from https://www.statista.com/topics/7463/esg-and-impact-investing/
[61] Schmeling, M. (2008). *Investor sentiment and stock returns: Some international evidence*. St. Louis: Federal Reserve Bank of St Louis. Retrieved December 31, 2022, from https://www.proquest.com/working-papers/investor-sentiment-stock-returns-some/docview/1698414596/se-2
[62] Tasche, D. (2002). Expected shortfall and beyond. *Journal of Banking & Finance, 26(7)*, 1519–1533.

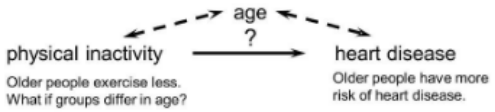
https://doi.org/10.1016/S0378-4266(02)00272-8
[63] Taylor, T. & Collins, S. (2022). *ESG investing and sustainability*. Deloitte Insights. Retrieved October 3, 2022, from https://www2.deloitte.com/uk/en/insights/industry/financial-services/esg-investing-and-sustainability.html
[64] Thomann, A. (2021). Multi-asset scenario building for trend-following trading strategies. *Annals of Operations Research, 299(1)*, 293–315. https://doi.org/10.1007/s10479-020-03547-2
[65] Triodos Investment Management. (n.d.). *Sustainable investing strategies: What are the differences?*. Retrieved October 25, 2022, from https://www.triodos-im.com/knowledge-centre/sustainable-investing-strategies
[66] Shaikh. (2021). Analysing the volatility index: How disease outbreak news impacts equity and commodity markets. *Financial Express*.
[67] Ullah, S., Zaefarian, G., Ahmed, R., & Kimani, D. (2021). How to apply the event study methodology in STATA: An overview and a step-by-step guide for authors. *Industrial Marketing Management*. https://doi.org/10.1016/j.indmarman.2021.02.004
[68] Valls Martínez, M. & Martín Cervantes, P. A. (2021). Testing the Resilience of CSR Stocks during the COVID-19 Crisis: A Transcontinental Analysis. *Mathematics (Basel), 9(5)*, 514.
https://doi.org/10.3390/math9050514
[69] van Duuren, E., Plantinga, A., & Scholtens, B. (2016). ESG Integration and the Investment Management Process: Fundamental Investing Reinvented. *Journal of Business Ethics, 138(3)*, 525–533.
https://doi.org/10.1007/s10551-015-2610-8
[70] Vass, C. (2019). Industry Classification - Benchmark (ICB) reclassification - Expanded and improved. *FTSE Russell, Taxonomy Insights- Industry Classification*.
[71] Vicente-Ortega Martínez, C. (2021). *ESG Investments and their Evolution during the COVID-19 Pandemic*. (Master's thesis). Comillas Universidad Pontifica, Madrid.
[72] Walsh, B. & Hallegatte, S. (2020). Measuring Natural Risks in the Philippines: Socioeconomic Resilience and Wellbeing Losses. *EconDisCliCha, 4*, 249–293. https://doi.org/10.1007/s41885-019-00047-x
[73] Watelet, U. (2021). *The impact of COVID-19 on the economic and financial performance of Social Banks* (Master's thesis). Université Libre de Bruxelles, Bruxelles.
[74] Wayne, W , & Sullivan, L. (n.d.). *Confounding and Effect Measure Modification* Retrieved January 8, 2023, from https://sphweb.bumc.bu.edu/otlt/mph-modules/bs/bs704-ep713_confounding-em/bs704-ep713_confounding-em_print.html
[75] Wu, J, & Juvyns, V. (2020). On the Minds of Investors. *J.P. Morgan, Asset Management*. Retrieved December 26, 2022 from https://am.jpmorgan.com/sg/en/asset-management/per/insights/market-insights/on-the-minds-of-investors/COVID-19-esg-matters/
[76] Yoo, S., Keeley, A. R., & Managi, S. (2021). Does sustainability activities performance matter during financial crises? Investigating the case of COVID-19. *Energy Policy, 155, 112330*.
https://doi.org/10.1016/j.enpol.2021.112330
[77] Zerbib, O. D. (2019). *A Sustainable Capital Asset Pricing Model (S-CAPM): Evidence from Environmental Integration and Sin Stock Exclusion (SSRN Scholarly Paper ID 3455090)*. Social Science Research Network.
http://dx.doi.org/10.2139/ssrn.3455090

Chapter 7

Appendices

7.1 Glossary

Variable names	***Definition***
Alpha	Alpha is a term widely used in finance to measure performance, indicating whether a strategy has been able to consistently beat the market. It is also called the *excess return* or the *abnormal rate of return*. The latter designation relies on the efficient market hypothesis (EMH) - according to this theory, prices on the market reflect all information thus it is only possible to earn higher returns by purchasing more risky investments. It is usually an indicator of performance for hedge funds or similar investments as they can easily be compared to broad indexes.

Confounding effect	Confounding effects happen when potential cause and effect relationships are investigated - e.g. event studies or regressions. Thus, confounding variables are correlated with at least one of the independent variables and causally related to the dependent variable. It occurs when features not used in regressions differ with respect to the analyzed groups. For instance, in the below example *age* is a confounding factor because it is associated with the exposure (i.e. old people are likely not to make physical activity), and it is also linked with the outcome (i.e. old people bear greater risk of having heart disease) (Wayne & Sullivan, n.d.).  One of the main techniques to resolve this issue is to perform matching. The latter removes the effects of possible confounding effects in the variables used for the matching - this approach is the one used in this thesis. In the end, confounding effects can assume that a cause and effect relationship is true, although it does not actually exist. Left unchecked, it can induce biases in regressions estimations and erroneous interpretations of investigated patterns.
Flight-to-safety	It can be defined as a sudden increase in inflows for safe assets relative to risky assets, following market stress, increasing market volatility, or large and negatvie equity returns. Investors abruptly prefer to invest in a blend of safe assets (i.e. low volatility and downside risk), high quality assets (i.e. presenting low default), and highly liquid assets (i.e. easily convertible into cash within a short amount of time) (Baele et al., 2012).

Gaussian Kernel	It starts from the idea that histograms of observations can be seen such as empirical counterpart of empirical densities. Thus the histogram's bars (i.e. the empirical probability to fall between two ranges of observations) are replaced by smooth bumps which are themselves the Kernel. The formula for the Gaussian kernel is the following: $K(\frac{y_{i,t}-\zeta_i}{h}) = \frac{1}{\sqrt{2\pi}} \exp \frac{-1}{2}(\frac{y_{i,t}-\zeta_i}{h})$ where h is the bandwidth or the smoothing parameter and it plays the same role as the class length for histograms (i.e. controlling for under/over-smoothing).
Internal Rate of Return (IRR)	The internal rate of return (IRR) is a measure that estimates the profitability of investments. It is linked to the Net Present Value (NPV) as it is the discount rate that makes the NPV of an investment's cash flows equal to zero. The following formula reflects it: $0 = NPV = \sum_{t=1}^{T} \frac{C_t}{(1+IRR)^t - C_0}$ where C_t is the net cash-flow during period t, C_0 is the total initial investment cost, and t the number of periods taken into account to receive cash-flows from this investment.
Tracking error	It is a measure of financial risk for an investment portfolio. It measures the difference between the fluctuations of a portfolio's returns and the fluctuations of a chosen benchmark. The formula to compute it is the following: TE $= \sqrt{\mathrm{Var}(r_p - r_b)} = \sqrt{E[(r_p - r_b)^2] - (E[r_p - r_b])^2}$
VIX	VIX is an index designed to produce a measurement of the expected volatility of the US stock market - it is based on S&P 500 index options. More precisely, it corresponds to Chicago Board Options Exchange's (CBOE) Volatility Index. It is also often referred to as the fear index given the fact that it gauges market participants' sentiment.

Table 7.1: Glossary

7.2 Countries of exchange of the listed stocks

Stock exchange country	Leaders (Frequency in %)[1]	Laggards (Frequency in %)
France	2 (13.33%)	2 (11.76%)
Germany	2 (13.33%)	4 (23.53%)
Italy	1 (6.67%)	1 (5.88%)
Spain	3 (20%)	1 (5.88%)
Sweden	1 (6.67%)	1 (5.88%)
Switzerland	3 (20%)	4 (23.53%)
United Kingdom	3 (20%)	4 (23.53%)

Table 7.2: Countries of exchange of the listed stocks

7.3 Industries of the listed stocks

Industry	Leaders (Frequency in %)	Laggards (Frequency in %)
Consumer discretionary	4 (26.67%)	4 (23.53%)
Financials	3 (20%)	4 (23.53%)
Health Care	2 (13.33%)	2 (11.76%)
Industrials	2 (13.33%)	3 (17.65%)
Technology	1 (6.67%)	3 (17.65%)
Utilities	3 (20%)	1 (5.88%)

Table 7.3: Industries of the listed stocks

7.4 Lockdown announcement dates in the sampled European countries

Company Name	Stock exchange country
France	12/03/2020
Germany	18/03/2020
Italy	09/03/2020
Spain	13/03/2020
Sweden	10/03/2020
Switzerland	13/03/2020
United Kingdom	23/03/2020

Table 7.4: Lockdown annoucement dates in sampled countries

[1] Companies highlighted in green correspond to those selected for *leaders* group - it is also effective for the next section, namely Appendix 7.3

7.5 Historical VaR estimation from Dec. 2018 until Nov. 2019

The following tables exhibit VaR estimations for the aforementioned period. They are useful in the calculation of Δ VaR which . Ultimately, it gives an assessment of the resilience of one portfolio to the extent of its VaR risk component. As a matter of fact, if one portfolio displays higher Δ, it would suggest that it was less resilient than its counterpart given the fact that the counterpart would have been able to better mitigate the effect of the crisis on its maximum losses encountered that year.

- **Equally-weighted portfolio**

	VaR level		
Type of portfolio	95%	97.5%	99%
ESG Leaders	3.593	4.283	6.123
ESG Laggards	4.616	6.398	8.058

Table 7.5: Historical VaR for the equally-weighted portfolio - from Dec. 2018 until Nov. 2019

- **Capitalization-weighted portfolio**

	VaR level		
Type of portfolio	95%	97.5%	99%
ESG Leaders	3.039	4.342	5.659
ESG Laggards	4.608	6.768	8.723

Table 7.6: Historical VaR for the capitalization-weighted portfolio - from Dec. 2018 until Nov. 2019

7.6 Reasoning to determine the type of model specification in the event study

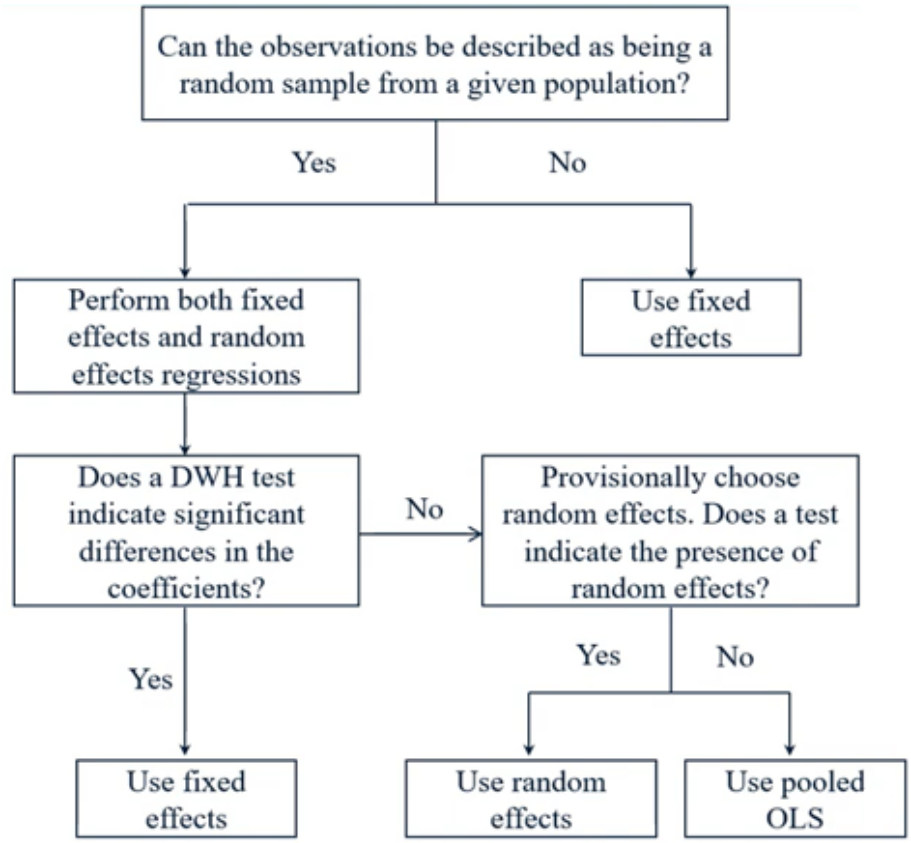


Figure 7.1: Pathway to decide on the type of event study regressions - source: HKT Skills (2023).

7.7 Tests for specification of the model

Output Stata for the LM tests

```
. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

        Firms_Return[id,t] = Xb + u[id] + e[id,t]

        Estimated results:
                             |       Var     SD = sqrt(Var)
                -------------+------------------------------
                Firms_R~n    |    6.213361       2.492661
                           e |    4.025257       2.006304
                           u |    .0054643       .0739212

        Test: Var(u) = 0
                                     chibar2(01) =      0.00
                                  Prob > chibar2 =    0.4986
```

Figure 7.2: Lagrange Multiplier (LM) test to test the presence of random effects - case of France in the market regression model.

It has been decided to only report the results of LM tests for the case of France as all other countries exhibited the same decision rule. That is, not rejecting the H_0 that states the variance of the errors is dependent on the values of the independent variables. Therefore, the pooled OLS model cannot be rejected.

Output Stata for the Hausman tests

```
. hausman POOL FE

                 ---- Coefficients ----
                 |      (b)          (B)          (b-B)     sqrt(diag(V_b-V_B))
                 |     POOL          FE        Difference       Std. err.
-----------------+------------------------------------------------------------
Market_Ret~y     |   .7768896     .7768906      -9.67e-07        .0009063
------------------------------------------------------------------------------
                           b = Consistent under H0 and Ha; obtained from regress.
            B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

    chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
            =   0.00
Prob > chi2 = 0.9991
```

Figure 7.3: Hausman test to compare the pooled OLS and fixed-effects models - case of France in market regression model.

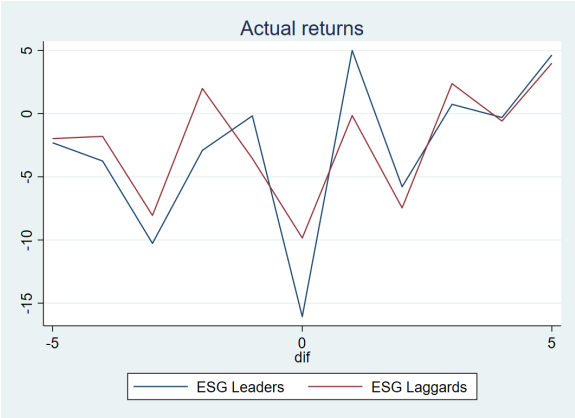
As in the above subsection, only results for France have been retrieved - results were similar for other countries. The null hypothesis of the Hausman test is not rejected, meaning that it cannot be assumed that the fixed-effects model is preferred over the pooled OLS model.

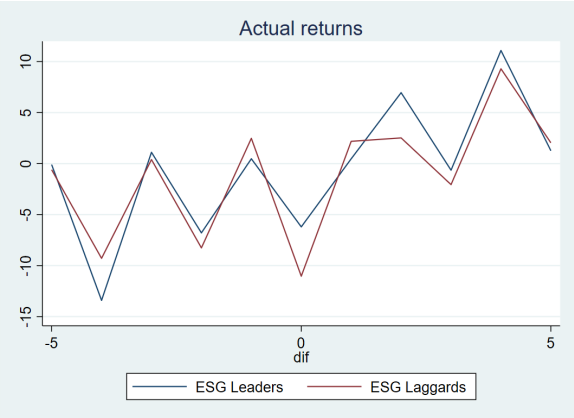
7.8 Graphical display of event study measures

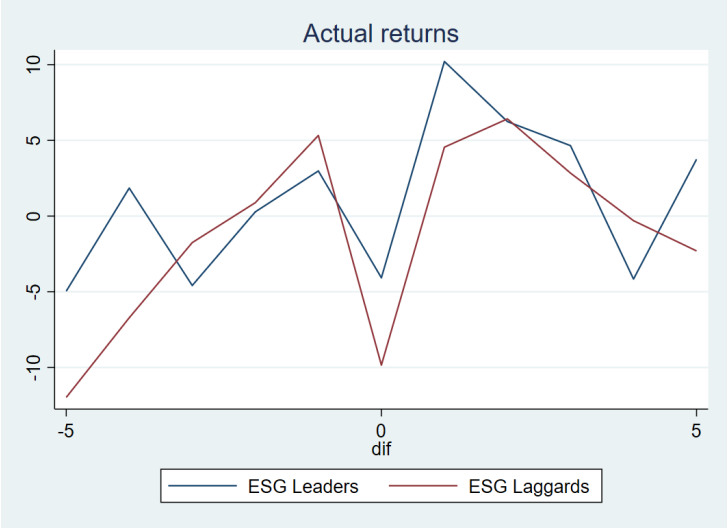
The following plots present graphically the measures from the fitted regressions around the three time windows under analysis (i.e. from 5 days before until 5 days after the lockdown announcement date for a particular country).

Market regression

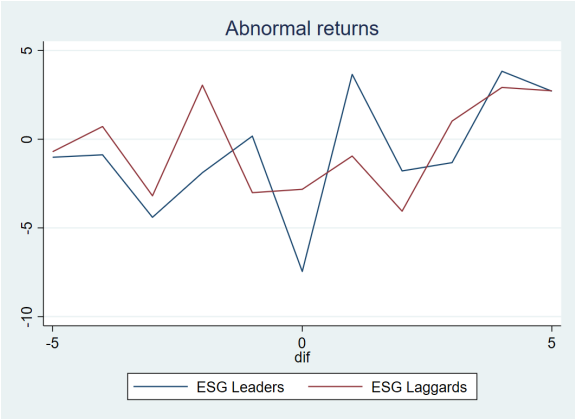
Based on the estimations of the market model, the following plots exhibit the daily mean evolution of firms' stock returns around the time event window, respectively for *ESG leaders* and *ESG laggards* firms.
First, average actual (i.e. ex-post) returns are displayed for each group per country.

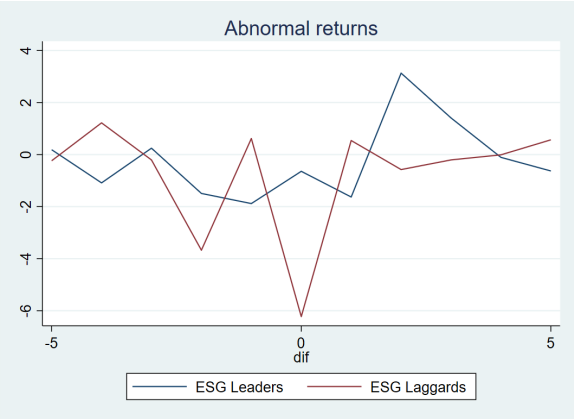


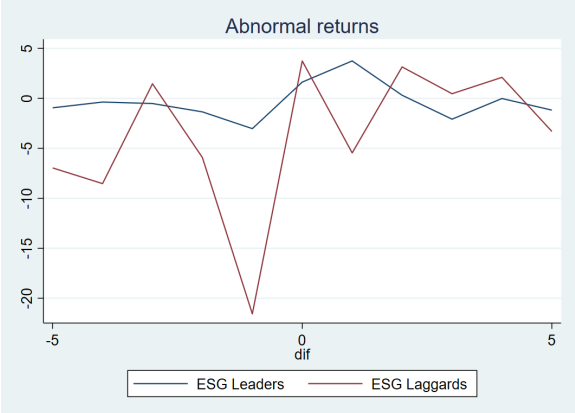


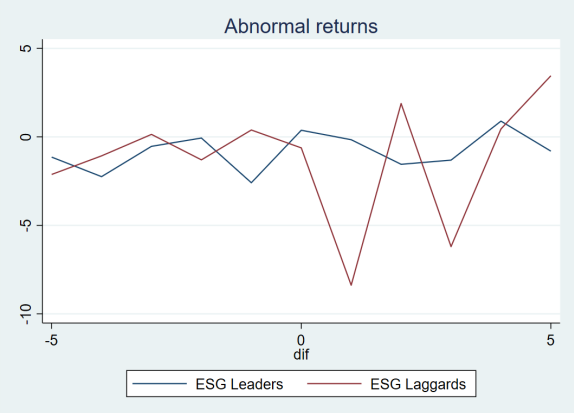


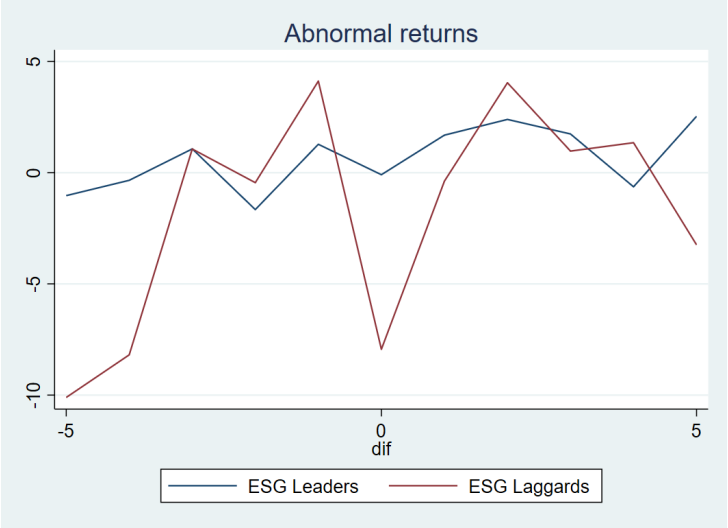
Second, average abnormal returns can be seen below.





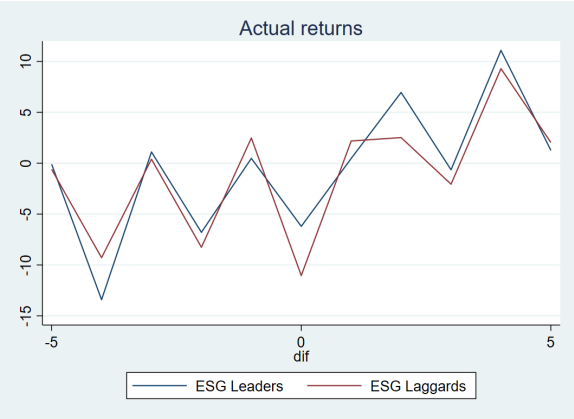


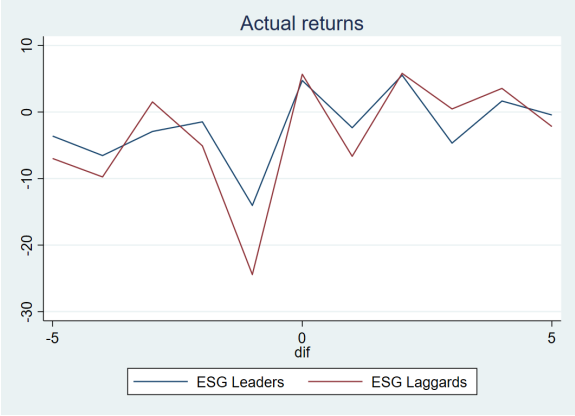


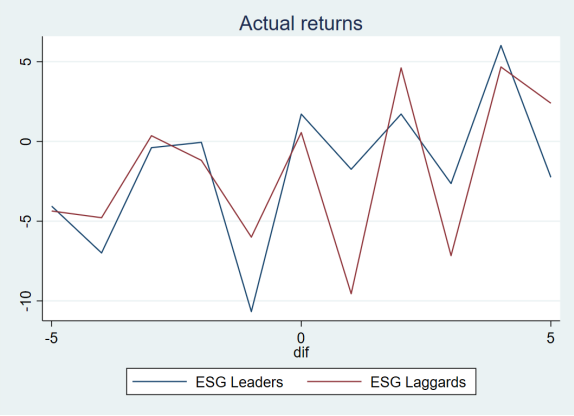


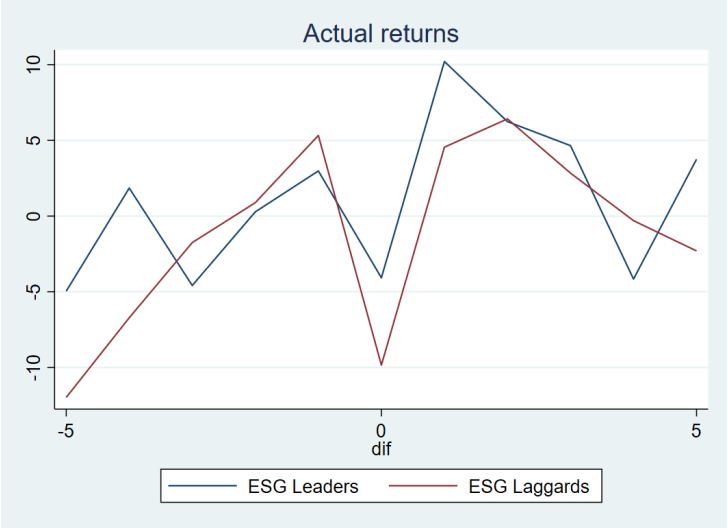
Firms' features regression

Based on the estimations of the firms' features model, the following plots exhibit the daily mean evolution of firms' stock returns around the time event window, respectively for *ESG leaders* and *ESG laggards* firms. First, average actual (i.e. ex-post) returns are displayed for each group per country.

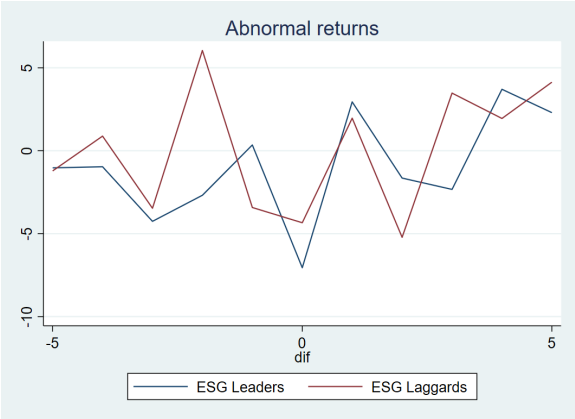


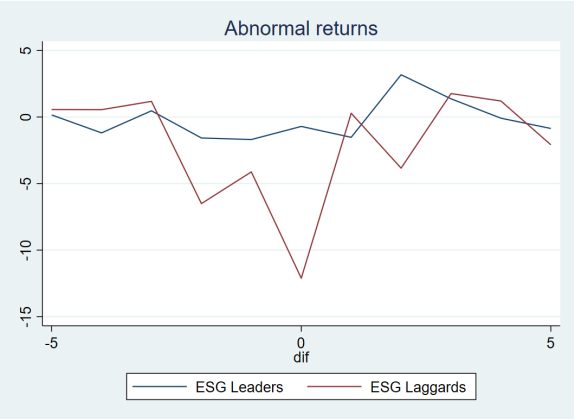


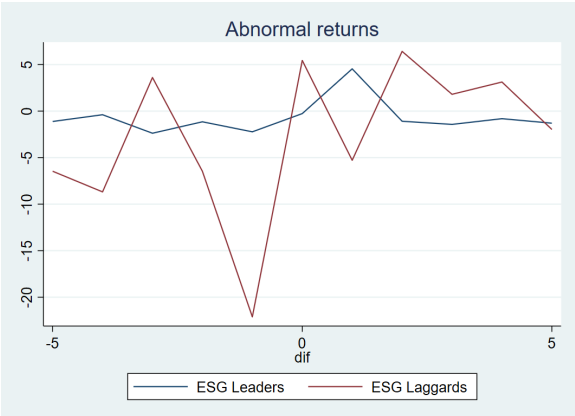


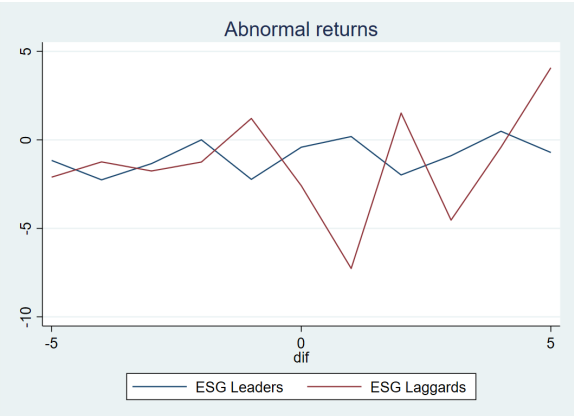


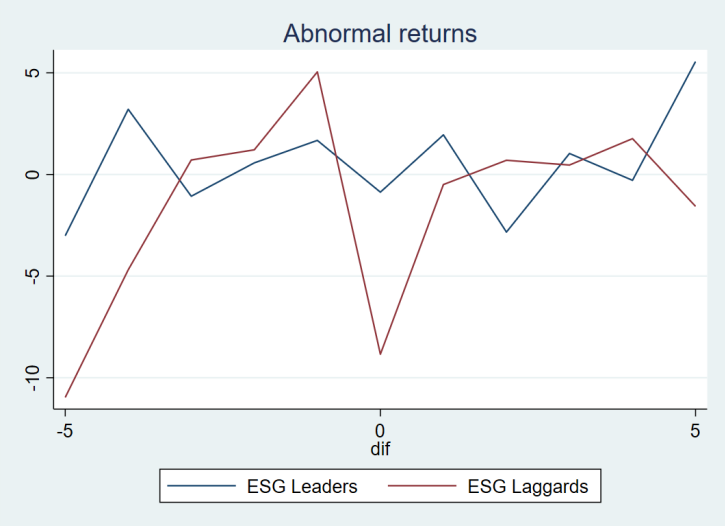
Second, average abnormal returns can be seen below.











7.9 GitHub repository

The statistical analysis was coded through the statistical programming language *R* and the event study was partially coded in *Stata*. In order to allow interested readers to deep dive and potentially adapt the assumptions (i.e. hypotheses to deal with missing values, choice of time span, and decision on the financial provider to create the dataset being used) to further research, the following link redirects to a GitHub repository: https://github.com/hvenance/Solvay_Thesis_ESGTimeSeries. Any comment is greatly appreciated and I would be eager to discuss and look at this thrilling topic of ESG investments analyses more thoroughly.