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Finance embraces sustainability:

An empirical analysis of the financial performances of ETFs investing in sustainable real estate and green building

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Summary

Preface

Disruptive events have affected the beginning of this new decade. Many innovative trends are arising in the global economy and the financial sector is, and will be, one of the main actors driving the future global challenges.

In the last ten years the volume of assets under management related to socially and environmentally sustainable investments has been increasing dramatically, as well as the number of private funds adopting ESG criteria while constructing their investment portfolios. An increasing number of investors consider, in their utility functions, not only the financial returns provided by the investments, but also the non-financial outcomes that might be generated while allocating their money. Therefore, the financial sector has been put under pressure from the international community to make it become the driver of those sustainable economies able to generate positive impacts, as well as positive financial returns.

This thesis focuses on impact finance, and it provides an analysis of the financial performances of Exchange Traded Funds (ETFs) that integrate the principles of impact investing in their investment portfolios. In particular, the Real Estate and the Building & Construction industries have been selected as interesting sectors to analyse, given their importance in national economies and the environmental impact that construction activities produce all over the world.

The first part of this thesis covers the analysis of the current state of the art of the impact investing segment, as well as the review of the role of professional investors in enhancing the practice of impact investing. Moreover, the Covid-19 pandemic has revealed many hidden risks and social needs, and in the next decade new business opportunities might arise for innovative small and medium enterprises.

The second chapter provides a review of the recent European regulation concerning sustainable investments. Furthermore, it provides an analysis of the potential development of the Real Estate and the Green Building industries, which have recently been affected by innovative regulations concerning energy efficiency and environmental protection.

One of the most discussed issues concerning impact investing is the evaluation of the financial performances compared to those of traditional investments. Being this a huge obstacle for the diffusion of this type of securities, the impact of screening activities in the risk-return profile of these portfolios, and the potential risk mitigation derived from the integration of ESG criteria will be discussed.

After having presented a review of the financial models that can be used to evaluate the sensitivity of the returns to different risk factors, an empirical analysis is presented using real market data taken from the major financial markets. The empirical analysis provides some insights about the sensitivity of the returns of four different ETFs, investing in Europe and in North America, to different risk factors, by comparing the efficacy of different versions of the Fama and French multi-factor model. Moreover, an extended version of the well-known Fama and French six-factor model is presented, with the addition of a *sustainability* risk factor. Finally, the financial performances of the selected ETFs are evaluated and compared to those of the benchmark indexes and other ETFs with different sustainability characteristics.

The main purpose of this analysis is to understand whether impact investing allows the investors to mitigate some risks, as well as to investigate how the integration of ESG criteria affects the returns of Exchange Traded Funds in bear and bull market conditions.

Chapter 1

Impact Investing: a growing trend in the global financial markets

1.1 Introduction to impact investing

The financial sector is one of the biggest industries all over the world, having been worth approximately $5.59 trillion at the end of 2020 (Kenton, 2020). This sector affects our everyday lives in mostly all the operations that we carry on day by day. Therefore, the way retail and professional investors allocate their capitals can produce huge impacts on the worldwide economy and on our lives.

The impact generated through the allocation of capitals is not only economic, but indeed investment decisions do also produce huge impacts on local communities and on the environment.

Philanthropists, economists, and professionals in the financial sector used the term *impact investing* for the first time in 2007, during an event organized by the Rockefeller Foundation. Even though this topic has already been discussed for many years so far, the development of the impact investing segment inside financial markets and among international communities has always been quite slow, mainly because of the uncertainty over the financial performances of these investments and the lack of a clear and uniform definition of impact finance. Indeed, when analysing the topic of sustainable investments many different definitions are provided.

The research conducted by Höchstädter & Scheck (2015) proves that during the last decade the terms "impact investing" and "socially responsible investments" (SRIs) have been used in many ways. For example, some researchers have adopted these terms as synonyms, while others have classified SRIs as a subcategory of impact investing. On the contrary, other researchers still consider SRIs and impact investing as two distinct forms of investment, while recognizing some similarities.

According to Höchstädter & Scheck (2015), these investments can also be analysed by looking at their size and nature. Indeed, when the research was conducted, in 2014, it seemed that SRIs were mainly related to investments made in big corporations through publicly traded capitals (in the forms of equity and debt). On the contrary, impact investing was thought to be strictly connected to private equity and debt capital used to finance small and medium enterprises.

Moreover, the risk-return profile of these two investment's classes seemed to be different: while SRIs were thought to earn at least the return of the market, impact investors seemed to be willing to accept below market returns, while generating higher social and environmental outcomes (Höchstädter & Scheck, 2015). Finally, SRIs usually integrate some ESG criteria using the *negative screening strategy*, which will be discussed in Chapter 3. On the contrary, impact investing has always been considered more proactive in the definition of the outcomes that should be generated through the capital allocation.

Nevertheless, practitioners observed in the past that these characteristics could not be considered relevant for the definition of the entire segment, but instead they represented the state of the art of the market of impact investing in those years. As a matter of fact, practitioners and researchers had already declared that because of the potential evolution of impact finance, many opportunities could have arisen in the future also in the form of publicly traded financial products, and not only in the field of private equity and venture capital funds. This innovative trend can already be observed in the financial markets, where an increasing number of financial products have become available both to retail and professional investors, as well as a few impact funds, which have been launched in the form of sustainable Exchange Treaded Funds (ETFs).

In this thesis, the terms "impact investing", "ESG investments", "sustainable investing" will be used as synonyms. All these terms will refer to one clear definition provided by the Global Impact Investing Network (GIIN): "*impact investments are investments made with the intention to generate positive, measurable social and environmental impact alongside a financial return*" (GIIN, 2021).

Some characteristics must be highlighted while defining impact investing: first of all, the term is used to describe those investments that are made with the *intention* to generate positive social and/or environmental impacts, which must be *measurable*. Moreover, the term is linked to investments that do produce a *financial return*, which might be equal or above the return of the market.

Therefore, this thesis will never refer to charities, donors, philanthropists, and social enterprises that accept lower financial returns compensated by higher social and/or environmental impacts. On the contrary, the object of this thesis are those investors who seek a financial return equal or above the market return, belonging to the category of impact investors. Therefore, investors who allocate their capitals in profitable companies in order to generate both a positive financial return and a non-financial outcome.

1.2 The role of professional investors embracing impact investing

A research published in 2020 by the International Finance Corporation of the World Bank Group reveals that the market of impact investing has been growing dramatically in the last few years.

In 2019, the assets under management (AUM) belonging to the impact investing market have been worth approximately $505 billion, while considering the broad category of sustainable investing (therefore, putting less constraints in the assets' selection), the market is worth about $2 trillion (Gregory & Volk, 2020).

Another research published by Uzsoki (2020) about sustainable investing shows that an increasing number of institutional and professional investors are integrating ESG criteria in their investment strategies. One of the key factors leading the shift from traditional to sustainable finance is the increasing awareness over the financial relevance of ESG risks.

Therefore, on the one hand retail investors demonstrate a higher interest and attention to the evaluation of non-financial performances in their investment portfolios, but on the other hand institutions themselves recognize the importance of assessing financially relevant ESG risks.

Even though the initial phase of this transition has mainly involved private funds, this trend is slowly affecting public markets too. Indeed, many asset managers such as BlackRock, Amundi and Mirova have presented innovative financial products that are exchanged in public markets. Moreover, the International Institute for Sustainable Development declared, in a recent report[1] , that in the next twenty-five years the spending power of Millennials (those who were born between 1981 and 1996) will increase dramatically and, because of their attention for sustainability, it is thought that the demand for impact investing-related products will increase significantly (Uzsoki, 2020).

According to Uzsoki (2020) those companies who will not price efficiently ESG risks might incur in higher cost of capital, decreasing share prices and a reduction in the demand of their stocks. Furthermore, in the future ESG parameters might also become relevant for companies' valuation and credit ratings (Uzsoki, 2020).

As mentioned in Section 1.1, the measurement of the impact generated by the investment is one of the key factors when dealing with the classification of the investment portfolios into the category of impact finance. Indeed, even the definition of impact investing provided the GIIN[2] refers to a measurable and well-defined impact, and not to a generic intent to generate some outcomes.

Unfortunately, even though many guidelines have been published at international level to guarantee a transparent disclosure of all the information related to the measurement of the generated impact, only few investors have been using these tools so far. As a matter of fact, only 24% of private funds in the U.S. respect all the principles that allow them to be considered impact funds, according to the definition of the GIIN (Gregory & Volk, 2020). Moreover, these funds are mainly private equity and venture capital, as well as funds investing in Real Estate and other industries.

Another interesting aspect analysed by Gregory & Volk (2020) is the size of impact funds, which are estimated to be worth $235 million on average, against $365 million of conventional funds. This fact highlights that impact investing can not be considered a niche market anymore, and that the attention towards this segment has been steadily increasing in the last few years.

Finally, both conventional and impact funds target investments in North America and Europe, which are the two biggest markets for impact investing. An interesting figure for the purposes

[1] Uzsoki (2020).

[2] Global Impact Investing Network.

of this thesis is that almost 65% of the investments made by private impact funds in developed countries target infrastructures (51,1%) and natural assets and Real Estate (13,8%). The evaluation of assets under management (AUM) that comply with the definition of impact investing in public markets is even harder, even though the International Finance Corporation estimated them to be worth around $747 billion (Gregory & Volk, 2020). This amount of capital represents only 7% of all the AUM traded in public markets in the field of sustainable investing, and it is represented by the green, social, and sustainable bonds issued by private companies in the field of impact finance.
On the contrary, 93% of the total AUM ($10.582 billion) is represented by public equity managed through the integration of ESG criteria and through the analysis of risks derived from ESG components. Even though these assets might generate some positive outcomes, usually no measurement strategy is used to evaluate the impact. As a consequence, even though these AUM do not fully comply with the definition of the GIIN, by adopting the international standards for the evaluation of the impact, a large proportion of these capitals might be classified as impact investments.
Therefore, professional investors cover a key role for the evolution of impact investing, and figures show that the volume of AUM integrating ESG criteria in the U.S. has already increased by 66% from 2014 ($5919 billion) to 2018 ($9835 billion) (Gregory & Volk, 2020).
To conclude, the adoption of international principles to manage impact investing will be a key aspect for the evolution of the segment.

1.2.1 The Operating Principles for Impact Investment Management

Being the lack of uniform, international standards still a huge obstacle for the evolution of impact investing, in April 2019 the World Bank Group together with the International Monetary Fund (IMF) launched the Operating Principles for Impact Investment Management. These principles have been adopted by more than 100 professional investors so far, and they represent high quality standards for the management of impact funds.
These guidelines are made of nine core principles[3], which are reported below:

[3] Gregory & Volk (2020).

i. According to their investment strategy, impact investors must set their strategic impact goal. The impact goal must be achievable and proportionated to the size of the investment portfolio, therefore it must be consistent with the adopted investment strategy.
ii. Impact investors must control the strategic impact at portfolio level, even though the impact might be generated non uniformly by different assets composing the portfolio.
iii. Managers must disclose, through official financial and non-financial documents, how they actively contribute to the achievement of the impact objective.
iv. Adopting a systematic approach and using relevant indicators, managers must evaluate the potential impact generated by the investment. In particular, managers must provide information about what type of impact they want to generate, who the beneficiaries are and how relevant the impact is.
v. Managers must be able to manage potential ESG risks and potential negative impacts derived by the investment strategy.
vi. Impact investors must select appropriate tools that allow managers to continuously check whether the real impact generated through the investment is aligned to the potential impact estimated initially. The tools used must allow managers to efficiently collect and manage real time data.
vii. In case of disinvestment, through an exit strategy, managers must consider what effects might be produced over the expected impact generated by the investment.
viii. All the real data collected about the financial and non-financial performances of the investment must be used to improve the efficiency and efficacy of the investment strategy in the future.
ix. All managers must verify the alignment of the investments to these principles, and they must publish a public report, on an annual basis, in order to prove the correct application of these principles.

According to the research published by Gregory & Volk (2020), most of the impact investors using these principles invest in emerging markets, while about 38% invest in Europe and less than 10% in the U.S. and Canada. Moreover, the largest proportion of the signatories of these principles (84%) declared that their strategy was aimed to gain risk-adjusted market returns, while only few investors had a strategy that implied below market returns.

When looking at the industries chosen by impact investors using these principles, some differences can be observed by comparing investments in developed and emerging economies. Financial inclusion, health, education, and green tech are, in order, the first four areas of investment in developed countries. On the contrary, in emerging markets most of the investments are made in the field of financial inclusion, green tech, agriculture and employment generation (see Gregory & Volk (2020)).

Innovative regulations and policies issued by central banks and international institutions are going to have a core function in the near future for the evolution of sustainable investing. Moreover, according to a survey conducted in 2019 by the European Climate Foundation, global warming and climate change are considered important factors by more than 2/3 of the European electors (Uzsoki, 2020).

New regulations will act as drivers to change the current structure of our economies and new taxes, bans and incentives might be set to drive the change to more sustainable economies. In this context, professional investors who manage big AUM will cover a key role in the definition of the capital allocation strategies.

For this reason, in Chapter 2 a focus on the recent European regulation about impact investments is presented. More specifically, the regulation is analysed to understand what the potentials of impact investing in the Real Estate and Green Building industries are.

1.3 Exchange Traded Funds dealing with sustainable finance

The empirical analysis carried out in Chapter 5 is based on the evaluation of the performances of sustainable exchange traded funds (ETFs) operating in the Real Estate and Green Building industries. Therefore, this section provides some information about the current state of the art of ETFs dealing with sustainable investing.

An exchange traded fund "*is a type of security that tracks an index, sector, commodity, or other asset, but which can be purchased or sold on a stock exchange the same as a regular stock. An ETF can be structured to track anything from the price of an individual commodity to a large and diverse collection of securities*" (Chen & Scott, 2021).

The portfolio of an ETF can include shares, bonds, commodities, as well as alternative combinations of different securities. Being traded on exchange, ETFs provide investors the opportunity to buy and sell securities easily, while paying low expenses and commissions.
The prices of ETFs change continuously during trading days, and they are considered more liquid than other investments, such as mutual funds.
Tracking an index, an industry, a currency or other assets, ETFs usually guarantee a good portfolio diversification, even though thematic ETFs might reduce it in the case of the selection of specific industries.
An important distinction is made between actively and passively managed ETFs: the first are usually slightly more expensive than the latter, but they provide investors the possibility to exploit favourable market conditions in the short term by using active trading strategies (McWhinney, 2021).
As mentioned in Section 1.2, the two largest markets for impact investing are North America and Europe. According to the research conducted by Hale (2021) for Morningstar, 2020 has been a disruptive year for the evolution of ETFs dealing with sustainable investing. Indeed, according to the author around 33% of the AUM in the U.S. are now managed according to a sustainable investment strategy. Moreover, the number of sustainable ETFs increased up to 30% in respect to the previous year, and the number of net flows reached a peak of $51.1 billion (Hale, 2021).
The current landscape of sustainable ETFs in Europe is similar to the one observed in the American market. Indeed, an increasing number of professional investors last year recognized the importance of managing ESG risks in their investment portfolios. Moreover, the dramatic change towards sustainability was driven by the recent European regulations published in the field of sustainable investing.
As shown in the report by Bioy et al. (2021), the AUM of sustainable ETFs increased sharply in 2019 and even more in 2020. Indeed, at the end of the year the volume of sustainable AUM reached a peak of €1,101 billion, almost ten times more than the value registered in 2010 (€112 billion). Moreover, the volume of inflows received by these funds in 2020 reached its highest-level, €233 billion, almost two times the number of inflows recorded in 2019.
Overall, the entire segment of sustainable funds in Europe in 2020 was represented by 3196 funds, and Morningstar registered the launch of 505 new sustainable ETFs, as well as the

repurposing of 253 funds, which changed their strategy to become ESG funds (Bioy et al., 2021). These figures relate only to those ETFs (open-end and exchange traded) that by prospectus declare the use of strict ESG criteria in the definition of their investment strategies, as well as those who fix a sustainability objective as core factor of the investment strategy. Therefore, all the funds that integrate ESG factors in a non-compulsory way, and those whose primary intent is not the generation of an ESG impact, are not considered in the analysis published by Morningstar (Bioy et al., 2021).

Another interesting finding is that, apart from having better financial performances during the Covid-19 pandemic crash in March 2020, the best performing ETFs in 2020, in terms of net flows, have been those pursuing an environmental objective related to climate change and the production of clean energy (Bioy et al., 2021).

It is worth to say that an increasing trend among asset managers (such as BlackRock, Amundi, Robesco and BNP Paribas) is the reduction of the portfolio's exposure to non-renewable energies, in line with the Paris Agreement on Climate Change that was signed in 2015.

For what concerns the different types of ETFs, figures show that the number of actively managed funds is dramatically higher than those that are passively managed (22% over the total). While, in terms of sustainability, figures show that 8.6% of the total amount of assets managed by ETFs in Europe at the end of 2020, were represented by ESG assets. Moreover, during the last quarter of the year, around 50% of the total flows in ETFs were allocated to sustainable funds, which also charged slightly lower fees than traditional funds (Bioy et al., 2021).

Morningstar has developed an index called "Morningstar sustainability rating" to measure to what extent ETFs' investment strategies comply with ESG risks' management criteria. The aim of this index, which is computed as an asset-weighted average from 0 to 100, is to measure how much of a company's financial value is exposed to ESG risks. Five categories of risk have been identified by Morningstar, which assigns a score only to those organizations that have at least 67% of their AUM evaluated through an ESG risk rating (Morningstar Research, 2019).

The results of the research conducted in 2021 about the state of the art of sustainable ETFs in Europe, show that the largest proportion of sustainable and repurposed funds are classified in the two highest levels of the ranking scale, therefore in the two levels with the minimum exposure to ESG risks. Only a small proportion of ETFs (less than 10%) are exposed to severe ESG risks (Bioy et al., 2021).

Finally, the research shows that the majority of sustainable ETFs invest in companies with small capitalization and, even though they are usually well diversified, they often present a quite high exposure to specific sectors. For the purposes of this thesis, it is worth mentioning that exposure to Real Estate accounts for less than 10%, and it belongs to the cyclical strategy, which is referred to the exposure to industries that are highly sensitive to market movements and business cycles (Bioy et al., 2021).

To conclude, according to Bioy et al. (2021) more than 50% of the existing sustainable ETFs are equity funds, while the second largest group is represented by fixed income funds, which are continuously increasing because of the availability of many different financial products integrating ESG criteria.

1.4 New risks and opportunities for SMEs with innovative business models: the impact of the Covid-19 pandemic

The Covid-19 pandemic has brought many changes in our societies, and it has highlighted many risks that were not taken seriously into account before this event occurred.

This is also the case with many environmental and social risks that are now considered material under a financial point of view. Therefore, it might be possible to state that this pandemic has changed the way economic actors perceive risks.

Moreover, all the industries have been impacted by the worldwide pandemic, even though with different magnitudes, and the effects of this disruptive event are thought to last in time. As a matter of fact, Accenture presented a research about the impact of Covid-19 over consumers' behaviour, showing that people are even more worried for the state of the economic system and their personal health (Accenture, 2020). Moreover, this survey shows that the demand for non-essential products has fallen dramatically, while an increasing number of consumers have changed their priorities (Accenture, 2020).

Some of the new trends that have recently been observed are a higher attention towards the limitation of food waste, more conscious behaviours while doing shopping, and also an increasing attention to sustainability in the purchase selection procedure. Furthermore, this survey shows that people's habits have changed as well. Therefore, many companies might exploit this unprecedent event to innovate their business models and to give an answer to those social needs that have been arising during these months.

In the last decade, lot of attention has been paid to the evolution of start-up companies dealing with innovative technologies and social challenges. As mentioned by Arena et al. (2018), an arising trend in entrepreneurship is the launch of social tech start-ups, whose hybrid business models combine both financial and non-financial objectives.

These innovative businesses do not operate as traditional for-profit organizations, and neither as charities. On the contrary, they can be defined *hybrid organizations* or *multidimensional enterprises* whose cost and revenue structures depend on the financial, social and/or environmental capitals (Viviani & Carole, 2019). This innovative trend in entrepreneurship has already been observed in 2018, when the researchers counted already the launch of 2 million social impact start-ups in the European Union (Arena et al., 2018).

According to Eurostat, small and medium enterprises (thus, firms with less than 50 and 250 employees respectively), represent the largest proportion of firms in the European Union (Eurostat, 2021). In 2018, 97% of the existing companies in the EU were small enterprises, and it is said that these companies will drive the change towards more sustainable economies, by exploiting the principles of circular economy and the potential of new technologies (Pizzi et al., 2021). Indeed, the success of innovative social start-ups seems to be related to the capability of their business models to develop new products and services that, apart from being profitable, meet relevant social needs that are not satisfied by other existing companies and public institutions (Arena et al., 2018).

In the last decade, in many developed countries it has been observed a dramatic reduction in investments in welfare state, and this phenomenon has led to the rapid spread of new social needs, particularly in the housing, health, energy, food and agricultural industries (Viviani & Carole, 2019). Moreover, as never before, the Covid-19 pandemic has revealed the huge business potentials of these hybrid companies in the most fragile industries of our countries. As shown by Arena et al. (2018), one of the biggest challenges that these multidimensional companies have to face is the access to financial capitals. Indeed, according to the traditional financial approach, these multi-objectives business models might be more expensive and less efficient to manage, if compared to those of traditional companies (Viviani & Carole, 2019). On the other hand, Viviani & Carole (2019) think that having hybrid business models allow these companies to adapt more quickly to disruptive changes and to the needs of stakeholders. Moreover, hybrid companies usually exploit their broader vision over the society's unsatisfied needs in order to tackle business opportunities in specific sectors. This strategy usually gives the chance to develop disruptive innovations (both in products and services), which allow the companies to create new markets, while being fully diversified and without having to face too strong competitors.

Under a financial point of view, these start-ups can decrease their default risk, they can have a stronger cost and revenue structure and they can also reduce their cost of capital, by receiving funds from different types of investors (Viviani & Carole, 2019). As a matter of fact, start-ups working in the field of impact investing can be financed by three types of investors: equity investors, debt investors and donors (Block et al., 2021).

The most interesting finding by Block et al. (2021) for the purposes of this thesis, is the result of the conjoint analysis about the criteria of equity and debt investors in the decision-making process for the purposes of capital allocation.

Block et al. (2021) show that equity investors do pay lot of attention to:

- the characteristics of the funding team
- the relevance of the societal issue targeted by the company
- the scalability of the business model.

On the contrary, debt investors are influenced by:

- the characteristics of the funding team
- the financial sustainability of the business
- the relevance of the societal issue target by the company.

The different attention paid to the scalability of the business model and the financial sustainability of the company, can be explained by looking at the investment's time horizon of these types of investors: while equity investors allocate capital with a long-term strategy (therefore, aiming for an IPO), debt investors are more focused on short-term results and, consequently, on short term financial returns.

To conclude, the role of public institutions setting new laws, combined with the increasing attention to social needs and the environmental protection, is significantly affecting the economic system and the evolution of entrepreneurship. Finally, the increasing awareness over the financial impact of ESG risks (which might affect companies' evaluations, cost of capital, access to funds), is working as an incentive to innovate and generate new value through the creation of hybrid business models.

In the next chapter a review of the recent European regulation about sustainable finance is presented. The second part of the chapter analyses the potential business opportunities arising in the sustainable Real Estate and Green Building industries.

Chapter 2

The international regulations and the evolution of impact investing

2.1 The European regulation as a driver for future sustainable economies

The crucial event that brought the attention of the entire world towards the environmental deterioration and the potential risks of climate change on our economic systems is the Paris Agreement on Climate Change. Signed in December 2015, and entered into force in November 2016, it is the first binding agreement for the control of global warming and the limitation of global emissions.

The financial sector has the huge power to control and move big AUM and to decide the criteria of capital allocation strategies. Therefore, financial institutions, professional and institutional investors belong to the category of economic actors that can effectively affect the change towards more sustainable economies.

Nevertheless, the use of binding international and national regulations can drive this change more quickly and can significantly affect the way investors build and manage their investment portfolios.

The European Commission has released many regulations in the last six years to boost the attention of financial institutions and entrepreneurs towards the need of considering social and environmental objectives while dealing with investment decisions.

According to the European Commission, the climate change phenomenon and the environmental deterioration have not been taken seriously into account by the operators of the financial sector so far (European Commission, 2018). Indeed, the European Commission has declared that the risks related to disruptive events that might occur because of climate change must be considered relevant also under a financial point of view, both in the short

and in the long term, particularly by those financial institutions whose capitals are allocated in companies exposed to high ESG risks.
Moreover, according to the European Commission (2018), insurance companies and banks are among those organizations that currently bear the highest ESG risks, having a huge exposure in capitals of companies whose cost and revenue structures and profitability are strongly vulnerable to the adverse effects of climate change.
Finally, in the last decade financial losses due to extreme natural events have increased by 86%, and it is estimated that almost half of the exposure to risk of the credit institutions in the euro area is directly or indirectly related to the phenomenon of climate change (European Commission, 2018).

2.1.1 Integrating ESG risks and investors' sustainability preferences in investment portfolios: the European Action Plan for a Sustainable Growth

One of the first steps toward a more sustainable economic system in the EU was taken in 2018 with the presentation of the European Commission's Action Plan on Financing Sustainable Growth, which is based on ten actions[4]:

i. the introduction of the EU taxonomy regulation, used to establish a standard European classification system to classify sustainable products and activities
ii. the creation of European standards to label sustainable financial products
iii. the promotion of capital allocation in sustainable projects
iv. the disclosure of information about the sustainability characteristics of financial products and the evaluation of the investors' sustainability preferences when giving financial advice
v. the establishment of high-quality indicators to price efficiently financial products and to evaluate ESG performances
vi. the integration of sustainability parameters in credit ratings and market research, to provide more exhaustive information about the companies' capabilities of managing ESG risks

[4] See European Commission (2018).

vii. the establishment of a uniform law to set the responsibilities of institutional investors and asset managers who evaluate ESG risks in the investment decision process
viii. the integration of risks derived by climate change and environmental risks in the prudential requirements of financial institutions
ix. the establishment of new European guidelines for the disclosure of non-financial information in the organizations' annual reports
x. the intensification of the awareness over the importance of defining short and long-term sustainability strategies at corporate level.

For the purposes of this thesis, the second action is extremely important to guarantee the expansion of the impact investing market. Indeed, as mentioned in Section 1.1, the lack of a uniform definition still represents a huge obstacle for the diffusion of sustainable investments, particularly among retail investors. The use of standardized labels might allow investors to screen the available financial products more easily, and it is said that setting internationally recognized standards would increase the investors' trust toward sustainable investing.

Even the fourth action, which relates to the modification of the MIFID II regulation, is extremely important to boost the European sustainable investing market.

This action has been implemented step by step, first of all with the adoption of the Regulation (EU) 2019/2088, which sets new rules to guarantee that the official documents of all financial products provide sufficient information about the way sustainability objectives, if any, are achieved within the investment strategy.

Secondly, the Taxonomy Regulation (EU) 2020/852, analysed in the next section, has introduced standardized criteria to classify sustainable activities and investments, with the aim to create a class of sustainable financial products to be offered to investors who express some sustainability preferences (European Commission, 2021).

Finally, the commission delegated regulation C(2021) 2616 final issued in April 2021, which amends the previous Regulation (EU) 2017/565, stresses the importance of integrating sustainability preferences when giving financial advice to retail investors, and it introduces the ESG risks evaluation as part of the organizational requisites of financial institutions (European Commission, 2021).

Indeed, according to the previous regulation (EU) 2017/565, financial advisors had to gather information about the investor's knowledge of the investment field and to define his/her personal risk profile. Nevertheless, this suitability assessment process was only related to the definition of the investment's financial objectives, while it did not require to gather any information about the investor's sustainability preferences in terms of social, environmental and governance factors, which might affect the investment portfolio's performances (European Commission, 2021).
Therefore, the new regulation states that, considered the impact that non-financial factors can have on the risk-return profile of the investment, sustainability preferences must be assessed during the suitability assessment process, without never prevailing the investors' personal investment objective, which is the factor that must always be defined at first (European Commission, 2021).

2.1.2 The European framework for sustainable investments: the Taxonomy Regulation

As mentioned in Section 2.1.1, one of the most important regulations issued by the European Commission is the so-called "Taxonomy Regulation" (EU) 2020/852. Published in June 2020 in the Official Journal of the European Union, it amends the previous Regulation (EU) 2019/2088.
The Taxonomy Regulation is a standardized framework providing the criteria that must be applied in the European Union to qualify economic activities and investments as environmentally sustainable[5].
One of the main objectives of this regulation is to tackle the phenomenon of greenwashing and to increase the investors' awareness over the impact of sustainable financial products. Moreover, to boost the market of impact investing in Europe, the European Commission has recognized the importance of reducing market fragmentation and to provide retail investors the appropriate tools to evaluate and compare the available financial products.

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[5] (Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088, 2020)

Specifically, according to the Taxonomy regulation, the investors must be able to gather information about the construction of the investment portfolios and to understand in which measure the investment contributes to the financing of environmentally sustainable activities.

So, what does it mean to be "*environmentally sustainable*" in the European Union? First of all, the objectives that a company should pursue to be considered "*environmentally sustainable*" have been defined in Article 9[6]:

i. *the mitigation of climate change,*
ii. *the adaption to climate change,*
iii. *the protection and the sustainable use of water and marine resources,*
iv. *the shift to a circular economy,*
v. *the control and the prevention of pollution,*
vi. *the restoration and the protection of the ecosystems and biodiversity.*

According to Article 3[7], a sustainable investment is the one that is made in a company whose economic activity contributes to one or more of these objectives, or in organizations that do not compromise any of these targets.

Moreover, according to Article 18[8], these organizations must comply with the minimum safeguards' procedures, which refer to the international principles of the OECD and the United Nations concerning the respect of human and labour rights[9].

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[6] (Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088, 2020).

[7] (Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088, 2020).

[8] (Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088, 2020).

[9] (Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088, 2020).

For what concerns the disclosure of information of publicly traded sustainable investments, Article 5 sets two important rules: firstly, the issuer must provide specific information about the objective(s) in Article 9 that is (are) targeted by the investment strategy.

Secondly, it is compulsory to provide exhaustive information about how and in which measure the sustainable financial product(s) relates to "*environmentally sustainable*" activities. On the contrary, when the financial product does not comply with the Regulation (EU) 2020/852, the issuer must explicitly disclose this piece of information by adding a specific statement (Article 7, Regulation (EU) 2020/852).

Finally, Articles 10-15 provide the specific conditions under which an economic activity can consider itself to contribute *substantially* to one or more objectives in Article 9.

For the purposes of this thesis, the first and the fifth objectives, which relates to the mitigation of climate change and the control and the prevention of pollution, are particularly relevant.

Indeed, these goals involve those companies that, by exploiting the benefits of innovation, can significantly contribute to the reduction of greenhouse emissions in the atmosphere, by pursuing the long-term goal fixed by the Paris Agreement on Climate Change of limiting global temperatures to rise more than 1.5°. Moreover, companies that contribute to the improvement of energy efficient systems and to the reduction of polluting emissions are also considered in this definition. Therefore, firms operating in the Real Estate and Green Building sectors might have the huge potential of adapting their business models to become more sustainable in respect to this regulation.

To conclude, Article 19 of the Taxonomy Regulation defines the technical screening criteria that must be applied by the organizations to quantify their substantial contribution to the defined objectives. In particular, the technical screening criteria must be quantitative measures used to identify how the organizations contribute to the objective(s) in the short and in the long term, which minimum requirements must be met to avoid harmful behaviours, and they must apply the appropriate certification schemes and sustainability indicators (European Commission, 2021).

Overall, the Taxonomy Regulation is one of the key steps for the transition toward sustainable investing, and these standardized criteria will be crucial to guarantee the correct classification of sustainable companies and investments in the European Union.

2.1.3 The European Green Deal Investment Plan and the growth of sustainable investments in the European Union

In January 2020, the European Commission presented the European Green Deal Investment Plan, an official document that sets short- and long-term objectives to transform the economic system of the European Union into a competitive and inclusive economy, based on the efficient use of resources and the complete zeroing of greenhouse emissions.

The plan, which strengthens the importance of shifting to a green economy to reduce environmental deterioration and to contrast the dramatic effects of climate change, covers many different policy areas from sustainable agriculture to clean energy, from sustainable industry to building and renovation, and again from sustainable mobility to climate action.

One of the main objectives of the European Green Deal is to protect and restore the natural capital to secure the European community from severe environmental risks.

This plan, which aims to reach climate-neutrality by the end of 2050, is based on more than €1 trillion assigned to sustainable investments, of which one fourth will be used to finance climate investments (European Commission, 2020).

Such a challenging goal requires the cooperation of many different public and private institutions; therefore, these investments also target private investors managing AUM in strategic industries, such as agriculture and building and construction.

The European Investment Bank, acting as the new EU Climate Bank, is responsible of coordinating these funds, even though the mobilization of this capital (€1 trillion) will take place with the management of four different funds: the European Budget, the InvestEU Fund, the Just Transition Mechanism (which also includes the co-financing from Member States), and the Innovation and Modernisation funds, which have the key role of supporting investments in innovative businesses working in the field of renewable energies and energy intensive industries (European Commission, 2020).

By the end of 2025, the goal of the European Investment Bank is to assign at least 50% of the investments to projects that are related to climate action and environmental sustainability. Moreover, the use of the European Budget will be extremely important to support investments of private institutions in critical, high-risk projects (European Commission, 2020). Therefore, the objective of the European Commission is to use public funds to partially cover the risk that private investors have to bear investing in such projects, as well as to leverage private financing.

In this context, the InvestEU Programme will be the key instrument to support sustainable investments of both public and private institutions, by targeting many different industries.

Even the Action Plan on Sustainable Growth and the EU Taxonomy regulation have a crucial role for the enhancement of sustainable investing among retail and professional investors, who will cover a central position by allocating capitals and by defining their personal investment strategies.

As stated by the (European Commission, 2020) all these tools have been launched with the aim of transforming sustainable finance into the core area of the European financial system, by involving professional and retail investors.

2.1.4 The "InvestEU" Programme

The InvestEU Programme has been established in March 2021 with the Regulation (EU) 2021/523 and it is one of the strategic tools to support the objectives of the European Green Deal Investment Plan, being expected to move more than €372 billion of public and private investments.

The InvestEU Fund is based on "*an overall irrevocable, unconditional and on demand budgetary guarantee provided by the Union budget (…)*" (Regulation (EU) 2021/523 of the European Parliament and of the Council of 24 March 2021 establishing the InvestEU Programme and amending Regulation (EU) 2015/1017, 2021).

This instrument works through the *guarantee agreement*, which is the legal framework used by the Implementing Partner and the Commission to define the conditions of the financing and investment activities[10].

As stated by Article 16, paragraph 1(a), the EU guarantee can be used to finance "*loans, guarantees, counter-guarantees, capital market instruments, any other form of funding or credit enhancement, including subordinated debt, or equity or quasi-equity investments (…)*"

[10] (Regulation (EU) 2021/523 of the European Parliament and of the Council of 24 March 2021 establishing the InvestEU Programme and amending Regulation (EU) 2015/1017, 2021).

(Regulation (EU) 2021/523 of the European Parliament and of the Council of 24 March 2021 establishing the InvestEU Programme and amending Regulation (EU) 2015/1017, 2021).
According to Article 3 of the Regulation (EU) 2021/523, the Invest EU fund shall contribute to specific, well defined objectives.
Firstly, the scope of this fund is to improve the competitiveness of the economic system in the EU by enhancing the efficient use of resources and by boosting innovation and digitalisation among Member States. Secondly, the fund should sustain organizations that apply the principles of circular economy and that promote a more sustainable and inclusive economic growth. All the projects supported by the InvestEU fund must be monitored, as well as the ESG impacts generated by the investments. Thirdly, the fund should contribute to the creation of a sustainable financial system by orienteering private capitals to sustainable investments, in accordance with the principles established in the Action Plan on Financing Sustainable Growth, the European Green Deal Investment Plan and the EU Taxonomy Regulation.
Finally, one of the main objectives of this fund is to support SMEs hit by the Covid-19 pandemic, especially those working in strategic sectors for the economic system of the EU. Moreover, the fund must be used to finance innovative start-ups, by providing the necessary investments and working capital to allow them to scale up. If necessary, the Advisory Hub of the InvestEU fund should also provide advisory support in the field of patents and intellectual property law. To conclude, the fund can be used to finance social enterprises and to support social investments and microfinance.
Overall, the InvestEU Programme covers all the strategic industries of the European economy, which are classified in Article 8 of the Regulation (EU) 2021/523 into four Policy Windows:

i. *Sustainable infrastructure*, which includes investments in mobility infrastructures, renovation of buildings, energy efficiency, improvement of digital connectivity and waste management.
ii. *Research, innovation, and digitalisation*, which includes investments for the development of innovative ideas and product development projects.
iii. *Small and medium enterprises*, which includes financing of innovative firms.
iv. *Social investment and skills*, which includes investments in benefit corporations, social start-ups and social infrastructures related to education, health, and cultural activities.

One of the most strategic areas identified by the InvestEU Programme is the energy sector, which is relevant for the purposes of this thesis that relates to the Real Estate and Green Building industries.

Indeed, Annex II of the (Regulation (EU) 2021/523 of the European Parliament and of the Council of 24 March 2021 establishing the InvestEU Programme and amending Regulation (EU) 2015/1017, 2021) mentions, in the list of targeted investments, those made for the refurbishment of existing buildings and the improvement of their energy efficiency, as well as projects for the development of critical, innovative infrastructures and public facilities.

Therefore, the Real Estate and Green Building sectors have been identified as a key investment area of the InvestEU Programme, being crucial under many points of view. Firstly, public, and private constructions are responsible of a large proportion of the global greenhouse emissions. Secondly, these sectors are essential to guarantee safety among the communities. Finally, thanks to innovation, these industries have been changing quickly by introducing the use of innovative construction materials and techniques.

To conclude, the InvestEU Programme puts lot of attention to the financing of projects that relate to the construction of highly energy efficient private and public infrastructures, as well as to the renovation of existing buildings, whose energy performance can be improved to reduce emissions in the atmosphere.

2.2 Sectors driving the change towards sustainable finance: the Real Estate and Green Building industries

Green building is referred to the design and construction of residential, commercial, and industrial infrastructures that reduce or eliminate negative environmental impacts (World Green Building Council, 2021). Green constructions are designed with the aim to reduce pollution's emissions and to exploit energy efficiently, by adopting renewable energies and using sustainable materials.

According to the available forecasts, the global green building market, which was worth almost €250 billion in 2020, is expected to grow at a compounded annual growth rate ranging between 9% and 13% in the next seven years.

Even though the market is equally split between residential and commercial buildings, the residential sector is expected to increase significantly in the future, driven by national and international regulations about energy efficiency, the increasing awareness of consumers for sustainability issues and the decreasing costs of materials used in sustainable constructions.
Even though analysts present these optimistic future trends, the Covid-19 pandemic has dramatically affected the industry of building and constructions, especially in the EU.
Indeed, according to Eurostat (2021) the overall production in the industry dropped by 5.7% in the euro area in 2020, if compared to the previous year.
The worldwide pandemic has generated the worst economic shock in the EU, where companies operating in the construction industry have cut their activities dramatically because of the restrictions, especially during the first half of 2020 (De Vet et al., 2021). Even in those countries where firms had been allowed to continue their operating activities, they had to face higher costs for security measures and significant shortage issues, because of the effects of the pandemic over supply chains (De Vet et al., 2021).
According to the forecasts, the industry in the EU is expected to grow again at a rate of 4.1% in 2021, 3.4% in 2022 and 2.4% in 2023, by fully recovering in the latter (De Vet et al., 2021).
If compared to other industries that are estimated to grow very slowly (such as aerospace and cultural activities), construction is expected to have the fastest recovery, also thanks to the introduction of the European Green Deal Investment Plan, whose primary goal is to reach climate neutrality by the end of 2050.
The European statistics show that in 2018 Italy was the second country in the EU by number of enterprises working in the construction of residential and non-residential buildings (see Figure 2.1).

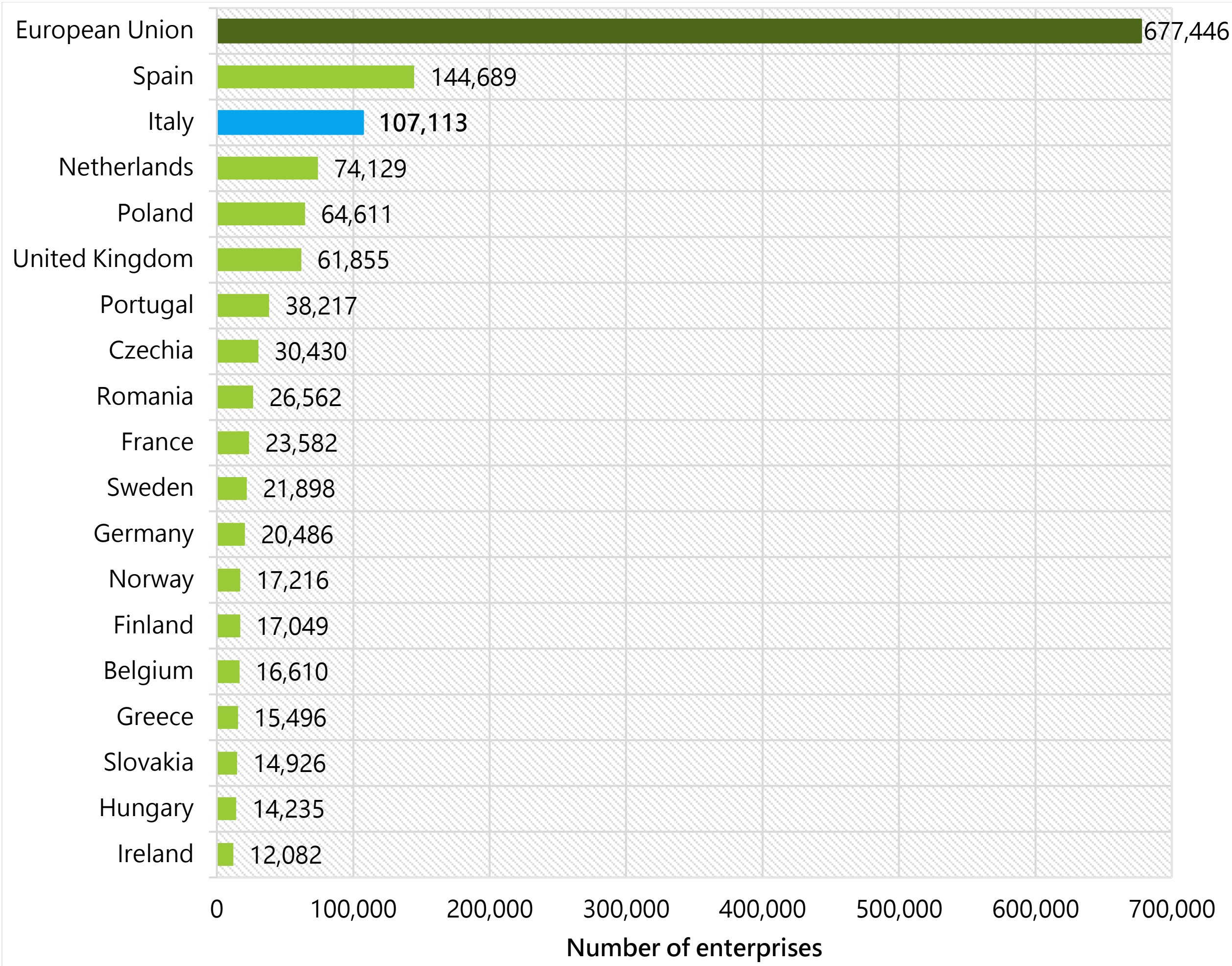

Figure 2.1. Enterprises working in the construction of residential and non-residential buildings (2018). Source: Re-elaborated figures from Eurostat (2021).

While looking at the total production in 2018 (see Figure 2.2), the three countries with the highest value in the European Union were, in order, the UK, Germany and Italy, followed by Spain and France, all with a total production being worth more than €40 million (Eurostat, 2021).

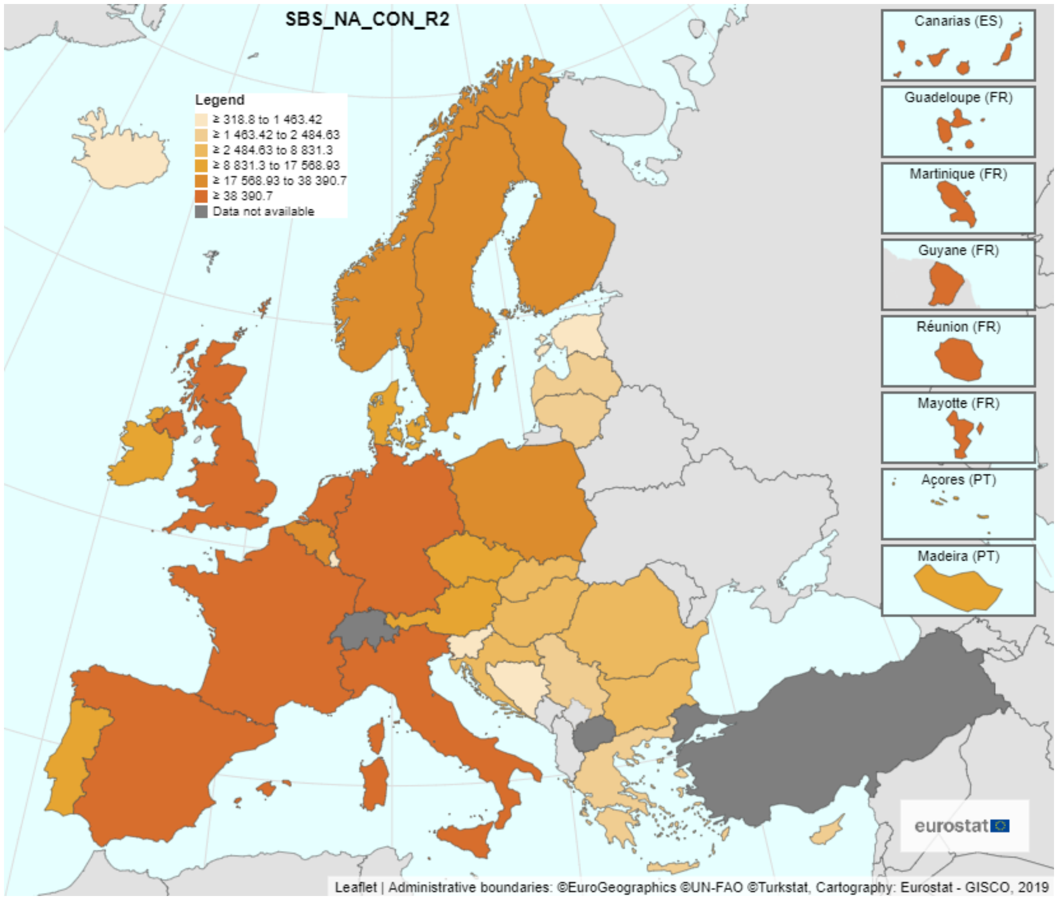

Figure 2.2. Total production value of the industry of construction of residential and non-residential buildings by country in 2018 (in million euro). Source: Eurostat (2021).

The construction and Real Estate industries are highly sensitive to economic cycles and both in Italy and in other European countries they were dramatically hit by the financial crises started in 2009. During the economic drop and, in some countries, also in the following years, the demand for green buildings felt dramatically because of the decreased households' incomes and the increasing poverty rate.

Nevertheless, statistics demonstrate that this shrinkage, which also affected the international Real Estate industry, did not hit all the countries in the same way. For example, in the UK and in Germany a sharp increase of the total production value was registered after 2012, while the industry in Italy started to recover only since 2016 (see Figure 2.3). In that context, an important tool that governments used to boost the industry of green buildings were public incentives, which allowed the market to recover faster in the following years (Dell'Anna & Bottero, 2021).

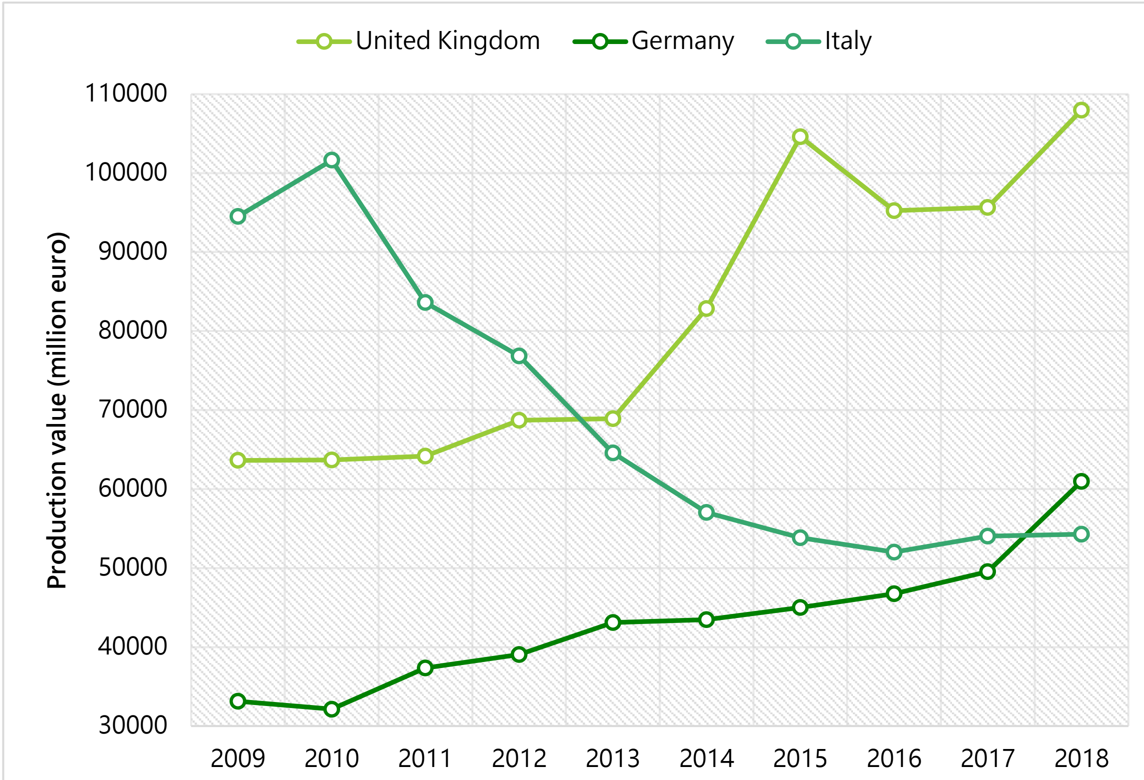

Figure 2.3. Total production value of the construction of residential and non-residential buildings industry from 2009 to 2018 (in million euro). Source: Re-elaborated figures Eurostat (2021).

According to the Centro Studi Federlegnoarredo (2019) there are some key factors that drive the industry of buildings and construction, especially the residential segment: people's available income, the availability of houses fallen into disuse and the demographic growth.
The last factor is of crucial importance for the development of the industry. Nevertheless, the population growth in Europe is stagnant and the drop of the demand for residential buildings in the future represents a huge risk for the industry. Overall, figures prove that the Real Estate industry has been slightly growing only in north European countries, while in southern Europe it has not reached the pre-crisis values yet (Centro Studi Federlegnoarredo, 2019).
The buildings and construction sector now represents one of the strategic industries in the EU, and in 2019 it counted for 9% of the European Union's Gross Domestic Product, by providing around 18 million jobs (De Vet et al., 2021). Nevertheless, it is also one of the most energy-consuming sectors, responsible for 39% of the global CO_2 emissions in 2018, and for 36% of the total energy consumption worldwide (Global Alliance for Buildings and

Construction, International Energy Agency and the United Nations Environment Programme, 2019).

Recent trends show that both energy consumption and emissions have continuously increased in the last few years. The largest proportion of energy consumption (70%) derives from residential buildings, whose demand increased especially for space cooling purposes (Global Alliance for Buildings and Construction, International Energy Agency and the United Nations Environment Programme, 2019).

Moreover, the International Energy Agency declared in a recent report that the majority of the countries still do not have mandatory energy codes, meaning that in 2019 the construction of more than 5 billion m^2 did not comply with any compulsory energy requirement (IEA, 2020). Furthermore, since 2000 the floor space used for construction activities worldwide has been increasing far more quickly, in proportion, than the decline of energy use through the instalment of energy efficient systems (IEA, 2020).

According to the International Energy Agency, the largest proportion of CO_2 emissions, which have been increasing significantly in the last thirty years, is derived from indirect CO_2 emissions, which include those produced by electricity consumption and heating systems installed in commercial buildings (see Figure 2.4).

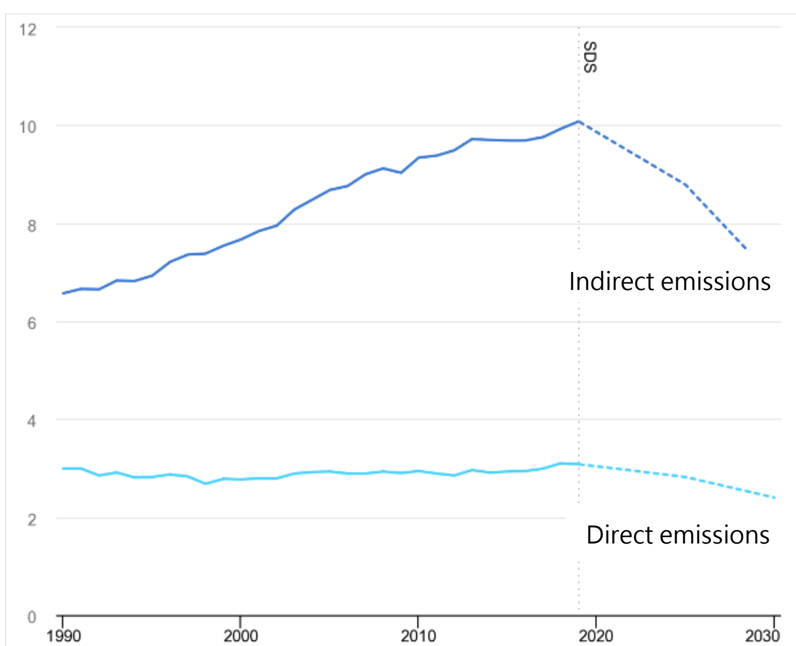

Figure 2.4. Building sector energy-related CO2 emissions in the Sustainable Development Scenario, 2000-2030 (in Gigatons). Source: IEA (2020).

Overall, there are some key factors that contribute to the growing global energy demand, which are the increasing population, the growing floor area and the changes in people's habits, with a rising demand for appliances and cooling/heating systems (Global Alliance for Buildings and Construction, International Energy Agency and the United Nations Environment Programme, 2019). Researchers believe that if nothing is done to reduce the impact of buildings and energy consumption, global emissions will rise by 50% in the next thirty years.
All this considered, it is possible to state that the buildings and construction industry produces huge impacts on the environment through the generation of emissions in the atmosphere, the use of land and the exploitation of energy resources.
Therefore, the decarbonisation of this sector is particularly relevant to reach the objectives set by the Paris Agreement on Climate Change and the European Green Deal Investment Plan, and giant innovations might affect this industry in the future.

2.2.1 A focus on the Green Building industry in Italy

In the last decade, the construction industry in Italy has been characterized by the sharp increase of extraordinary maintenance operations (+44%), while the request for the construction of new residential buildings has fallen (-59%) (Centro Studi Federlegnoarredo, 2019).
Overall, the Italian green building market in 2018 was worth €742 million. The largest proportion of the turnover arose from the construction of residential buildings (79%), while the remaining part was referred to commercial and industrial structures (Centro Studi Federlegnoarredo, 2019). At national level, 3423 green buildings were built in 2018, of which 3147 were residential buildings.
The report published in 2019 by Federlegnoarredo indicates that the green building market in Italy has been growing significantly in the last few years (around 5% per year), and according to the figures, 7.1% of the new residential buildings are now constructed according to the principles of green constructions (Centro Studi Federlegnoarredo, 2019).
At European level, Italy is now the fourth country by production of greenhouses after Germany, Sweden, and the UK.

In 2018 there were 203 small and medium enterprises working in the green building market in Italy. Most of these companies had an annual turnover lower than €1 million (58%) and up to €10 million (37%), while only 5% of the firms registered a turnover higher than €10 million. Therefore, the industry is represented by SMEs, which are mainly based in northern Italy (Lombardia, Trentino Alto Adige, Veneto and Piemonte) (Centro Studi Federlegnoarredo, 2019).

Finally, the reports indicates that the industry is characterized by a huge volume of import of sustainable raw materials (around €148 million in 2018), and a considerably high value of export of greenhouses mainly to Germany, Switzerland, Norway, Croatia, and Algeria. Indeed, the international trade counted for €50 million in 2018, 28% more than the value registered in 2017 (Centro Studi Federlegnoarredo, 2019).

2.2.2 How Energy Performance Certificates enhance the value of real estate assets

Being one of the most strategic industries in the European Union under a financial and environmental point of view, the potential innovations that might be applied to the industry of buildings and construction are huge. Indeed, according to the EU Building Stock Observatory more than 50% of the existing residential buildings in Europe were built before 1970, therefore without any energy efficiency parameter (Dell'Anna et al., 2019). Thus, apart from potential investments for the construction of new residential and non-residential green buildings, the current market's growth mainly depends on the renovation of the existing real estate assets that do not meet energy savings requirements.

The green building market characterizes itself for the use of sustainable materials and innovative building techniques, which might be more expensive for the contractor and, consequently, for the final buyer.

Many researchers have investigated, under a financial point of view, the economic benefits of investing in the construction of green and nearly zero-energy buildings.

For what concerns the contractor point of view (thus, the supply side), it is said that the green building market's growth strongly depends on the green price premium received by investing in this segment, which should be sufficiently high to cover the extra costs of adopting sustainable construction practices (Deng & Wu, 2014).

The research published by Deng & Wu (2014) shows that some differences in price premium can be observed in the pre-sale and the resale phase. In real estate the pre-sale stage is the selling transaction that is concluded before the ultimation of the construction, while the resale stage is the selling that takes place once the building is ready.

By running an analysis of the green building market in Singapore, Deng & Wu (2014) proved that the price premium paid by final customers in the resale stage is far higher (9.9%) than the one paid in the pre-sale (4.1%). This price mismatch is financially inconvenient for the contractor, as the firm should be willing to postpone all cash inflows after the physical delivery of the housing units, with the aim to receive higher returns. Furthermore, by analysing the reasons of this price mismatch, it seems that consumers' willingness to pay in the pre-sale stage is strongly affected by the lack of information about the dwellings' actual energy efficiency. Therefore, the opportunity to materially see the residential units and to effectively evaluate the efficiency of the structures, increase the customers' willingness to pay (Deng & Wu, 2014).

Another interesting study is the one published by He et al. (2019) about the factors that increase customers' willingness to pay for green buildings. The research, which was conducted in Wuhan (China) where this small market has been increasing significantly in the last few years, shows that middle class costumers' willingness to pay is mainly driven by the availability of green areas in the surroundings, the accessibility to public facilities, the neighbourhoods' characteristics, and the availability of indoor water efficient systems.

On the contrary, upper-middle class buyers are more willing to pay for the indoor air quality, the total floor area, the availability of green areas and the thermal characteristics of the dwellings (He et al., 2019). Moreover, some factors such as the potential savings on the cost of energy and public incentives for the purchase of energy efficient buildings, are important benefits that affect customers' willingness to pay in the Real Estate market (Mangialardo et al., 2019).

In the European Union, the same analysis about green price premium has been done by referring to the building energy labelling system that was introduced in 2010 with the directive 2010/31/EU. This directive was published to set the minimum energy requirements for existing buildings object of renovation operations and for new constructions. The original law was amended by the entry into force of the new directive (EU) 2018/844, which has established new requirements in line with the long-term objectives of the EU in terms of greenhouse emissions and climate change (Mangialardo et al., 2019).

Currently, the EU labelling system consists of ten energy classes (A4, A3, A2, A1, B, C, D, E, F and G), where A4 applies to the most efficient buildings and G to the least. In Italy, the largest proportion of existing properties belong to class D or below, while only 1/3 of the constructions have a higher label.

Even though the Italian government has set many incentives to refurbish existing structures, it seems that customers have a lack of awareness about the benefits of renovating energy inefficient residential units; indeed, the number of buildings whose energy class is below D decreased only by 10.7% from 2014 to 2019 (Bisello et al., 2020).

Overall, the same situation is reflected in the European Union, where only 3% of the existing buildings are classified in A and B classes, while 92.1% of them belong to the lowest energy class (Bisello et al., 2020).

In the literature, many studies can be found about the evaluation of green price premiums for investments in sustainable real estate.

Some researchers proved that after the introduction of the mandatory energy labelling system in 2010, the buildings belonging to the first energy classes had a price premium that was three times the one recorded before the entry into force of the directive. Moreover, the new law dramatically affected those real estate assets with very low energy classes (F and G). Indeed, the prices of these properties declined from 13% to 24%, if compared to the most energy efficient buildings (Bisello et al., 2020).

Bisello et al. (2020) investigate the price premium of green buildings in the Italian housing market, and more specifically in Bolzano (Trentino Alto Adige), where the number of structures being labelled A and B is significantly higher than the national average (11% against 7%, according to 2017 figures).

The energy performance certificate seems to significantly affect the price of real estate assets. As a matter of fact, statistically significant price premiums around 6.3% for A-class, 5.4% for B-class and 2.9% for C-class dwellings are observed (Bisello et al., 2020).

Even though the energy certification affects customers' willingness to pay for high energy classes residential buildings, the research also proves that buyers are significantly affected by other factors, such as specific accessibility and location features (Bisello et al., 2020). Moreover, the study does not prove significant price reductions of low energy classes buildings in Bolzano, which usually present peculiar historical features and whose renovation is bound by particular laws for the protection of the artistic and historical heritage.
Another study about the sustainable Real Estate market in Milan (Italy) demonstrates that a significant and positive price premium can be earned for the sale and rent of green residential buildings. This research, conducted by Mangialardo et al. (2019), is based on the comparison between the price of non-certified buildings and those certified according to the LEED rating system, which is an international, worldwide used certification for the classification of green constructions.
According to this research, the prices of residential structures that are certified with the LEED rating system in Milan are from 7% to 11% higher (depending on the LEED's class) than those of non-certified buildings, while the incremental construction costs that have to be borne by the contractor range from 5% to 7% more than those of traditional buildings. Therefore, Mangialardo et al. (2019) proved that a positive return on investment can be obtained by investing in green buildings, as the price premium of sustainable real estate assets is far higher that the exceeding construction's costs.
Another interesting aspect analysed by the authors is the time needed to rent the buildings, which is much shorter for certified constructions, thus, proving a higher customers' preference for this type of dwellings. Indeed, after 30 months, the number of vacant certified buildings is half the number of non-certified dwellings available in the market (Mangialardo et al., 2019).
Finally, the study conducted by Dell'Anna et al. (2019) compares the green price premiums in Barcelona (Spain) and Turin (Italy) from 2014 to 2018, by considering different climate zones as a key factor for their evaluation. According to the authors, the entry into force of the mandatory Energy Performance Certificate (EPC) in the EU has not affected real estate assets' prices in all the countries in the same way. One of the reasons behind this, is the non-standardized application of the European directives, as well as the adoption of different national performance standards. Nevertheless, the most interesting factor analysed by the

authors is the way the characteristics of each climate zone affect the interest of buyers toward EPC and, thus, their willingness to pay for green constructions (Dell'Anna et al., 2019). Indeed, in Barcelona, where the annual average temperature is around 16.5°, the price premium of sustainable real estate assets has been estimated to be around 1.88%. On the contrary in Turin, where the annual average temperature is around 12.6°, green buildings are worth 6.33% more than traditional structures.

Therefore, this study proves that the climatic peculiarities of each zone significantly affect customers' preferences. As a result, in colder regions customers are influenced by the information about buildings' total energy consumption and thermal performances, and they assign more importance to EPC.

To conclude, even though in the past years, before the entry into force of the directive 2010/31/EU, few researchers did not find any correlation between EPC and price premiums in some countries, currently most of the literature agrees about the existence of a positive correlation between price premiums and buildings' energy efficiency classes.

Chapter 3

Analysing impact investing: from risk management to financial performances

3.1 The impact of screening strategies over the financial performances of sustainable investments

This chapter provides a review of the existing literature about the evaluation of sustainable investments' performances and risks. This analysis is a key factor of this thesis, as in the fifth chapter the estimation of the returns of different ETFs will be presented.

According to the existing literature, there are two opposite theories that have tried to explain the trend of the performances of sustainable investments.

The first is based on the well-known concepts of the Modern Portfolio Theory presented by Markowitz in 1952, which argues that incorporating ESG factors significantly reduces diversification and, consequently, the portfolio's profitability.

The second, on the contrary, is stakeholder theory, suggesting that sustainable investments can gain returns higher than or equal to the market, because of the allocation of capitals in more competitive companies.

Therefore, these two theories highlight some of the crucial points that are discussed by researchers when evaluating the performances of sustainable financial products: the diversification risk and the impact of screening strategies over the risk-return profile of the investments.

The construction of a portfolio based on the principles of sustainable investing requires an active strategy to select securities according to specific criteria. The first step is usually represented by the sourcing procedure, which is based on the definition of the geographical areas, the industries and the impacts that must be targeted by the investment.

Secondly, a screening process is used to select securities that satisfy definite requirements under a financial and non-financial point of view. The screening process should consider aspects such as the environmental and social impacts generated through the investment, as well as financial indicators and information about the business strategies of the selected companies.

Pereira et al. (2019) defined the environmental pillar as the way "*a company uses best management practices to avoid environmental risks and capitalize on environmental issues*", the social pillar as "*the measure of a company's capacity to generate trust and loyalty with its workforce, customers and society, while reflecting the company's reputation*", and the governance pillar as the measure of "*a company's systems and processes, which ensures that its board members and executives act in the best interests of its long-term shareholders*" (Pereira et al., 2019).

The definition of the screening criteria and their intensity can vary depending on the objectives set by the fund managers. Common methods used to build sustainable investment portfolios are *positive screening*, *negative screening*, and *exclusion.*

By applying negative screening and exclusion, those companies working in industries that generate negative social and environmental impacts are avoided, as well as industries whose activities are considered harmful for the environment and the society. Some of these are tobacco, weapons, alcohol, gambling, animal testing, adult entertainment and organizations that do not respect human and labour rights (Lee et al., 2010). Nevertheless, these two strategies are not fully aligned with the current concept of impact investing. Indeed, excluding companies operating in harmful industries, or entire unsafe sectors, does not guarantee that the investment portfolio is represented by companies (intentionally) generating positive impacts and mitigating ESG risks.

In contrast, positive screening is usually considered a better strategy to build sustainable investment portfolios, being based on the selection of "best in class" companies that present high ESG scores.

Therefore, on the one hand negative screening and exclusion allow fund managers to build well-diversified portfolios, by selecting securities from a broad bunch of assets. On the other hand, even though positive screening has a greater, negative impact on diversification, this strategy guarantees the selection of companies whose core business is aligned to the principles of impact investing.

One of the main reasons why screening activities have been studied by researchers in the last decade is that they do have a huge impact over diversification and portfolio's profitability. Diversification is, indeed, one of the most important concepts when dealing with the construction of investment portfolios, as it allows the investors to reduce specific risk. Therefore, according to the traditional financial theory, positive screening, the exclusion of specific industries and the consequent reduction of available securities, might be reflected in an increasing idiosyncratic risk beard by the investors (Barnett & Salomon, 2006).

On the contrary, according to stakeholder theory, the selection of companies that are managed through ESG principles can provide higher returns in the long term, as the control over environmental, social and governance issues can increase companies' competitive advantage in the mid and the long term (Barnett & Salomon, 2006).

The research conducted by Barnett & Salomon (2006) suggested that higher returns can be observed when low and high levels of screening intensity are applied to portfolio's construction, while those built with a moderate number of screening criteria are usually characterized by poorer performances (see Figure 3.1).

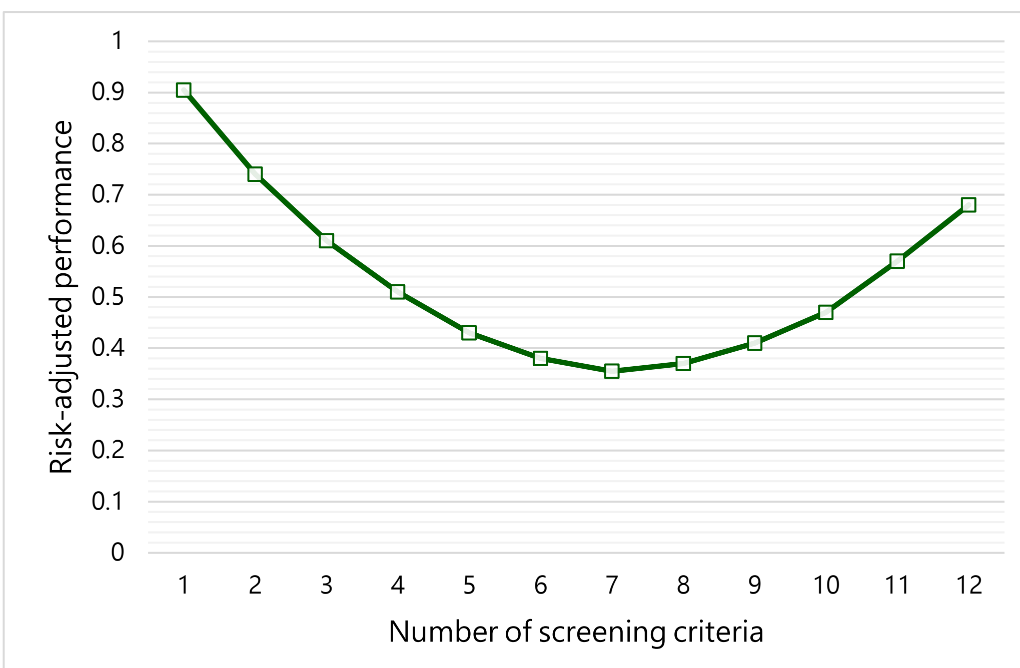

Figure 3.1. This figure shows the non-monotonic effects of screening intensity on the portfolio's risk-adjusted returns (y-axis). The x-axis indicates the number of screening criteria applied to the construction of an investment portfolio. Source: Re-elaborated figures from Barnett & Salomon (2006).

As a matter of fact, Figure 3.1 shows that increasing the number of screening criteria applied to the construction of an investment portfolio might reduce potential returns. Nevertheless, the risk-adjusted returns might still outweigh the cost of applying these strategies if and only if, fund managers are able to detect the sustainable activities that are more efficiently priced in a specific point in time, as well as best ESG-scored companies that exhibit a great competitive advantage (Barnett & Salomon, 2006).

More precisely, by testing different hypothesis, the authors found that screening by the quality of labour relations and environmental criteria produced a negative effect on the risk-adjusted performances (Barnett & Salomon, 2006).

On the contrary, a significant, positive correlation was found between the investment's return and the screening by community relations. This finding was, and still is, in line with stakeholder theory, which states that improving relations between the company and the local community can significantly increase long term financial performances, by providing lower expansion's costs and higher attraction of highly skilled workers (Barnett & Salomon, 2006).

Nevertheless, the rejection of the hypothesis about the existence of a positive correlation between screening strategies based on environmental criteria and financial returns, might have been partially influenced by the weak recognition of ESG risks during the analysed period (Barnett & Salomon, 2006). Indeed, covering the period from 1972 to 2000, it is reasonable to think that environmentally sustainable practices were not still priced correctly in those years. Overall, the research proves that a "U-shaped" curvilinear relationship exists between screening intensity and the investment's financial performances (see Figure 3.1), and that the screening process has a cost for the investors.

In 2010 another research was published by Lee et al. (2010), who focused on the effects of screening intensity over the investment's systematic and idiosyncratic risks. One of the main findings was that the use of a moderate number of criteria (less than six), allowed the investors to reduce the portfolio's standard deviation, while intensifying screening intensity (i.e., using more than six criteria) generated an increasing risk exposure because of the lack of diversification, as shown by the curvilinear relationship between the number of screening criteria and the standard deviation in Figure 3.2 (Lee et al., 2010). Moreover, any correlation was found between the portfolio's idiosyncratic risk and the level of screening intensity.

Nevertheless, a realistic explanation provided by the authors is that the observed reduction of the standard deviation associated to higher screening intensity, might have been due to the intentional selection of low beta securities (Lee et al., 2010). In fact, this strategic choice would have allowed fund managers to compensate the higher portfolio's risk, determined by the lack of diversification, with the lower volatility of low beta stocks.

Therefore, this research proved that screening intensity significantly affects portfolio's returns and that a moderate screening activity does not expose investors to higher systematic and unsystematic risks.

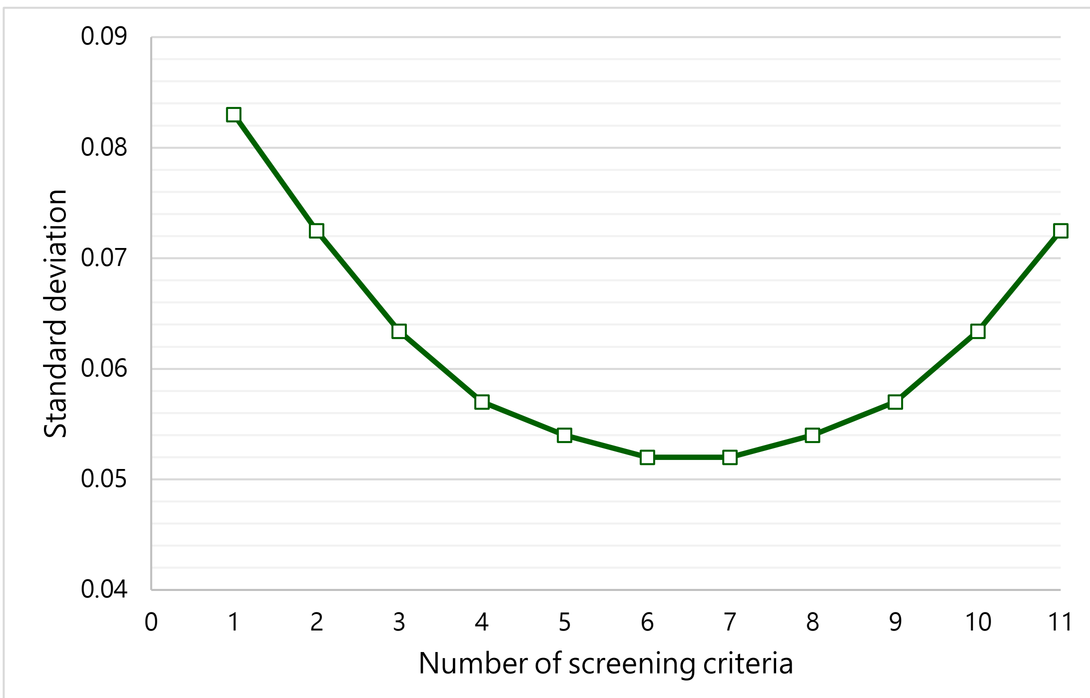

Figure 3.2. This figure shows the non-monotonic effects of screening intensity over systematic risk, measured by the standard deviation (y-axis). The x-axis indicates the number of screening criteria applied for the construction of an investment portfolio. Source: Re-elaborated figures from Lee et al.(2010).

Another research published in 2014 by Ortas et al. (2014) provided an analysis, from 2001 to 2010, of the risk-adjusted performances of two sustainable European equity indexes (DJSI-Stoxx and DJSI-EuroStoxx) and their benchmarks, with the aim to compare their riskiness and to analyse how screening strategies affected their risk-return profiles.

Their findings showed that both sustainable equity indexes did not underperform their benchmarks during the period, but the beta analysis (used as a measure of risk), proved that investors allocating capitals in sustainable indexes had to bear a higher risk.
Analysing the beta levels of these indexes, by using time varying, conditional beta series, the authors found that the risk exposure was influenced by market conditions, as the analysed time series covered both the Dot-com bubble and the Global Financial crises.
Nevertheless, the examination of beta levels, which were always higher than one during the period, led the authors to the conclusion that, especially during bear market conditions, investors were exposed to a higher risk if compared to the market.
This finding was in line with the principles of the Modern Portfolio Theory, indicating that the reduced diversification directly impacts the portfolio's systematic risk (Ortas et al., 2014). Indeed, the higher risk exposure during market downturns, was also influenced by the exclusion of "non-ethical" industries, which are usually less sensitive to negative market conditions.
Finally, by using three different multi-factor models, Lesser et al. (2016) analysed more than 200 equity funds in the period from 2000 to 2012, by comparing the returns of green and socially responsible funds recorded in bull and bear market conditions.
Overall, their results suggested that green funds tend to perform as traditional benchmarks during downturns, while they underperform significantly during expansion periods. On the contrary, socially responsible investments show a negative performance both in bear and bull market conditions (Lesser et al., 2016).
This discrepancy depends on the type of screening strategy applied. Indeed, apart from confirming that screening significantly affects investments' performances, it was also demonstrated that during the analysed period, screening by environmental criteria allowed the investors to obtain far higher returns than social criteria (Lesser et al., 2016).
Consequently, their result is coherent with the theory presented by Barnett & Salomon (2006) and Lee et al. (2010), who stated that fund managers must understand which screening criteria are more efficiently priced in a specific point in time, as they generate different impacts on the investments' performances. Thus, the largest proportion of the past literature, proves that screening strategies and their intensity significantly affect the financial performances of investments by increasing diversification risk.

Nevertheless, more recent academic research, also demonstrates that the impact of screening strategies has been varying due to the changing perception over ESG risks, and the recognition of the economic relevance of sustainable practices.

As a matter of fact, Henke (2016) performed an analysis of the returns of a sample of 103 socially responsible bond funds, based in the U.S. and in the Eurozone, between 2001 and 2014. His research demonstrates that ESG screening explains 8%-10% of the variation of the returns of these funds, which significantly outperformed conventional funds during the selected period.

The observed excess returns are, according to Henke (2016), a further evidence that sustainable investments are likely to be used as hedging instruments during financial downturns, as the overall outperformance of socially responsible bond funds over conventional ones, strongly depended on the occurrence, during the period, of three crises (the Dot-com bubble, the 2007 Global Financial Crisis and the European Sovereign Debt crisis). Moreover, a deep analysis of the distribution of these funds, shows that negative screening, thus, the exclusion of securities with the lowest ESG scores, was the most applied strategy among SRI bond funds.

By comparing socially responsible funds using ESG screening strategies and those not applying the screening procedures, the author found that the excess returns of the former were significantly higher than the latter; hence, proving that screening strategies generated a positive systematic effect on the returns of bond funds, especially during bear market conditions (Henke, 2016).

Finally, in December 2018 the global asset management company Amundi published a research that demonstrates how financial markets have recently started to appreciate specific screening criteria. The analysis covers an eight-year time series, which was split into two periods: the first from 2010 to 2013, and the second from 2014 to 2017.

The results clearly demonstrate that the application of ESG screening strategies had a negative or neutral effect on the investments during the first half of the period. In contrast, the use of screening strategies provided a positive excess return in the second period, especially in Europe, where selling worst-in-class and buying best-in-class stocks generated up to 6.6% excess return (Bennani et al., 2018).

Even more interesting is the result of the separate analysis about the impact on financial performances of applying environmental, social or governance screening, which showed that from 2014 to 2017 environmental criteria were those generating the highest positive impact over risk-adjusted returns (Bennani et al., 2018).
Conversely, screening by governance criteria did not generate neither positive nor negative returns, while social criteria seemed to negatively affect the investments' performances.
Therefore, this literature review proves that most researchers agree on the negative effects of too intense screening strategies, which would dramatically reduce portfolios' diversification and its profitability, while increasing unsystematic risk.
Moreover, this analysis shows that the impact of screening is not homogeneous, as the effects of applying environmental, social and governance criteria are different depending on their intensity, the time, and the geographical area in which they are used.
The recent appreciation of environmental criteria and their positive impact on portfolios' performances, is an example of how changes in risks' perception can also affect the way investments are evaluated.
To conclude, screening strategies should be used to optimize investment portfolios and researchers suggest applying moderate screening intensity, in order to preserve investors from an avoidable, considerably high exposure to diversification risk.

3.2 Impact investing and the mitigation of risks

There are multiple reasons why investors might decide to allocate their capitals to impact investments, but two are considered particularly important: ethical motivations, which imply the willingness to avoid investments in harmful industries, and the mitigation of long-term risks that might not be considered when investing in traditional financial products (Bennani et al., 2018).
Several studies have contributed to the analysis of how sustainable investing can mitigate different sources of risk. Indeed, retail, and professional investors have recently recognized the impact of ESG risks, which might significantly affect the financial performances and the stability of different economic actors.

Allianz Global Investors (2019) defined different risks associated to ESG factors, such as:

i. Macro risk: the risk associated to systemic events (such as environmental phenomena and climate change) affecting the global economy by generating cross sectoral, negative impacts.
ii. Sectoral risk: the risk of an entire industry to drop because of the systematic exposure to environmental and social risks. This threat is usually associated to those industries that generate negative externalities; therefore, it can be managed through the application of negative screening strategies.
iii. Issuer risk: the higher exposure to downside risk and the greater probability of a company to underperform due to governance and environmental issues that are not efficiently controlled by the organization.
iv. ESG portfolio risk: the risk of recording extreme losses due to the presence in the portfolio of underlying assets particularly exposed to unforeseen events in the social, environmental and governance spheres.
v. Regulatory risk: the potential negative implications caused by the introduction of new international regulations and national laws impacting on the company's core and operating business.

The urgency of considering ESG macro risk has also been studied by the 2018 Nobel prize in economics William Nordhaus, who presented his research about the integration of climate change as a risk factor into a long-run macroeconomic analysis.

Nordhaus declared that climate change will inevitably affect the availability and the price of natural resources, and that the technological change will play a central role to guarantee that the future economic growth will satisfy human needs, while also protecting the environment and the available natural resources (Nordhaus, 2018). Moreover, climate change is now recognized as a source of macro risk, as it involves many different industries and disciplines, many of which are also highly interconnected to each other.

According to Nordhaus, the use of policies and regulations and the introduction of penalties for those (countries and companies) not adhering to international agreements, might be the fastest and most efficient solution, in the short term, to control the dramatic phenomenon of global warming (Nordhaus, 2018). Indeed, the price of natural resources and the penalties' amount should be estimated according to the cost of the generated negative externalities (i.e., global warming).

As a result, sectoral and issuer risks might become even more relevant in the near future, and the increasing cost structure of those companies who will not comply with the new regulations might dramatically reduce their profitability.

The research conducted by Allianz Global Investors (2019) highlighted that portfolios with low ESG scores usually present a higher kurtosis, thus exposing investors to financially material extreme events and tail risk. Therefore, the increasing awareness over the potential impacts of ESG risks has led many researchers to study their introduction as an innovative risk factor in models for cross section of stock returns.

The cross-sectional analysis is used to understand, in a specific point in time, which factors (independent variables) explain the variation of individual assets' prices and returns.

Some of the most famous models are the Capital Asset Pricing Model (CAPM), which is a one factor model based on the assessment of the risk measured by the beta, and the Arbitrage Pricing Theory (APT), which is a multi-factor model based on the use of multiple macroeconomic and firm-specific risk factors, which explain the variation of expected returns and assets' prices.

Recently, traditional models have been proven to be inefficient in explaining the variation of excess returns, as new risk factors are now influencing the evaluation of financial assets. Therefore, already in 1992, the Fama and French three-factor model was presented as an expansion of the CAPM, and in the last decade it was expanded again to consider the impact of new risk factors.

Bennani et al. (2018) and Maxfield & Wang (2020) conducted extensive research about the role of sustainable investing as a risk mitigation tool. More precisely, Bennani et al. (2018) tested four different factor models, based on three (environment, social and governance), five (size, value, momentum, low volatility, quality), six (size, value, momentum, low volatility, quality and ESG), and eight factors (size, value, momentum, low volatility, quality, environment, social and governance).

The results of this study demonstrate that ESG are emerging as relevant risk factors, especially in North America and in the Eurozone, where they describe the largest proportion of the investments' excess returns variation (Bennani et al., 2018). Conversely, the performed

regressions show a slightly positive impact on the performances and the risk of the assets exchanged in developed countries outside the Eurozone.
In another research, Maxfield & Wang (2020) analysed to which extent the selection of assets according to ESG principles can affect portfolio's risk. The authors selected a sample of almost 6000 equity mutual funds based in the U.S. between January 2016 and June 2020, all presenting the Morningstar sustainability score. Furthermore, the standard deviation, the beta (as a proxy for systematic risk), and the standard deviation of the residuals from the CAPM (as a proxy for idiosyncratic risk), were chosen as measures of risk and dependent variables in the performed regressions.
In order to assess the impact of sustainable investing on portfolio's risk, the authors applied a multivariate generalized linear model based on nine factors (independent variables)[11].
Firstly, they proved that all three risk measures are negatively correlated to the Morningstar sustainability score, especially in actively managed funds, meaning that increasing the portfolio's exposure to sustainable investing reduces the funds' total risk, particularly during market downturns (Maxfield & Wang, 2020). Moreover, they demonstrated that even corporate social responsibility practices are negatively correlated to the considered measures of risk. Thus, companies investing in sustainability have recently been able to decrease their overall risk exposure.
These findings are coherent with stakeholder theory, suggesting that the assets' selection according to ESG factors allows the investors to exclude companies that might suffer severe extreme events and negative market shocks related to ESG issues.
These results are particularly relevant in all the countries where a stakeholder-oriented approach is applied, and where these practices are recognized as an efficient risk management strategy to reduce litigation risk, employees' turnover and companies' cost of capital, as well as to increase customers loyalty and employees' productivity and satisfaction (Maxfield & Wang, 2020).

[11] The selected independent variables are the Morningstar sustainability score, the size of the fund, the age of the fund, the portfolio concentration ratio, the fund turnover ratio, the leverage, the manager tenure, the monthly net fund flows and the percentage of assets owned by the management team (Maxfield & Wang, 2020).

The importance of managing ESG risks has also been discussed by Henke (2016) and Hoepner et al. (2020), who declared that a negative ESG exposure might also led to other threats, such as reputational, operational, social, default and financial risks.

By analysing the impact of stakeholder engagement strategies over companies' downside risk, Hoepner et al. (2020) found that, in the last decade, environmental issues have gained the highest attention from the investors, and that engagement over environmental practices has a slightly positive, significant effect in the reduction of the downside risk. On the contrary, stakeholder engagement over social and governance issues does not significantly affect downside risk.

The same findings were shown by Reboredo & Otero (2021), who proved that investors' sensibility to climate risk has been increasing significantly, by affecting the capital inflows to equity mutual funds based in the U.S. Therefore, even though investors still recognize the profit potentials of investments related to fossil fuels, many of them prefer shifting their capitals to mutual funds that better control climate risks.

Finally, Cerqueti et al. (2021) discussed how sustainable investing can be exploited for the purposes of risk management to reduce the exposure to contagion risk, which is the risk of negative shocks affecting single organizations or industries, to spread to entire industries or to financial markets.

The sharp growth of interdependency among different markets has dramatically increased this risk at international level, and both during the 2007 Global Financial Crisis and the Covid-19 Pandemic the risk of contagion has led many financial institutions and companies to suffer from huge financial losses.

Cerqueti et al. (2021) demonstrated that during the period from March 2016 to June 2018, funds presenting high ESG scores suffered lower financial losses than traditional funds.

One of the most important findings of this research, is that the impact of contagion risk in ESG funds seems to be lower because of the different behaviour of investors choosing these assets. Indeed, while traditional funds might experience fire sales, especially during bear markets, ESG funds are less sensitive to this risk in case of financial distress, even because of the long-term oriented approach that usually characterizes this investments' class.

To conclude, allocating capitals to sustainable investing might become a strategic choice to mitigate risks that have recently become financially material.

Moreover, sustainable investing might expose investors to higher diversification risk due to the strict securities' selection that must be performed to guarantee high ESG standards, as well as the pursuit of non-financial objectives alongside financial returns. Nevertheless, there are risks, such as litigation, climate, and ESG, which are not always efficiently priced when investing in traditional financial products.
ESG and climate risks, in particular, have been recognized as financially material for most of the existing financial and non-financial institutions. Moreover, the impact of extreme negative events associated to environmental, social and governance factors might be catastrophic for many existing organizations, whose profitability and total financial value are exposed to severe tail risks.
The literature review that has just been presented highlights an increasing attention of researchers and practitioners over the need to implement new financial models embedding ESG risks. Moreover, accounting for environmental risks has become a priority in some geographical areas, such as the Eurozone and North America, even though the perception over the seriousness of ESG risks is not geographically homogeneous yet.
Overall, new dynamics affecting the way environmental issues are treated, will also affect the cost of capital, the profitability, the competitive advantage, and the overall financial stability of many existing companies. As a result, sustainable investing might become a core asset class to hedge against these risks.

3.3 The financial performances of sustainable investing: a literature review

In this section a literature review about the financial performances of impact investments is presented. The review covers the academic research published in the last twenty years, which is a significant period for the discussed topic, as it includes the analysis of the impacts of the major global crises (the Dot-Com Bubble, the Global Financial Crisis, the European Sovereign Debt Crisis, and the Covid-19 Pandemic).

Moreover, as mentioned in Section 3.2, during the last decade the perception over the urgency of considering non-financial risks has been changing dramatically, as well as the economic relevance of environmental, social and governance practices.

The analysis of the financial performances of sustainable investing has always been considered by researchers and practitioners a key aspect for the evolution of this asset class. Evaluating the returns of sustainable investing involves considering many different factors. Firstly, the intensity with which companies integrate ESG factors and pursue sustainability practices is not homogeneous and, especially among investment funds, it is quite common to observe significant changes in the amount of AUM allocated to sustainable investing, which might determine, over time, a portfolio construction more similar to traditional funds (Auer & Schuhmacher, 2016). Therefore, the use of official ESG scores (such as the Morningstar Sustainability Rating), allows the analysts to classify and study organizations according to their exposure to non-financial activities.

Furthermore, even though many researchers have tried to analyse expected returns of sustainable investing at global scale, the literature proved that geographical differences are relevant in the evaluation of the financial performances of these investments.

Finally, in order to evaluate the returns and to perform efficient comparisons between sustainable and traditional investments, the analysis must consider the different behaviour of returns during bear and bull market conditions.

The following literature review is split in two periods: the first covers the academic research about the analysis of the performances from 1992 to 2018; while the second period goes from 2018 to 2021, thus covering also the most recent global crisis due to the Covid-19 Pandemic.

3.3.1 Literature review: from 1992 to 2018

The academic research that covers the period from 1992 to 2018 is manly driven by the idea that sustainable investing performs as well as, and in some circumstances worse, than traditional investments.

Becchetti et al. (2015) presented an analysis covering figures from January 1992 to April 2012, which is a significant period as it includes both the Dot-com bubble and the 2007 Global

Financial Crisis, showing that the performance of socially responsible funds (SRFs) was similar to the one of conventional funds.

Nevertheless, a more careful analysis during the two global crises highlighted that, while SRFs did not outperform conventional funds during the Dot-com bubble Crisis, they performed much better during the 2007 Global Financial Crisis. Therefore, according to the authors, this different behaviour of the returns might have been affected by the change in the way sustainable investing was perceived: a hedging instrument to protect investors from ethical risk factors, which usually generate the most negative consequences during financial crises (Becchetti et al., 2015).

Furthermore, by applying the five-factor model, they proved that significant geographical differences exist in the performances of sustainable investments. Indeed, a clear outperformance of SRFs was found in Europe and Asia, especially during bear market conditions, even though these funds were also more exposed to systematic risk than traditional funds.

The same results were proven by Cortez et al. (2012) who performed the analysis from August 1996 to August 2008, showing that SRFs performed as well as traditional funds in Europe, while they significantly underperformed in the U.S.

Moreover, by applying the Fama and French three and five-factor models, they found a significant exposure to the size factor, which measures the sensitivity of funds' returns to the size of the companies' market capitalization. Indeed, SRFs in those years were mainly investing in small-capitalized companies, while large firms were usually excluded because of the applied screening criteria (Cortez et al., 2012).

Other two studies conducted by Auer & Schuhmacher (2016) and Azmi et al. (2020) using figures from 2004 to 2012 and from 2002 to 2013 respectively, confirmed that SRFs tend to perform better than conventional funds when markets are bear, while in the post crisis periods their returns tend to perform similarly to traditional funds in the Asia-Pacific region and in North America.

Geographical differences affecting the performances of sustainable investments have been studied by many researchers, as cultural aspects related to the recognition of ESG risks, and differences in the financial evaluation of corporate social responsibility practices, represent relevant obstacles to the development of this asset class in some countries.

Therefore, the research conducted by Badìa et al. (2020) covering a timeseries from January 2005 to December 2014, provides a deep analysis of the financial performances in five different regions: North America, Europe, United Kingdom, the Pacific region[12] and Emerging Markets[13].

In the selected period, the authors found that the global sustainable portfolio performed as well as the S&P 500 index. Nevertheless, using a conditional six-factor model, which also differentiates bull from bear market periods, they proved that the financial performance of the sustainable portfolio was geographically dependent. Indeed, while in bull markets returns were comparable to those of the S&P 500, they tended to underperform significantly in the UK, in Emerging Markets and in the Pacific region in case of financial distress.

This result is coherent with the well-known cultural differences about the recognition of sustainability and CSR practices. Indeed, only in Europe and in North America, where they are recognized as a source of financial benefit instead of an additional cost, firms listed in the global sustainable portfolio outperformed the traditional benchmarks, while performing neutrally during market downturns (Badìa et al., 2020).

Two other pieces of research analysed the existence of abnormal returns and the hypothesis about the mispricing issue.

Mollet & Ziegler (2014) tested three different hypotheses:

I. the increasing interest for sustainable investing generates the rise of stock prices, making sustainable securities overpriced in respect to conventional stocks;
II. the weak recognition of the investors of the financial benefits provided by CSR practices in the economic performance of the company, generates the underpricing of sustainable securities;
III. sustainable securities are not mispriced as, according to the traditional financial theory, when capital markets are efficient and demand curves are elastic, ESG factors do not influence companies' cost of capital.

[12] Australia, Hong Kong, Japan, New Zealand and Singapore.

[13] Brazil, India, South Africa, South Korea and Taiwan.

The analysis proved that from January 1998 to April 2009 no statistically significant abnormal returns were found in the European and the American stock markets, while confirming the third hypothesis according to which sustainable stocks are correctly priced by investors.

More recently, Pereira et al. (2019) tested two different hypotheses about the mispricing of sustainable securities.

Firstly, the shunned stock hypothesis, which states that traditional securities exhibit higher returns because of the reduced number of investors choosing these assets, while the increasing demand for sustainable securities leads their prices to increase, therefore experiencing lower returns.

The second, more realistic, hypothesis is the errors in expectations, therefore the presence of temporary abnormal returns given by the difficulties of financial actors in pricing the value of intangibles.

According to Mollet & Ziegler (2014) and Bebchuk et al. (2013), the presence of abnormal returns due to investors' errors in expectations was an observable phenomenon before 1998, when the learning process about the benefits of corporate governance practices over the companies' economic performances was still weak.

Nevertheless, the analysis performed by Pereira et al. (2019) proved that from 2003 to 2007 investors going long on high ESG securities and short on those with low ratings, would have earned higher significant positive returns, compared to traditional investments, and the same result was found by Kemps and Osthoff (2007) and by Statman and Glushkov (2009).

Nevertheless, these abnormal returns were not significant anymore after 2007, showing that the beginning of the global financial crisis also marked the end of the investors' learning process about the relevance of ESG factors (Pereira et al., 2019).

To conclude, Leite & Cortez (2018) decided to analyse the performances of SRFs investing in fixed income in Europe by using a time varying, conditional multi-factor model.

This study covers the period from February 2002 to December 2014 and it differentiates the performances of SRFs investing in bonds (SR bond funds) and those investing also in stocks (SR balanced funds).

During the selected period, SR bond funds performed significantly better than conventional bond funds, while no significant difference was found between SR and conventional balanced

funds. Moreover, the authors proved that SR bond funds were also less exposed to default risk and to bonds issued by the GIIPS[14] countries during the European Sovereign Debt crisis. Finally, by separately analysing the returns of funds investing exclusively in corporate bonds, and those investing also in government bonds, they confirmed the findings of Henke (2016), thus that the presence of government bonds and the exclusion of those issued by companies with low ESG scores, explained the better financial performances of SR bond funds.
The significant outperformance of sustainable bond funds during bear markets (especially in Europe and North America), was also confirmed by the studies of Henke (2016), Nofsinger and Varma (2014) and Lins et al. (2015).
In conclusion, most of the academic literature prior 2018 proves that sustainable investing performs better than traditional investments when markets are bear, especially in North America and Europe, where these securities are considered an efficient hedging strategy in case of financial distress.
The geographical dependency of the returns of sustainable investments is proved by the different performances observed in bull market conditions. Indeed, while they underperform significantly in Emerging Countries and Asia, no significant difference was found in Europe and North America, where they performed as well as conventional investments.

3.3.2 Literature review: from 2018 to 2021

The most recent literature about the performances of impact investing is driven by the idea that sustainable finance can be exploited as a hedging strategy to reduce financial losses during market downturns. Moreover, recent research proves that achieving social and environmental goals can provide higher financial returns, by generating an *impact alpha*.
The Impact Capital Managers (ICM) network, which is a group of venture capital and private equity funds, defined *impact alpha* as an innovative concept which embeds the opportunity to exploit high quality investments, the possibility to create value by developing more effective businesses and accessing more differentiated sources of capital, and the chance to strengthen companies' outcomes by managing risks more efficiently and reducing the cost

[14] Greece, Italy, Ireland, Portugal, and Spain.

structure Bell et al. (2018). The generation of the *impact alpha* is related to the efficient exploitation of different drivers, such as the opportunity to allocate capitals in niche, high growth markets and to optimize ESG and reputational risks.

The drivers represent multiple sources of financial value, having a direct impact on periodic revenues, company's cost of capital, downside risk, company's operating costs and revenues' volatility rate (Bell et al., 2018).

Recently, the performances of the firms listed in the Morningstar Sustainability Index have been proven to significantly outperform the traditional benchmarks in the period from 2010 to 2017 in Europe and Asia, where the excess returns were driven by a considerable exposure to the energy, the communication, and the technology sectors (Morningstar Inc., 2018).

Conversely, in the U.S. the Morningstar Sustainability Index underperformed, due to the exclusion of high growth stocks (such as Apple, Amazon, Facebook) and a significant exposure to consumer cyclical stocks, which did not perform well during the analysed period.

Recent figures confirm that 75% of sustainable indexes are formed by stocks of companies which have a greater sustainable competitive advantage, which generates higher excess returns than traditional companies (Morningstar Inc., 2018).

Moreover, more than 50% of them also show a better financial health factor, which measures the default risk based on the leverage and equity volatility. Therefore, these peculiar characteristics might drive the rise of future returns of these alternative asset class.

In a research published by Miralles-Quiròs et al. (2019), the authors studied the impact of adding an investment in sustainable ETFs into a stock-bond portfolio. The analysis covered daily returns of six ETFs which were selected according to the amount of AUM allocated to specific sustainable development goals.

Thus, the selection included ETFs investing in good health and well-being (goal 3), clean water and sanitation (goal 6), affordable and clean energy (goal 7), decent work and economic growth (goal 8), industry, innovation, and infrastructure (goal 9), and responsible consumption and production (goal 12). Moreover, two traditional stock-bond ETFs were selected as benchmarks (the SPDR S&P500 ETF and the iShares Core U.S. Aggregate Bond ETF).

The summary statistics of the 1-year out-of-sample analysis, computed using the Capital Allocation Line and the Risk Parity allocation strategies, show that three out of six and five out

six ETFs performed better than the benchmarks. By extending the out-of-sample analysis to 5 years (June 2013 – March 2018), the statistics show that all sustainable ETFs performed better than traditional, confirming the longer-term strategic approach of sustainable funds.
Moreover, using the standard deviation of the returns as a measure of the volatility, all the selected ETFs (both sustainable and traditional) exhibit similar values, while the Sortino ratio, which measures the negative deviation of returns from the mean (the downside risk), is far higher in sustainable ETFs when the Risk Parity allocation strategy is used.
Furthermore, comparing descriptive statistics of conventional and sustainable ETFs, the latter show a higher negative skewness, and a lower positive excess kurtosis (leptokurtosis), therefore a greater exposure to negative excess returns and a lower tail risk (Miralles-Quiròs et al., 2019).
According to the authors, one of the main findings of this research is that adding sustainable ETFs in a stock-bond portfolio can significantly increase excess returns, especially when choosing ETFs that target goals 8 (decent work and economic growth), and 9 (industry, innovation, and infrastructure) (Miralles-Quiròs et al., 2019).
While the previous research did not analyse the different behaviour of returns during bear and bull markets, as mentioned in Subsection 3.3.1 a large proportion of the academic research is focused on the study of the performances of sustainable investments during market downturns, as these securities seem to be negatively correlated to traditional asset classes and, therefore, to be potentially used as hedging instruments when markets are bear. Thus, the Covid-19 crash and its devastating impacts over the global economy, represent a new opportunity for researchers to study the returns of these investments, with the huge difference, compared to the last Global Financial Crisis, that the market of impact investing has been increasing dramatically, having been worth almost $30 trillion in December 2020.
Moreover, as shown in Figure 3.3, the overall amount of cash flows to sustainable funds has been growing sharply in the last year, proving that today’s market of sustainable investments is much more mature and attract far more interest from international investors, if compared to the past.

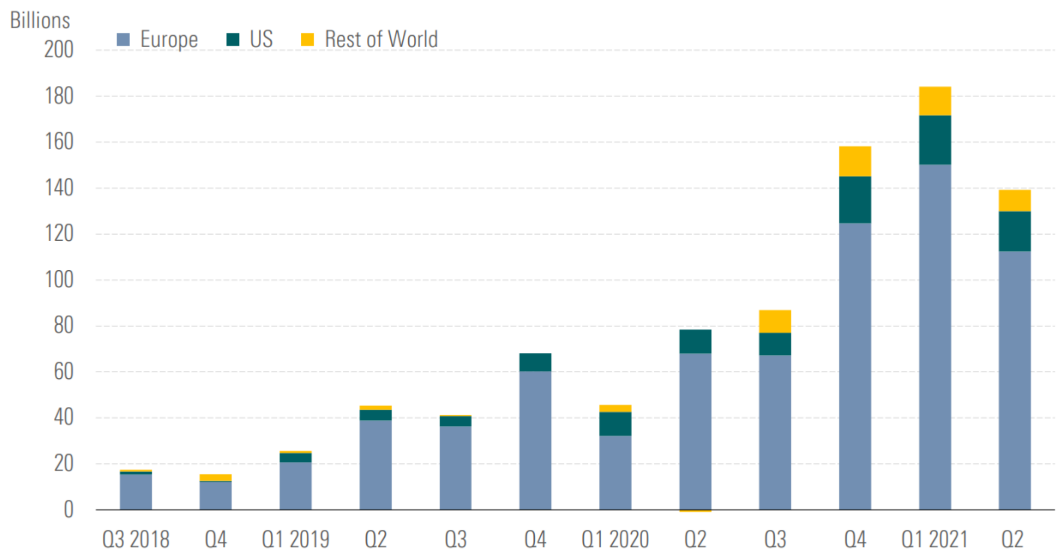

Figure 3.3. Quarterly Global Sustainable Fund Flows (USD Billion). Source: Morningstar Direct, Manager Research. Data as of June 2021.

The recent literature is still divided between research that proves the outperformance of sustainable investments, and that which considers this alternative asset class to perform as well as traditional investments.

Therefore, starting from the latter, some researchers such as Omura et al. (2020), Pavlova & de Boyrie (2021) and Folger-Laronde et al. (2020) did not find any outperformance of ESG ETFs during the Covid-19 crash.

Indeed, Omura et al. (2020) used the Fama and French five-factor model to study the returns of four MSCI SRI Indexes and twenty-four ESG ETFs based in the U.S. from January 2018 to June 2020. Their results show that in Europe and in the U.S., the MSCI SRI Indexes performed significantly better than conventional ones, especially when financial markets crashed because of the announcement of the pandemic.

On the contrary, ESG ETFs never performed better than conventional funds during the selected period, probably due to an incorrect use of positive and negative screening strategies and the application of fees (Omura et al., 2020).

Pavlova & de Boyrie (2021), who performed the analysis from November 2019 to May 2020, found that ESG ETFs had outperformed conventional in the pre-crisis period, when especially funds investing in clean technology (renewable energies, waste management, sustainable

mobility) had provided significant higher returns. On the contrary, according to their analysis, during the Covid-19 crisis ESG ETFs performed as well as the market.
On the other hand, a group of researchers have proven that sustainable investments can guarantee better protection from downside risk, especially when markets collapse.
Indeed, according to Morningstar Inc. (2021) not only 75% of ESG indexes outperformed their benchmarks in 2020, but they also registered lower losses during the Covid-19 crash in the first quarter of 2020. These findings were particularly relevant in Europe and Asia, while in North America the exclusion of high-growth stocks related to the technology sector led these indexes to underperform their benchmarks.
Kanamura (2021) analysed the returns of two ESG ETFs[15] and a conventional fund[16], selecting data from October 2018 to May 2020. By analysing the correlations between the prices of the three selected funds, the author found that a negative correlation exists between the returns of sustainable and traditional ETFs. Indeed, by using the dynamic conditional correlation (DCC) and the price correlation and volatility (PVC) models, the author concluded that when financial markets crashed in March 2020, the ESG factors embedded in the two sustainable ETFs hedged the downside risk, by decreasing investors' losses and their exposure to extreme volatility, compared to the conventional fund (Kanamura, 2021).
The same results were also proven by Pastor and Vorsatz (2020) and Albuquerque et al. (2020), who found a significant outperformance of ESG ETFs during the Covid-19 crash and a substantial reduction of returns' volatility during the first quarter of 2020.
Thus, it is possible to state that the observation of different trends in the performances of ESG ETFs during the Covid-19 crash, might be due to the different characteristics of these funds, such as their exposure to diverse industries, their ESG rating and their securities' different geographical allocation.
Nevertheless, nowadays, and especially after the global pandemic, sustainable investments have been recognized as defensive securities to hedge against downside risk.

[15] Nuveen ESG and iShares ESG high yield corporate bond ETFs.
[16] SPDR Bloomberg Barclays high yield bond ETF.

Moreover, compared to the previous crisis in 2007, which was generated by financial distress, the current crunch involves environmental, social, and political factors, which will be all strategic areas for the recovery of the global economy (Singh, 2020).

Therefore, the great uncertainty over the future of many diverse economic activities, has led investors to shift their capitals from cyclical to defensive securities, which should guarantee a better protection against high volatile markets and extreme, negative returns.

In this context, Singh (2020) who analysed the performances of three portfolios from May 2017 to May 2020, proved that ESG, which are now recognized as defensive portfolios, have been those with the best financial performances and the fastest recovery after the financial markets' crash in March 2020.

Therefore, the rapid flow of capitals to sustainable investments in bear market periods, which leads to the appreciation of these securities, might also explain why ESG investments usually perform better than conventional in case of financial distress (Singh, 2020).

Finally, Sharma et al. (2021) analysed different ESG indexes and their conventional benchmarks from January 2011 to June 2020, with the aim to understand whether a causality exists between the returns of these asset classes.

The analysis of the behaviour of the investors during the Covid-19 crash highlights that during market downturns they tend to shift their capitals to sustainable investments, by confirming the findings of Singh (2020). Moreover, while in the short term a unidirectional causality has been observed from sustainable to traditional indexes, in the mid and the long term the causality seems to become bidirectional.

The existence of a bidirectional causality between conventional and sustainable indexes (which has not been observed in Europe surprisingly), means that, in the long term, they tend to impact each other. Therefore, according to the authors, this would suggest that the growing asset class of sustainable investments might become the reference benchmark for the evaluation of the performances of traditional indexes in the future (Sharma et al., 2021).

To conclude, the literature review proves that it is not possible to state that sustainable investments always provide greater returns than traditional securities.

Nevertheless, the increasing attention of investors towards multiple sources of risk, has transformed ESG into financially material factors, which must be considered when evaluating the investments' risks.

Before the Covid-19 pandemic, most of the research was driven by the idea that sustainable investing performed much better than traditional investments in case of financial distress, while little research proved an underperformance of these securities in some geographical areas, such as Asia, the UK, and Emerging Markets.

On the contrary, most recent studies prove that, even more after the Covid-19 crash, investors have been recognizing this alternative investment as a defensive security, which can effectively reduce financial losses when markets are bear, as well as decrease the downside risk and the exposure to high volatile markets and stocks.

The global pandemic has undoubtedly brought out new investors' preferences. Indeed, lot of them have already shifted their investments from unethical to more sustainable industries (such as from fossil fuels to renewable energies).

Moreover, recent research proves that many investors avoid, or ask for higher returns, investing in securities which are exposed to high climate risk and carbon intensive industries. Indeed, negative environmental externalities are now translated into a higher tail and volatility risks, which can be efficiently hedged by selecting high ESG securities.

To conclude, the future academic research about the risk-return profile of sustainable investments should try to assess whether the outperformance of this alternative asset class during the Covid-19 Pandemic will be, again, restricted to the period of financial distress, or whether the new appreciation of non-financial factors and risks will determine an outperformance even during periods of economic upturn. Finally, future studies might analyse whether investors will continue to shift their capitals to impact investments in the future and to recognise these securities as defensive.

Chapter 4

Methodology: linear factor models

4.1 Introduction to single and multi-factor models

In this chapter different factor models are presented. Such models have been studied since the '60s, when the first and most famous single factor model was presented by William Sharpe: the Capital Asset Pricing Model (CAPM). Then, starting from the 70s, many other researchers such as Merton (1972) and Ross (1976) focused on the study of multi-factor models.

Nowadays, the increasing uncertainty over asset prices and the frequent instability of financial markets, have led many academic researchers to study and develop innovative multi-factor models, which are used to analyse those elements that have the greatest impact over prices' movements and expected returns (Glantz & Kissell, 2014).

The understanding of these factors is crucial for the forecast of asset returns and the analysis of the sources of a portfolio's risks (The Research Foundation of the Institute of Chartered Financial Analysts, 1994).

The starting point of the theory about portfolio optimization is the Modern Portfolio Theory presented by Markowitz in 1952, based on the maximization of expected returns given a certain level of risk, and the strategic capital allocation that, thanks to diversification, allows investors to reduce the exposure to non-systematic risk.

The CAPM, see equation (4.1), was the first single-factor model to be developed with the aim to measure systematic risk, which is, by definition, non-diversifiable:

$$E(r_{it}) = r_f + \beta_i \, [E(r_{mt}) - r_f], \tag{4.1}$$

where:

$E(r_{it})$ *is the expected return on the security i,*

r_f *is the risk-free rate of return,*
β_i *is the beta of the security i,*
$E(r_{mt})$ *is the expected market return.*

In equation (4.1) the systematic risk is measured by the beta, which indicates the riskiness of a security with respect to the market, whose beta is always equal to one (Corporate Finance Institute, 2021). This indicator quantifies the volatility of a single security with respect to the entire market and its value, which allows to understand how a single stock moves compared to the market, is derived by dividing the covariance between the security's returns and the market's returns, by the variance of the market's returns, as follows:

$$\beta_t = \frac{Cov(r_{it}, r_{mt})}{Var(r_{mt})},$$

where:

r_{it} *is the return on the security i at time t,*
r_{mt} *is the return of the market at time t.*

Moreover, the CAPM assumes that a higher risk exposure, must be compensated with higher expected returns. Nevertheless, one of the drawbacks of this model lies on the assumption that the systematic risk, intrinsic in the market, is the only source of risk. Therefore, in 1976 Ross presented the Arbitrage Pricing Theory (APT), which was the first attempt to transform the CAPM to consider more sources of risk:

$$r_{it} - E(r_{it}) = \beta_{i1} f_{1t} + \ldots + \beta_{ik} f_{kt} + \varepsilon_{it}, \qquad (4.2)$$

where:

r_{it} *is the total return on asset i, realized at the end of period t,*
$E(r_{it})$ *is the expected return on asset i, at the beginning of period t,*
β_{ij} *is the sensitivity of the asset i to the risk factor j (for j = 1,...,k),*
f_{jt} *is the value of the jth risk factor at the end of the period (for j = 1,...,k),*

ε_{it} *is the value of the asset-specific (idiosyncratic) shock at the end of period t.*

Being asset returns generated by a linear factor model, the following assumptions of non-correlation among risk factors and asset-specific shocks are formulated, together with the assumption of non-arbitrage opportunities[17] :

$$\text{cov}[\varepsilon_{it}, f_{jt}] = 0, \qquad for\ all\ j = 1,\dots,k,$$
$$\text{cov}[f_{jt}, f_{jt'}] = \text{cov}[\varepsilon_{it}, \varepsilon_{it'}] = 0, \qquad for\ all\ j = 1,\dots,k\ and\ for\ all\ t \neq t',$$
$$E[f_{1t}] = \dots = E[f_{kt}] = E[\varepsilon_{it}] = 0.$$

The APT model, as reported in equation (4.2), is a general model which allows to consider the exposure to multiple risk factors that are not specified and, as the traditional financial theory, it assumes that an exposure to higher risk should be compensated by higher returns.
Nevertheless, one of the drawbacks of using this model is the difficulty in defining the number and the type of factors that should be selected when performing the analysis. Indeed, factors must be robust over time, and they should be chosen according to their capability to explain the variation of the returns, as well as the portfolio's potential sources of risk (The Research Foundation of the Institute of Chartered Financial Analysts, 1994).
For what concerns the number of factors that should be selected to build the model, different researchers have tried to consider ten or even fifteen factors, proving that these numbers lead to dispersive results, which do not provide clear evidence of the returns' sensitivity to risks (Campbell et al., 1997). Therefore, five factors are considered acceptable to build a good multi-factor model.
Factor models can be distinguished into four main categories (Glantz & Kissell, 2014):

I. index models, which might consider a single market index (such as the S&P 500) or multiple indexes related to specific sectors or sources of risk (volatility, momentum, size, liquidity, growth);

[17] See the Research Foundation of the Institute of Chartered Financial Analysts (1994).

II. macroeconomic factor models, which are used to analyse the potential correlation between the stocks' returns and some macroeconomic variables, such as the GDP, the inflation rate, the value of the industrial production, the unemployment rate, or changes in interest rates;
III. cross-sectional multi-factor models, which analyse the impact of stock- and company-specific factors over the returns' sensitivity to systematic risk. Some of these factors are the market capitalization, the price-to-earnings ratio, and the book-to-market equity ratio;
IV. statistical factor models, which are based on the estimation of factors with the Factor Analysis and the Principal Component Analysis (PCA).

Multi-index, macroeconomic and cross-sectional factor models require the ex-ante selection of the factors that should capture a significant exposure to different sources of risk.
On the contrary, statistical factor models involve the use of large sets of asset returns, which are analysed through statistical methods. Even though these models might be harder to implement, they do not require any type of assumption and restriction over the factors' definition. Moreover, the statistical approach might also highlight some hidden covariance and correlation relationships between the returns and the risk factors (Glantz & Kissell, 2014).
Compared to others, multi-factor models present interesting features that allow to control both the risks associated to the selected assets, and the existing correlations among them, while also providing efficient risks' forecasts and analysis.
The general structure of a linear multi-factor model is the following:

$$R_{it} = \alpha_0 + f_{1t}\beta_{1t} + f_{2t}\beta_{2t} + \ldots + f_{kt}\beta_{ik} + \varepsilon_{it}, \tag{4.3}$$

where:

R_{it} *is the return on asset i at the end of period t,*
α_0 *is the constant term,*
f_{jt} *is the value of the jth risk factor in period t (for j = 1,...,k),*
β_{ij} *is the sensitivity of asset i to the risk factor j (for j = 1,...,k),*
ε_{it} *is the error term.*

β_{ij} are usually called *factor loadings* and they might be used as binary variables, thus taking the value of one in case of exposure to an industry and zero on the contrary, or as common standardized factors with mean equal to zero and standard deviation equal to one. In the latter case, their value should range between 1 and -1, indicating a positive, negative, or non-existing correlation between returns and risk factors (The Research Foundation of the Institute of Chartered Financial Analysts, 1994).
In the following sections, the different versions of the cross-sectional Fama and French multi-factor model are presented.

4.2 The Fama and French three-factor model

The Fama and French three-factor model was presented in 1992 as an extension of the CAPM. It differentiates itself from the APT as the number and the type of factors to be used are defined ex-ante.
The model was developed thanks to the authors' intuition about the multidimensionality of stock risks, which do not depend solely on the systematic risk measured by the beta in the CAPM (Fama & French, 1992). Indeed, Fama & French (1992) found that the cross-section of average returns was not fully explained by the systematic risk, and that other variables such as the book-to-market equity ratio, the market capitalization, the leverage, and the earnings-price ratio had a significant explanatory power.
The cross-section analysis is used to study how the defined variables behave across different industries, or portfolios, in a specific point in time. In this case, the Fama and French model provides information about the sensitivity of a stock, or a portfolio returns, to different and predefined risk factors.
Therefore, the CAPM was extended with the addition of two company-specific factors (4.4): the market capitalization (size factor), and the book-to-market equity ratio (value factor), which were found to significantly explain the variation of average returns across stocks:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1 (R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \varepsilon_{it}, \tag{4.4}$$

where:

R_{it} *is the return on asset i at time t,*
R_{ft} *is the risk-free rate of return at time t,*
α_{it} *is the constant term,*
β_j *is the risk factor coefficient,*
R_{mt} *is the market return at time t,*
$R_{it} - R_{ft}$ *is the expected excess return,*
$R_{mt} - R_{ft}$ *is the market risk premium,*
SMB_t *is the size factor (small minus big),*
HML_t *is the value factor (high minus low),*
ε_{it} *is the error term.*

The first factor of the model is the market risk premium $(r_{mt} - r_{ft})$, which is the measure of the excess return that an investor is expected to receive investing in securities that are riskier than the market and risk-free assets.

The second is the size factor (SMB_t), which measures the impact of market capitalization over the cross section of average returns. It is computed as the difference between the average excess returns of three portfolios representing small, capitalized companies and three portfolios representing big, capitalized companies (French, 2021).

Fama and French (1992) proved the existence of a significant and negative relation between average returns and the size, which is a pro-cyclical factor used to capture the tendency of small, capitalized stocks to outperform those issued by companies with large capitalization (MSCI Inc., 2021).

Finally, the third factor (HML_t) measures the impact over returns of the book-to-market equity ratio, and it is computed as the spread between the returns of firms with high and low book-to-market ratios. According to Fama and French (1992), a strong and positive cross-sectional relation exists between average returns and the book-to-market equity ratio, proved by the outperformance of low-priced stocks over pricier (MSCI Inc., 2021).

This ratio, computed as the book value of equity over the market capitalization, can be used to analyse whether company's securities are under or overpriced. Consequently, a ratio above one indicates that the traded securities are undervalued (book value greater than market value), while a ratio below one indicates the contrary.

The overvaluation of securities is usually related to positive returns' forecasts, for which investors demonstrate their willingness to pay a premium. Moreover, this ratio can be used as a risk factor, as in the case of persistently negative earnings (reflected by a negative ratio), or the sharp decrease of stock prices (reflected on a higher ratio), it represents negative earning perspectives and, consequently, the rise of the company's cost of capital (Fama & French, 1992).
Finally, as mentioned in the previous section, β_j are the factor loadings, which measure the sensitivity of expected returns to the selected risk factors.

4.3 The Carhart four-factor model

The four-factor model, as reported in equation (4.5), presented by Carhart in 1997 is an extension of the Fama and French three-factor model (4.4), considered inefficient by the author because of its "*inability to explain cross-sectional variation in momentum-sorted portfolio returns*" (Carhart, 1997).
For this reason, the original model was expanded with an additional factor called *momentum*, which is a *persistence factor* used to describe the general trend of winning and losing stocks' prices continuing to rise and fall for a certain period:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 \boldsymbol{WML_t} + \varepsilon_{it}, \qquad (4.5)$$

where:

R_{it} *is the return on asset i at time t,*
R_{ft} *is the risk free rate of return at time t,*
α_{it} *is the constant term,*
β_j *is the risk factor coefficient,*
R_{mt} *is the market return at time t,*
$R_{it} - R_{ft}$ *is the expected excess return,*
$R_{mt} - R_{ft}$ *is the market risk premium,*
SMB_t *is the size factor (small minus big),*
HML_t *is the value factor (high minus low),*

WML_t *is the momentum factor (winning minus loosing stocks),*
ε_{it} *is the error term.*

This stocks' behaviour allows investors to obtain abnormal returns generated by the *momentum anomaly*, a market inefficiency due to the slow reaction to information that characterizes investors, especially in mutual funds (Carhart, 1997). Nevertheless, the momentum anomaly might also depend on the existence of an autocorrelation between the returns generated in two consecutive periods, which would lead future returns to mimic their past trend.

The momentum factor (WML_t) is computed as the difference between the equal-weight average returns of two portfolios made of winning stocks and two made of losing stocks (French, 2021).

Overall, the four-factor model (4.5), thanks to the integration of the momentum factor, efficiently delates the pricing errors of the CAPM (4.1) and the Fama and French three-factor model (4.4), while also explaining better the cross-sectional variation of stock returns and avoiding multicollinearity (Carhart, 1997). Indeed, the cross-correlations test carried by the author showed that the selected factors were all low correlated to each other.

The latter is a significant issue when performing multiple regressions, and it relates to the selection of highly correlated independent variables, which might lead to unprecise coefficients' estimations and regression analysis.

4.4 The Fama and French five-factor model

In 2015, Fama and French presented an extended version of the three-factor model by adding two risk factors related to profitability and investment (4.6):

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 \boldsymbol{RMW_t} + \beta_5 \boldsymbol{CMA_t} + \varepsilon_{it}, \quad (4.6)$$

where:

R_{it} *is the return on asset i at time t,*

R_{ft} *is the risk free rate of return at time t,*
α_{it} *is the constant term,*
β_j *is the risk factor coefficient,*
R_{mt} *is the market return at time t,*
$R_{it} - R_{ft}$ *is the expected excess return,*
$R_{mt} - R_{ft}$ *is the market risk premium,*
SMB_t *is the size factor (small minus big, capitalized stocks),*
HML_t *is the value factor (high minus low book-to-market stocks),*
RMW_t *is the profitability factor (profitable minus unprofitable stocks),*
CMA_t *is the investment factor (conservatively minus aggressively stocks),*
ε_{it} *is the error term.*

The profitability factor (RMW_t) is computed as the difference between the returns of high and low profitable portfolios, while the investment factor (CMA_t) is computed as the difference between the returns of conservative and aggressive firms, whose classification is based on the different company-specific investment rates.
The need to modify the original model (4.4) came from the evidence that a large proportion of the average returns' variation was not sufficiently explained by the three previously selected risk factors: the market risk premium, the size, and the value factors (Fama & French, 2015).
Indeed, following the principles of the dividend discount model, the stock's market value can be computed as the present value of the future expected dividends (4.7):

$$M_t = \frac{\sum_{\tau=1}^{\infty} E(D_{t+\tau})}{(1+r)^{\tau}}, \tag{4.7}$$

where:

M_t *is the market value of a share at time t,*
$E(D_{t+\tau})$ *is the expected dividend per share,*
r *is the internal rate of return on expected dividends,*
$(1+r)^{\tau}$ *is the discount factor.*

Moreover, the valuation theory states that expected returns depend on the book-to-market equity ratio, the expected profitability, and the expected asset growth (Fama & French, 2006). Therefore, being shares' market prices computed as a function of future expected dividends, future expected returns, and changes in book-to-market equity values[18], Fama & French (2006) found that the profitability and the investment factors were relevant for the analysis of the returns' variation, while increasing the model's explanatory power (4.8):

$$\frac{M_t}{B_t} = \frac{\frac{\sum_{r=1}^{\infty} E(Y_{t+\tau} - dB_{t+\tau})}{(1+r)^{\tau}}}{B_t}, \tag{4.8}$$

where:

M_t *is the market value of a share at time t,*
B_t *is the book equity at time t,*
$Y_{t+\tau}$ *is the equity earnings per share at time t,*
$dB_{t+\tau}$ *is the change in book-to-equity ratio per share from time t-1 to time t,*
$E(Y_{t+\tau} - dB_{t+\tau})$ *is the expected dividend,*
r *is the internal rate of return on expected dividends,*
$(1+r)^{\tau}$ *is the discount factor.*

All this considered, Fama and French (2006) confirmed that for fixed levels of profitability and a constant book-to-market equity ratio, an increasing investment rate is reflected on lower returns. Thus, the reinvestment of the earnings generates a negative impact over expected returns.

On the contrary, higher expected profitability is positively correlated to expected returns, given a constant book-to-market equity ratio and investments' growth rate. Moreover, their research proved, again, the importance of the value factor, with the book-to-market equity ratio being positively and significantly correlated to expected returns (Fama & French, 2006).

[18] According to the clean surplus accounting.

After having tested the model at international level, Fama and French (2015) found that the value factor (HML_t) might become redundant (particularly in the American stock market), as a consequence of the introduction of the profitability (RMW_t) and the investment (CMA_t) factors. Indeed, the market risk premium, the size, the profitability, and the investment factors seem to capture the high average return of the value factor.

Nevertheless, the five-factor model explains up to 94% of the cross-sectional variation of returns, thus showing a greater explanatory power than the three-factor model (Fama & French, 2015). The efficacy of the five-factor model has been confirmed also by Horvath & Wang (2021), who tested it on the U.S. stock market during the Dotcom Bubble, the 2007 Global Financial crisis and the Covid-19 crisis. Their analysis shows that the model can explain up to 99% of the returns' variation even during severe market downturns.

4.5 The Fama and French six-factor model: the role of momentum

Despite being recognized by practitioners as an efficient asset pricing model, the Fama and French five-factor model (4.6) presented in 2015 does not consider the momentum factor.

As mentioned in Section 4.3, the momentum factor studied by Carhart for a long time, has a significant explanatory power in the cross-section of average returns, therefore the choice of avoiding its use has been largely discussed in the past literature.

In a recent research Fama & French (2018) examined the issue concerning the choice of the factors that should be used when implementing a multi-factor model. Indeed, lot of research has focused on the number of factors to select in order to explain the greatest cross-sectional variation of returns, by testing models based on the use of many different factors.

According to Fama & French (2018) the selection of a factor should never be based only on its empirical robustness, but also on a theoretical motivation. The lack of the latter is, according to them, the main reason why the momentum factor should not be added to the five-factor model. Indeed, earlier in 2016, the two researchers presented an analysis of the anomalies of the five-factor model, discussing some inefficiencies related to the lack of the momentum, the volatility, and the accruals factors [19], as well as the net share issues [20].

According to Fama and French (2016), the addition of the momentum factor does not improve the model's performance, unless the selected portfolios are built on momentum (therefore, following the strategy of going long on best-performing stocks and short on the worst-performing ones). Furthermore, being the profitability and the investment factors evaluated on the basis of the long-term internal rate of return on expected dividends, the choice of a short-term factor as the momentum would not be coherent with the overall model (Fama & French, 2016).

Nevertheless, in order to verify its impact and to contribute to the academic debate, Fama and French also tried to reformulate their five-factor model with the addition of that momentum factor (4.9).

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \\ + \beta_5 CMA_t + \beta_6 WML_t + \varepsilon_{it}, \tag{4.9}$$

where:

R_{it} *is the return on asset i at time t,*
R_{ft} *is the risk free rate of return at time t,*
α_{it} *is the constant term,*
β_j *is the risk factor coefficient,*
R_{mt} *is the market return at time t,*
$R_{it} - R_{ft}$ *is the expected excess return,*
$R_{mt} - R_{ft}$ *is the market risk premium,*
SMB_t *is the size factor (small minus big, capitalized stocks),*

[19] Accruals are determined by internal accounting decisions that generate differences between book and cash earnings (Fama & French, 2016).

[20] Net share issues are referred to the tendency of repurchased stocks to exhibit higher average returns and to new issued stocks to exhibit lower average returns immediately after the issue (Fama & French, 2016).

HML_t *is the value factor (high minus low book-to-market stocks),*
RMW_t *is the profitability factor (profitable minus unprofitable stocks),*
CMA_t *is the investment factor (conservatively minus aggressively stocks),*
WML_t *is the momentum factor (winning minus losing stocks),*
ε_{it} *is the error term.*

By comparing the maximum squared Sharpe ratio obtained with the CAPM, the three, five and six factor models, Fama & French (2018) proved that the three-factor model is more efficient than the CAPM, and that the five-factor model, with the profitability and the investment parameters, has a greater explanatory power than the others.

Moreover, even though the Gibbons-Ross-Shanken (GRS) test shows that all the selected models provide an incomplete description of the returns' variation, the test over the maximum squared Sharpe ratio confirms the six-factor model to be the best performing.

Therefore, most of the research in this field confirms the hypothesis that the six-factor model has a greater explanatory power than the others, even though recent publications have proven that some of the factors might lose their relevance when applied to specific, national markets.

As an example, Dirkx & Peter (2020) tested the three and six-factor models in a seventeen year time series (from 2002 to 2019) using the returns of the CDAX index. They proved that in the case of the German market, the six-factor model did not provide any significant improvement in the explanatory power of the cross-sectional returns, if compared to the three-factor model. Moreover, they found no significant results for the size and the profitability factors in that domestic market (Dirkx & Peter, 2020).

Geographical differences about the sensitivity of the returns' to risk factors have also been studied by Griffin (2002), who found that the use of a global Fama and French model leads to uncorrect pricing estimations and risks' evaluation.

More recently, Fama & French (2017) presented a study about the model's performances in North America, Europe, Japan and the Asia Pacific region, proving that the behaviour of avarege returns is not globally homogeneous. For this reason, in order to perform well and to efficiently explain the average returns' variation, the model should always be used to analyse well integrated markets. As an example, Fama and French (2017) found that the profitability and the investment parameters do not generate any significant premium in

Japan, while in Europe the investment factor's returns seem to be absorbed by the other factors (thus, to be redundant).

Another interesting study about the efficacy of the Fama and French model has been conducted by Jareno et al. (2020), who presented an extension of the six-factor model by adding the reversal factor (which measures the behaviour of stocks contrary to the momentum factor), the liquidity factor, and the long-term interest rate.

While Dirkx & Peter (2020) and Griffin (2002) proved the existence of relevant geographical differences in the efficacy of the selected risk factors, Jareno et al. (2020) focused their research on the study of temporary differences.

Therefore, in the overall analysed period (from 2003 to 2018) the market risk premium, the investment and the profitability factors were those explaining the largest proportion of the returns' variation. Nevertheless, by splitting the analysis in three time periods, Jareno et al. (2020) observed how the sensitivity of returns to risk factors has been changing over time.

Indeed, from 2003 to 2007 (pre-crisis), the factors explaining the largest returns' variation were the market risk premium, the investment and the profitability factors, while the others, and particularly the momentum, the size and the reversal factors, showed no significant results (Jareno et al., 2020).

During the second period, from 2007 to 2013, the analysis confirmed the market risk premium as the greatest explanatory variable, followed by the momentum, the investment and the value factors. Furthermore, during this period the returns' sensitivity to the liquidity factor increased significantly.

Finally, from 2014 to 2018, the market risk premium, the profitability and the size factors explained the largest returns' variation, even though also the momentum and the liquidity factors proved to be signficant.

Overall, looking at the adjusted R-Squared, which describes the proportion of variance explained by the selected independent variables, it is possible to state that the six-factor model augmented with the three additional factors performed quite well, especially during the period of the 2007 Global Financial Crisis (Jareno et al., 2020).

To conclude, the results of this study partially confirm the position of Fama & French (2018) about the momentum factor, which was not significant before the 2007 Global Financial

Crisis. Nevertheless, the overall period analysis presented by Jareno et al. (2020) shows also an increasing sensitivity of returns to this risk factor in the long term.

4.6 The Fama and French model and the ESG risk factor

The academic literature is still divided about the implications over an investment's risk-return profile of controlling for environmental, social, and governance issues. Nevertheless, the most recent research has recognized ESG as potential sources of risk, becoming relevant for the cross-section analysis of returns.

As discussed in Section 3.2, ESG risks are now considered financially material and researchers such as Henke (2016), Hoepner et al. (2020) and Maxfield & Wang (2020) have proven that good sustainability performances decrease the exposure to multiple sources of risk. Therefore, controlling for ESG issues is important to prevent from litigation and climate risks (just to mention some), and to assure the company's financial stability, while for retail investors controlling for ESG issues can significantly decrease the exposure to tail risk.

After the 2007 Global Financial Crisis, some researchers proved that the traditional risk factors were not sufficient anymore to explain the overall stocks' returns variation. Indeed, alternative risk factors such as low-volatility, momentum and ESG have been recognized to increase the explanatory power of different asset-pricing models (Ben Slimane et al., 2018) (Dìaz, et al., 2021).

As a consequence, some researchers have recently started to study multi-factor models that take into account a sustainability risk factor. As an example, Dìaz et al. (2021), Hübel & Scholz (2020) and Ben Slimane et al. (2020) presented an extended version of the Fama and French three, five and six-factor models, proving that the addition of the ESG risk factor significantly improves the explanatory power of the selected models.

For the purposes of this thesis, the extended versions of the five-factor (4.10) and the six-factor (4.11) models are considered:

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1(R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \quad (4.10)$$

$$+ \beta_5 CMA_t + B_6 \boldsymbol{ESG_t} + \varepsilon_{it},$$

and

$$R_{it} - R_{ft} = \alpha_{it} + \beta_1 (R_{mt} - R_{ft}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 RMW_t + \\ + \beta_5 CMA_t + \beta_6 WML_t + B_7 \boldsymbol{ESG_t} + \varepsilon_{it}, \quad (4.11)$$

where:

R_{it} *is the return on asset i at time t*
R_{ft} *is the risk free rate of return at time t,*
α_{it} *is the constant term,*
β_j *is the risk factor coefficient,*
R_{mt} *is the market return at time t,*
$R_{it} - R_{ft}$ *is the expected excess return,*
$R_{mt} - R_{ft}$ *is the market risk premium,*
SMB_t *is the size factor (small minus big, capitalized stocks),*
HML_t *is the value factor (high minus low book-to-market stocks),*
RMW_t *is the profitability factor (profitable minus unprofitable stocks),*
CMA_t *is the investment factor (conservatively minus aggressively stocks),*
WML_t *is the momentum factor (winning minus losing stocks),*
ESG_t *is the sustainability factor (high minus low ESG-ranked stocks),*
ε_{it} *is the error term.*

The largest proportion of the current literature agrees on the fact that the integration of the ESG risk factor significantly reduces the portfolio's risk and, in some circumstances, it allows to increase the risk-adjusted returns, particularly during market downturns (Hübel & Scholz, 2020) (Kaiser, 2020).

Hübel & Scholz (2020) found that the addition of the ESG factor significantly improves the explanatory power of the Fama and French five-factor model, and that a high ESG exposure is reflected in a higher portfolio's risk. Moreover, the authors believe that stocks with high environmental ratings are now overvaluated, as a consequence of the increasing awareness of investors towards ESG risks. The same findings are confirmed by Kaiser (2020), who found

that integrating the sustainability risk factor in the investment portfolio reduces systematic risk (measured by the market risk factor's beta) and the exposure to the size factor (SMB_t).
Furthermore, an extensive part of the research has focused on the analysis of the impact of adding an ESG factor in asset pricing models during severe market downturns. Indeed, the Covid-19 crash, which is an exogenous shock not originated because of economic distress, represents an important opportunity to study investors' behaviour. Therefore, Albuquerque et al. (2020) found that during the first quarter 2020 companies with high ESG scores, thus those exposed to low ESG risks, exhibited lower volatile returns. Moreover, the authors observed that investors choosing sustainable investments were less inclined to fire sales than traditional investors during the Covid-19 market crash. This behaviour might be the reason why ESG stocks' prices did not decline as much as those of traditional assets (Albuquerque, et al., 2020).

Furthermore, Shanaev & Ghimire (2021) studied the impact of ESG ratings changes over returns, finding that ESG rating downgrades generate far higher (negative) abnormal returns than those generated by rating upgrades, even though during the Covid-19 crash high ESG stocks received an increasing attention from retail and instituational investors.

One of the issues of developing a multi-factor model that considers ESG as a risk factor is the determination of its value. Indeed, its estimation must consider relevant geographical differences and also industry-specific peculiarities, which make the ESG level of materiality not homogeneous among different industries (Kaiser, 2020).

As an example, the industry materiality map presented by MSCI Inc. (2021) for the Real Estate industry highlights that for what concerns the environmental pillar, the two most relevant issues are the *Opportunities in Green Building*, described as "*the resource consumption and carbon intensity of property assets, the potential exposure to environmental building regulations and the efforts to improve the environmental performance of real estate assets*" (MSCI Inc., 2021), and *Water Stress*, defined as "*the water intensity of the operations, the water stress in the areas of operation and the efforts to manage water-related risks and opportunities*" (MSCI Inc., 2021). While for what concerns the social and governance pillars, the largest exposure to risk in the Real Estate industry is determined by *Human Capital Development*, thus the capability to attract and retain highly skilled workers, *Health & Safety*, described as the ability to assure safety standards in workplaces, *Product Safety & Quality* and, finally, *Data Security* (MSCI Inc., 2021).

Conversely, looking at the Construction & Engineering sector, the most relevant environmental issues are related to "(..) *clean tech innovation capacity, strategic development initiatives, and revenue generated from clean technologies"*, as well as "*the potential environmental contamination and toxic or carcinogenic emissions arising from the operations and the strength of the environmental management systems*" and, finally, the operations' impact over biodiversity and the use of land (MSCI Inc., 2021).

Therefore, according to Hübel & Scholz (2020) the main reason why multi-factor models that integrate ESG factors have been implemented only recently, is the lack of quantitative, comparable and easily accessible ESG data. Indeed, there are currently few rating agencies (Bloomberg, Thomson Reuters and Sustainalytics) that provide these figures, which are mainly reffered to big corporations.

Thus, one of the first issues in the computation of an ESG risk factor is the lack of a comprehensive ESG dataset that should cover the sustainability evaluation of both large and small companies. Moreover, the lack of data is also due to the quite high number of companies that do not publish sustainability or integrated reports yet.

Secondly, analysists should condider the difference between ESG exposures and ESG ratings, where the first are computed as the absolute exposure to ESG issues, while the latter are industry-benchmarked (Hübel & Scholz, 2020). The adavantage of using ESG ratings is that they are computed according to a materiality map, which condiders the specific risk expsure of each industry. On the other hand, the disadvantage is derived from the fact that a company belonging to very risky industries might still receive high ESG ratings when evaluated with respect to its industry peers, and not to the overall market (Hübel & Scholz, 2020).

To conclude, recent research proves that the addition of an ESG risk factor in asset pricing models such as those presented by Fama and French might significantly improve their explanatory power. Therefore, in the next chapter the empirical analysis based on the application of the previously discussed Fama and French models is presented, together with the estimation of the ESG factor for the Real Estate and the Building and Construction industries.

Chapter 5

Empirical analysis: the performances of ETFs investing in sustainable real estate and green building

5.1 Model presentation

The empirical analysis presented in this chapter is related to the study of the financial performances and the exposure to risk of four ETFs investing in the Real Estate and the Building & Construction industries in Europe and in North America.

The decision to analyse ETFs investing in both the industries is derived by multiple considerations. First of all, the two sectors are connected to each other, and they have been both indicated as strategic areas of investment in the *InvestEU* Program of the European Union. Moreover, as mentioned in Chapter 2, not only the Real Estate and the Building & Construction industries are important sectors for the economic development of the European Union, but they also generate huge environmental impacts, whose control is one of the challenges for the future evolution of the sector. Being among the industries that generate the largest amount of CO2 emissions and being highly energy-intensive sectors, investors allocating capitals to these industries are also exposed to high environmental risks.

Indeed, according to the *ESG Industry Materiality Map* published by MSCI Inc. (2021) the current and most relevant issue in the Real Estate industry is the capability of companies to improve the environmental performances of real estate assets, by taking advantage of new technologies in the field of green building. On the contrary, the Building & Construction industry is particularly exposed to issues related to the capability of exploiting clean technologies, with the aim to control and prevent from toxic emissions, as well as to assure the protection of biodiversity and to limit the operations' impact over the environment (MSCI Inc., 2021).

Considered the substantial exposure to environmental risks of these two industries, I believe that testing the Fama and French model augmented with the ESG risk factor might provide interesting insights about the impact, over the sensitivity of returns, of a high or low portfolio's exposure to sustainable companies.

In order to conduct the empirical analysis, I have searched and selected four different ETFs (see Table 5.1). As mentioned in Chapter 4, previous studies have shown that the Fama and French model provides an efficient estimation of the returns' sensitivity to risk factors when applied to well-integrated markets. Consequently, I have decided to analyse the performances of two ETFs investing in North America and two investing in Europe, while avoiding funds investing at global scale.

The parameters that I used for the selection of the funds are the inception date, which had to allow me to have enough data to carry the analysis of the funds' financial performances, the sector and the geographical exposure and, finally, the sustainability characteristics. The latter are particularly important for the purposes of this thesis, as my objective is to evaluate the performances and the exposure to risks of sustainable investing funds.

For the sake of clarity, I have to highlight that the selected ETFs are not categorized as sustainable funds by prospectus in the Morningstar website. Nevertheless, these funds present high sustainability scores if compared to other funds in the same category, and they have been selected because of their interesting sustainability characteristics (see Table 5.2). The reason for this selection is that sustainable ETFs by prospectus investing in sustainable Real Estate have been launched only recently, starting from 2019, when BNP Paribas launched the first ever ETF with a focus on green building. Nevertheless, the choice of the newest ETFs would not have allowed me to carry an exhaustive analysis of their financial performances and the returns' sensitivity to the ESG risk factor.

Table 5.1: Selected ETFs

ETF	Inception date	Geographical Focus	%	Sectoral Focus	%	Market Capitalization	Strategy
iShares STOXX Europe 600 Real Estate UCITS ETF (DE)	19/09/2006	European Region	100	Real Estate	100	Large-cap	Blend
		Germany	27.36	Real Estate	53.3		
		U.K.	25.43	REIT	41.27		
		Sweden	15.64	Internet	3.2		
		France	9.64	Investment banks	1.71		
		Switzerland	6.29				
		Belgium	5.75				
		Luxemburg	3.68				
		Spain	2.45				
		Finland	1.82				
		Norway	1.43				
iShares Cohen & Steers REIT ETF ICF	29/01/2001	US	100	Real Estate	100	Broad market	Blend
				REIT	99.85		
				Sovereign	0.15		
iShares STOXX Europe 600 Construction & Materials UCITS ETF (DE)	08/07/20202	European Region	100	Construction & Materials	100	Broad market	Blend
		France	29.66	Building products	58.88		
		Switzerland	26.73	Engineering & Construction	30.32		
		Sweden	16.25	Electronics	7.27		
		Ireland	13.64	Environmental control	1.82		
		Spain	7.02	Electrical components	1.68		
		Germany	2.89				
		The Netherlands	1.68				
		Denmark	1.05				
		Austria	1.05				
iShares U.S. Home Construction ETF	01/05/2006	US	100	Construction	100	Broad market	Blend
				Homebuilding	61.58		
				Building products	14.99		
				Building products (retail)	11.44		
				Chemicals	4.74		
				Engineering & Construction	3.31		
				Others	3.88		

As shown in Table 5.2, the evaluation of the funds' sustainability characteristics has been made according to different parameters. Firstly, the *ESG Morningstar Score* has been considered, which measures the capability of the funds' holdings to manage ESG risks compared to other companies in the same category. The value of this score ranges from 0 to 50, with 0 representing the lowest and 50 the highest exposure to ESG risks. Secondly, the *MSCI ESG Fund Rating* and the *MSCI ESG Quality Score* are taken into account. The latter is computed as the weighted average of the ESG scores of the funds' holdings, by considering thirty-five ESG risks specifically related to the industry, as well as the capability of the holdings to manage these risks (MSCI Inc., 2021). Morningstar also provides some information about the funds' exposure to fossil fuels and carbon, with a score ranging from 0 (lowest risk) to 100 (highest risk).

Finally, the selection of the ETFs has been made checking their *Business Involvement Metrics*, which are provided by MSCI Inc. measuring the funds exposure to the following industries: controversial weapons, nuclear weapons, civilian firearms, tobacco, UN Global Compact Violators, thermal coal, and oil sands. The selected ETFs are not exposed to the previously mentioned industries, and they all present a *Morningstar Sustainability Score* lower than the Morningstar's Global Category Average.

Table 5.2: Sustainability characteristics of the selected ETFs

ETF	ESG Morningstar score (0-50)		Fossil Fuel Involvement (0-100)	Carbon Risk Score (0-100)	Weighted average carbon intensity (tCO2e / $m sales)	Green Revenues	Historical Sustainability Score Percent Rank	MSCI ESG Fund Rating (AAA-CCC)	MSCI ESG Quality Score (0-10)
	Current	Historical							
iShares STOXX Europe 600 Real Estate UCITS ETF (DE)	12.27	12.59	0.00	N.A.	Moderate carbon intensity	19.20%	6/1144	AAA	8.41
iShares Cohen & Steers REIT ETF ICF	13.45	14.08	0.00	11.22	Moderate carbon intensity	15.80%	15/1144	A	6.20
iShares STOXX Europe 600 Construction & Materials UCITS ETF (DE)	22.74	23.34	0.00	N.A.	Very high carbon instensity	14.40%	24/150	AA	8.09
iShares U.S. Home Construction ETF	22.80	22.30	0.00	15.67	Low carbon instensity	10.70%	47/238	A	6.10

In order to evaluate the financial performances and the exposure to risk of the selected ETFs, I have decided to apply the three-, five- and six-factor Fama and French models as defined in equations (4.4), (4.6), (4.9) presented in Chapter 4. Moreover, the six-factor model, defined in equation (4.11), augmented with the ESG risk factor is tested. All the figures related to the Fama and French European and American daily factors (SMB_t, HML_t, RMW_t, CMA_t, WML_t) have been collected from the *French Data Library* (French, 2021), while the ESG risk factor (ESG_t) has been estimated by me.

As mentioned in Section 4.6, the computation of the ESG risk factor depends on the availability of data about companies or industries' exposure to sustainability risks. Moreover, even though at the time this thesis is written there is not a generally accepted model to compute this factor, the recent literature provides examples of different linear and machine-learning based models that can be used for its estimation.

For the purposes of this thesis, I have selected the research published by Dìaz et al. (2021), Hübel & Scholz (2020), Kaiser (2020) and Henriksson et al. (2018), who built a systematic ESG risk factor based on firms' sustainability ratings.

Therefore, the ESG risk factor, as reported in equation (5.12), is computed as the difference between the returns of a portfolio representing companies with high ESG scores and those of a portfolio representing low ESG scored companies:

$$ESG_t = R_t^{ESG^{high}} - R_t^{ESG^{low}}, \quad (5.12)$$

where:

$R_t^{ESG^{high}}$ *is the return at time t of the portfolio with the best sustainability performances,*

$R_t^{ESG^{low}}$ *is the return at time t of the portfolio with the worst sustainability performances.*

In contrast to the model proposed by Hübel & Scholz (2020), who computed three separated factors based on the environmental, social and governance pillars, I have decided to compute an overall ESG risk factor in order to overcome the issue of the lack of data about the companies' specific exposure to the three pillars. Therefore, I have obtained four different ESG risk factors:

- the European Real Estate ESG;
- the North American Real Estate ESG;
- the European Building & Construction ESG;

- the North American Building & Construction ESG.

In order to compute each factor, I have collected the sustainability ratings of the companies operating in those industries from three different sources: *Sustainalytics*, which provides the ESG risk ratings of major companies all over the world divided by sector, *Bloomberg Intelligence ESG* and, finally, the *S&P Global ESG Score* database.

For what concerns the construction of the ESG risk factor of the Real Estate industry, I have decided to exclude companies operating as services providers as well as investment banks and private funds investing in Real Estate. While for the construction of the ESG risk factor for the Building & Construction industry, I have selected companies classified in the following subsectors: Construction & Engineering, Construction Materials, Building Products and Homebuilders. Moreover, I have converted the sustainability ratings of the companies collected from the *Bloomberg Intelligence ESG* and the *S&P Global ESG Score* database to the same scale applied by Sustainalytics. Indeed, while the ESG rating used by Bloomberg and S&P ranges from 0 to 100, with 0 representing the worst and 100 the best ESG score, the one applied by Sustainalytics (which is the same used in this thesis), ranges from 0 to 50, with 0 representing the lowest and 50 the highest exposure to ESG risks.

I have decided to use the ESG risk rating provided by Sustainalytics as it presents interesting features: firstly, the rating is based on the computation of "*the degree to which each ESG issue puts the company's value at risk*" (Sustainalytics, 2021), by measuring the potential impact of the unmanaged ESG risks over the company's performances. Furthermore, the rating is computed considering both the exposure of companies to ESG risks (which mainly depend on the industry to which they belong) and their *active management system*, described as the group of actions taken by a company to mitigate its ESG risk exposure. Finally, the rating is computed as an absolute measure of risk, which allows it to be compared across different companies and industries. Therefore, according to the ESG risk rating, companies are divided into five risk categories:

i. 0 – 10.00: negligible risk;
ii. 10.10 – 20.00: low risk;
iii. 20.10 – 30.00: medium risk;
iv. 30.10 – 40.00: high risk;
v. 40.10 – 50.00: severe risk.

Looking at the collected figures (see Table 5.3), it is possible to observe that companies operating in the Real Estate industry are exposed to lower ESG risks if compared to those belonging to the Building & Construction ones. Moreover, as the number of observations in each risk category is quite heterogeneous, I have decided to perform a reclassification of the companies' risk categories, with the aim to define a new ESG risk scale that allows me to build the high and low ESG scored portfolios for each industry and region.

Table 5.3: Number of companies divided by risk category and total number of observations.

	Negiglible Risk	Low Risk	Medium Risk	High Risk	Severe Risk	Total
Europe Real Estate	11	65	6	-	-	82
North America Real Estate	3	99	5	2	-	109
Europe Construction & Building	-	23	30	11	1	65
h America Construction & Building	-	7	15	9	3	34

Therefore, I ordered all the collected ESG risk scores from the highest to the lowest and, using the box-plot representation, I selected the observations of the first and the fourth quartiles, splitting the available scores into three, new risk categories (see Table 5.4). The new ESG risk scale still highlights a huge difference in the ESG risk exposure of companies operating in the Real Estate and the Building & Construction industries. Moreover, the decision to use a wider range for the classification of the companies exposed to high ESG risks is due to the need to create comparable Best and Worst ESG portfolios for each industry and region.
Indeed, I had to clean the available figures in order to delete duplicates, ratings belonging to companies for which public market data were not available, as well as figures related to companies listed outside the considered regions. Finally, a significant number of firms could not be considered because of the lack of data, due to a too recent quotation in the stock market.

Table 5.4: ESG risk scale.

	Low ESG risk	Medium ESG risk	High ESG risk
Europe Real Estate	$0 \le x \le 10.50$	$10.50 < x < 15.00$	$15.00 \le x \le 40.00$
North America Real Estate	$0 \le x \le 12.50$	$12.50 < x < 18.20$	$18.20 \le x \le 40.00$
Europe Construction & Building	$0 \le x \le 20.00$	$20.00 < x < 27.50$	$27.50 \le x \le 45.00$
North America Construction & Building	$0 \le x \le 23.50$	$23.50 < x < 30.50$	$30.50 \le x \le 45.00$

Overall, the applied reclassification allowed me to create four portfolios representing companies with high sustainability performances, and four representing companies with low sustainability performances (see Table 5.5).

Table 5.5: Number of securities included in each portfolio. Worst ESG Portfolios are composed by companies exposed to high ESG risk, while Best ESG Portfolios are composed by companies exposed to low ESG risk.

	Worst ESG Portfolio	Best ESG Portfolio
Europe Real Estate	14	14
North America Real Estate	15	17
Europe Construction & Building	17	18
North America Construction & Building	11	9

Finally, I used the daily closing prices of each selected security to compute the daily returns, and I calculated the portfolios' equally weighted returns for the period from the 1st September 2007 to the 30th June 2021. In case the number of missing observations of daily closing prices for the same date was equal to or higher than five, the whole string was deleted, otherwise missing data were estimated using linear interpolation. In conclusion, the daily ESG risk factor was computed as the difference between the daily returns of the best ESG portfolios and those of the worst ones, as reported in equation (5.12).

I have decided to avoid estimating the ESG risk factor as a binary variable, which would have meant assigning a value of zero in case of bad sustainability performances and one on the contrary. Indeed, the use of a binary variable would not have been accurate enough, as it did not allow me to consider the different degrees of exposure to ESG risks. On the contrary, the estimation method that has just been presented allowed me to compute a risk factor which is comparable to those computed by Fama and French, and that takes into account the different exposure to ESG risks of the selected companies.

Nevertheless, it is important to stress that my estimation of this factor is based on portfolios that are particularly exposed to big, capitalized firms. Indeed, while Hübel & Scholz (2020) differentiated small from big-capitalized companies, the data in this thesis are referred to the major and most representative companies of the selected industries.

As a consequence, one of the drawbacks of this computation method is related to the lack of data about the sustainability performances of small firms, which is also one of the most discussed issues in the literature about the estimation of the ESG risk factor.

In the following sections the empirical analysis of the selected ETFs is presented. In order to analyse the European funds, I have chosen the following timeseries: the first, from the 1st January 2010 to the 30th June 2021, is referred to the Post Covid-19 Crisis period, while the second, from the 1st January 2010 to the 31st December 2019, corresponds to the Pre Covid-19 Crisis period. These time frames have been selected with the aim to compare the effects of the pandemic crisis over the returns' variation, as well as the potential changes in the sensitivity of returns to the selected risk factors. Moreover, as mentioned in Chapter 3, many researchers proved that investing in more sustainable funds generate better protection from losses during market downturns; therefore, the selected timeseries allow me to analyse the sensitivity of returns to the ESG risk factor in bear market conditions.

In order to test the significance and the impact over returns of the ESG risk factor, I have also decided to compare two other timeseries, which were analysed using the seven-factor model only. The first selected period, which goes from the 1st January 2010 to the 31st December 2015, represents the time frame before the introduction of the Paris Agreement on Climate Change. Conversely, the second timeseries, which goes from the 1st January 2010 to the 31st December 2019, allows me to analyse whether the sensitivity of returns to the ESG risk factor has changed as a consequence of the introduction of the agreement on climate change, while isolating the effects of the Covid-19 Crisis.

For what concerns the analysis of the American funds, the only difference is that the starting date of the selected timeseries is set on the 01st June 2009, instead of the 01st January 2010. The choice to exclude the second semester 2009 from the analysis of the European funds, is due to the consideration that most of the European countries started recovering from the 2007 Global Financial Crisis only at the beginning of 2010.

Finally, I have decided to exclude from my analysis the period between June 2007 and May 2009, as it generated a significant negative impact on the adjusted R-Squared of the performed regressions of the Fama and French models. Indeed, the Real Estate and the Building & Construction industries were dramatically hit by the Global Financial Crisis, and it is reasonable to think that the variation of the returns during that period was influenced by risk factors specifically related to the financial crisis.

5.2 Dataset: The Real Estate industry

5.2.1 Europe

For the European region, I have selected the iShares STOXX Europe 600 Real Estate UCITS ETF, which tracks the STOXX Europe 600 Real Estate Index. This ETF exploits a blend strategy, which means that the fund's portfolio is composed by both value and growth stocks. Value stocks are usually considered under-priced in respect to the financial status of the issuer company, and they refer to firms with high book-to-market equity ratios; while growth stocks are those issued by companies which are thought to have significant growth potentials in the future, and which are characterized by low book-to-market equity ratios. Moreover, the selected ETF's portfolio targets mainly large, capitalized firms.

The first part of the empirical analysis is related to the study of the risk factors that generate the greatest impact over the variation of returns. Therefore, I tested the Fama and French three-, five-, six- and seven-factor models in the Pre Covid-19 Crisis period (from the 1st January 2010 to the 31st December 2019) and in the Post Covid-19 Crisis period (from the 1st January 2010 to the 30th June 2021), whose results are reported in Tables 5.6 and 5.7.

First of all, by comparing the values of the Adjusted R Squared, it is possible to state that the addition of the profitability (RMW), the investment (CMA) and the momentum (WML) factors slightly improve the explanatory power of the Fama and French three-factor model. On the contrary, a more significant improvement is provided by the addition of the ESG risk factor in both samples. Moreover, while in the Pre Covid-19 Crisis period the analysis provides statistically significant coefficients for all the selected risk factors, in the other period many of them seem to lose their statistical significance.

Overall, the analysis of both the timeseries provides a value of the Adjusted R Squared that remains quite low, meaning that the selected risk factors do not capture the whole returns' variation, and that other risk factors should be considered in the model.

Table 5.6. This table shows the results of the regression analysis performed with the Fama and French three-, five-, six- and seven- factor models in the Post Covid-19 Crisis period for the ETF investing in the Real Estate industry in Europe. The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Period: 01/01/2010 - 30/06/2021				
Regression Statistics				
	3 Factor Model	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.461	0.465	0.465	0.526
Standard Error	0.0084	0.0084	0.0084	0.0080
Observations	2905	2905	2905	2905
Coefficients				
Factors	*3 Factor Model*	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	0.671 *	0.648 *	0.648 *	0.638 *
β SMB	-0.115 *	-0.128 *	-0.127 *	-0.055
β HML	-0.140 *	0.055	0.045	-0.031
β RMW		0.201 *	0.199 *	0.116
β CMA		-0.285 *	-0.284 *	-0.283 *
β WML			-0.011	0.048
β ESG				0.298 *

Table 5.7. This table shows the results of the regression analysis performed with the Fama and French three-, five-, six- and seven- factor models in the Pre Covid-19 Crisis period for the ETF investing in the Real Estate industry in Europe. The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Period: 01/01/2010 - 31/12/2019				
Regression Statistics				
	3 Factor Model	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.435	0.440	0.441	0.502
Standard Error	0.0080	0.0080	0.0080	0.0076
Observations	2526	2526	2526	2460
Coefficients				
Factors	*3 Factor Model*	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	0.599 *	0.569 *	0.570 *	0.545 *
β SMB	-0.329 *	-0.350 *	-0.355 *	-0.263 *
β HML	-0.316 *	-0.285 *	-0.254 *	-0.261 *
β RMW		-0.198 *	-0.223 *	-0.231 *
β CMA		-0.389 *	-0.415 *	-0.413 *
β WML			0.069 *	0.085 *
β ESG				0.286 *

Focusing on the results obtained with the seven-factor model (see Table 5.8), it is possible to observe that this portfolio's returns are particularly sensitive to the market risk factor (Mkt – Rf), whose beta, being lower than one, suggests that the portfolio's volatility is lower than the market. Moreover, the negative and statistically significant *Small minus Big* (SMB) coefficient confirms the fund's exposure to big, capitalized firms. This fund's portfolio seems to be particularly exposed to growth stocks (thus, to companies with a low book-to-market equity ratio), as indicated by the negative value of the *High minus Low* (HML) coefficient. Finally, the significant, negative beta of the profitability factor in first period (RMW) and that of the investment factor (CMA) in both periods, indicate an exposure to unprofitable firms, which adopt aggressive investment strategies.

Table 5.8. This table shows the comparison between the results of the performed regression with the Fama and French six- and seven-factor models over the Pre Covid-19 Crisis period (from the 1st January 2010 to the 31st December 2019) and the Post Covid-19 Crisis period (from the 1st January 2010 to the 30th June 2021). The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Regression Statistics				
	Period: 01/01/2010 - 31/12/2019	*Period: 01/01/2010 - 31/12/2019*	*Period: 01/01/2010 - 30/06/2021*	*Period: 01/01/2010 - 30/06/2021*
	6 Factor Model	*7 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.441	0.502	0.465	0.526
Standard Error	0.0080	0.0076	0.0084	0.0080
Observations	2526	2460	2905	2905
Coefficients				
Factors	*6 Factor Model*	*7 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	0.570 *	0.545 *	0.648 *	0.638 *
β SMB	-0.355 *	-0.263 *	-0.127 *	-0.055
β HML	-0.254 *	-0.261 *	0.045	-0.031
β RMW	-0.223 *	-0.231 *	0.199 *	0.116
β CMA	-0.415 *	-0.413 *	-0.284 *	-0.283 *
β WML	0.069 *	0.085 *	-0.011	0.048
β ESG		0.286 *		0.298 *
Annualized Alpha				
Alpha	3.352%	6.783%	0.084%	3.339%

One of the most interesting results of this test is the impact of the addition of the ESG risk factor, which improves the model's Adjusted R Squared (i.e., its explanatory power) by more than 6%. The positive and statistically significant coefficient indicates that this ETF's returns are sensitive to the ESG risk factor, and that the exposure to companies with high sustainability scores positively impact over the fund's returns. Moreover, its increasing coefficient between the Pre and the Post Covid-19 Crisis periods suggests that during market downturns returns become more sensitive to the ESG risk factor, while the higher annualized alpha indicates that when markets are bear the exposure to more sustainable firms is positively rewarded.

Finally, I investigated the potential effects of the introduction of the Paris Agreement on Climate Change over the returns' sensitivity to the ESG risk factor (see Table 5.9).

Table 5.9. This table shows the comparison between the results of the performed regression with the Fama and French seven-factor model over the period before the introduction of the Paris Agreement on Climate Change (from the 1st January 2010 to the 31st December 2015), and the period after the introduction of the Paris Agreement on Climate Change and before the Covid-19 Crisis (from the 1st January 2010 to the 31st December 2019). The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Regression Statistics		
	Period: 01/01/2010 - 31/12/2015	*Period: 01/01/2010 - 31/12/2019*
	7 Factor Model	*7 Factor Model*
Adjusted R Square	0.514	0.502
Standard Error	0.0080	0.0076
Observations	1472	2460
Coefficients		
Factors	*7 Factor Model*	*7 Factor Model*
Alpha	0.000 *	0.000
β Mkt-RF	0.537 *	0.545 *
β SMB	-0.292 *	-0.263 *
β HML	-0.296 *	-0.261 *
β RMW	-0.329 *	-0.231 *
β CMA	-0.238 *	-0.413 *
β WML	0.152 *	0.085 *
β ESG	0.297 *	0.286 *
Annualized Alpha		
Alpha	10.803%	6.783%

I have decided to exclude the period after December 2019, in order to isolate the effects of the Covid-19 Crisis, which have been analysed previously. The performed regressions confirm that this fund is particularly exposed to big, capitalized firms, which adopt an aggressive investment strategy, and that its portfolio is mainly represented by growth stocks of low profitable companies. By comparing the coefficients of the ESG risk factor, it is possible to state that the introduction of the Paris Agreement on Climate Change did not affect the sensitivity of returns to this factor. Nevertheless, by carefully thinking about the two compared timeseries, the first, which includes the period before January 2016, thus the European Sovereign Debt Crisis, might be considered a bear market period. Conversely, the time frame after the introduction of the Paris Agreement on Climate Change might be considered a bull market period, as any relevant crisis affected the European market in those years. Therefore, the slightly higher coefficient of the ESG risk factor before January 2016, as well as the higher annualized alpha, might again suggest that investments in more sustainable companies are more rewarded during market downturns.

Furthermore, the higher sensitivity of the returns to the sustainability factor in the first period might also be a consequence of the introduction, in 2010, of the European directive about the use of Energy Performance Certificates in Real Estate, which, as mentioned in Subsection 2.2.2, increased the attention towards the sustainability characteristics of real assets.

To conclude, I present the multicollinearity test applied to the risk factors of the seven-factor Fama and French model. Indeed, multicollinearity is one of the most common issues of the use of linear regression models, and it relates to the selection of highly correlated independent variables, which might provide biased coefficients' estimations. Being the proposed version of the Fama and French model derived by the six-factor model augmented with a risk factor (estimated by me), I consider this test necessary to verify the efficacy of the model.

Table 5.10. Correlation matrix.

Correlation Matrix							
	Mkt-RF	*SMB*	*HML*	*RMW*	*CMA*	*WML*	*ESG*
Mkt-RF	1						
SMB	-0.6037	1					
HML	0.423563	-0.27284	1				
RMW	-0.29529	0.219986	-0.7397	1			
CMA	0.012714	-0.08888	0.55817	-0.46568	1		
WML	-0.27701	0.213301	-0.56333	0.383537	-0.28075	1	
ESG	0.17755	-0.17506	0.191264	-0.10431	0.086395	-0.24142	1

Table 5.11. Variance Inflation Factor (VIF) computed as: $\mathbf{1/(1-R^2)}$.

Variance Inflation Factor		
	R Square	*VIF*
Mkt-RF	0.49095	1.96
SMB	0.38001	1.61
HML	0.72376	3.62
RMW	0.55472	2.25
CMA	0.38551	1.63
WML	0.34070	1.52
ESG	0.08016	1.09

Apart from the value factor (HML), which exhibits quite a high correlation with the investment (CMA) and the momentum (WML) factors, Table 5.10 does not show any particularly high correlation among the independent variables. Moreover, in order to test the presence of multicollinearity, I have computed the Variance Inflation Factor (VIF), which measures the collinearity of each independent variable with respect to the others. Usually, a VIF higher than ten signals the presence of multicollinearity, and it requires the model to be adjusted. As shown in Table 5.11, the VIF of the selected risk factors never exceeds 4.00, therefore I conclude that the model is not affected by multicollinearity.

5.2.2 North America

For the North American region, I have selected the iShares Cohen & Steers REIT ETF, which is a fund investing entirely in the U.S. Real Estate industry. This fund tracks the Cohen & Steers Realty Majors Index, and its portfolio is constructed using a blend strategy, therefore combining value and growth stocks. Moreover, following a broad market strategy, this ETF targets many different REITs companies working in different property sectors, with a significant but not preponderant exposure to large, capitalized firms in the U.S..

The performed regressions, shown in Tables 5.12 and 5.13, demonstrate that the addition of the ESG risk factor generates a significant increase in the model's Adjusted R Squared, even though the applied Fama and French models can only partially explain the variation of the returns, as in the case of the European fund. Therefore, also in this case, it would be necessary to investigate other factors affecting the variation of returns.

Table 5.12. This table shows the results of the regression analysis performed with the Fama and French three-, five-, six- and seven- factor models in the Post Covid-19 Crisis period for the ETF investing in the Real Estate industry in North America. The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Period: 01/06/2009 - 30/06/2021				
Regression Statistics				
	3 Factor Model	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.453	0.461	0.463	0.490
Standard Error	0.0105	0.0104	0.0104	0.0102
Observations	3043	3043	3043	2981
Coefficients				
Factors	*3 Factor Model*	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	0.853 *	0.883 *	0.878 *	0.803 *
β SMB	-0.077 *	-0.015	-0.003	0.060
β HML	0.191 *	0.024	0.093	0.162 *
β RMW		0.183 *	0.208 *	0.237 *
β CMA		0.464 *	0.442 *	0.350 *
β WML			0.081 *	0.108 *
β ESG				0.470 *

Table 5.13. This table shows the results of the regression analysis performed with the Fama and French three-, five-, six- and seven- factor models in the Pre Covid-19 Crisis period for the ETF investing in the Real Estate industry in North America. The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Period: 01/06/2009 - 31/12/2019				
Regression Statistics				
	3 Factor Model	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.348	0.361	0.372	0.428
Standard Error	0.0103	0.0102	0.0101	0.0097
Observations	2666	2666	2666	2610
Coefficients				
Factors	*3 Factor Model*	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	0.779 *	0.833 *	0.819 *	0.681 *
β SMB	-0.033	-0.002	0.034	0.108 *
β HML	0.128 *	-0.101	0.040	0.088
β RMW		0.121	0.146 *	0.141 *
β CMA		0.643 *	0.603 *	0.468 *
β WML			0.229 *	0.222 *
β ESG				0.651 *

The comparison between the goodness-of-fit of the selected models in the Pre and the Post Covid-19 Crisis periods, reveals that including the analysis of the most recent economic crash significantly improves the model's explanatory power. Moreover, the seven-factor model is the one providing the most statistically significant coefficients' estimation. The performed regressions confirm the findings of Fama and French, who argued that because of the introduction of the profitability (RWM) and the investment (CMA) factors, the value factor (HML) tends to become redundant in the American market. Conversely, the higher Adjusted R Squared of the six-factor model associated to the addition of the momentum factor (WML) (which exhibits a positive and statistically significant coefficient), does not confirm the hypothesis of Fama and French, according to which its addition does not improve the explanatory power of the model.

As for the European fund, I have decided to focus on the comparison of the results obtained with the six- and the seven-factor models (see Table 5.14).

Table 5.14. This table shows the comparison between the results of the performed regression with the Fama and French six- and seven-factor models over the Pre Covid-19 Crisis period (from the 1st June 2009 to the 31st December 2019) and the Post Covid-19 Crisis period (from the 1st June 2009 to the 30th June 2021). The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Regression Statistics				
	Period: 01/06/2009 - 31/12/2019	*Period: 01/06/2009 - 31/12/2019*	*Period: 01/06/2009 - 30/06/2021*	*Period: 01/06/2009 - 30/06/2021*
	6 Factor Model	*7 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.372	0.428	0.463	0.490
Standard Error	0.0101	0.0097	0.0104	0.0102
Observations	2666	2610	3043	2981
Coefficients				
Factors	*6 Factor Model*	*7 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	0.819 *	0.681 *	0.878 *	0.803 *
β SMB	0.034	0.108 *	-0.003	0.060
β HML	0.040	0.088	0.093	0.162 *
β RMW	0.146 *	0.141 *	0.208 *	0.237 *
β CMA	0.603 *	0.468 *	0.442 *	0.350 *
β WML	0.229 *	0.222 *	0.081 *	0.108 *
β ESG		0.651 *		0.470 *
Annualized Alpha				
Alpha	2.161%	5.357%	0.188%	2.831%

First of all, the increasing value of the Adjusted R Squared shown in Table 5.14, suggests that adding the ESG risk factor to the six-factor model slightly improves its explanatory power. Moreover, the positive and statistically significant ESG coefficient indicates a high sensitivity of the returns to the ESG risk factor. Furthermore, the estimated coefficients suggest that this fund is particularly exposed to profitable companies, which apply a conservative investment strategy (as proven by the positive profitability (RMW) and investment (CMA) factors).

Finally, the decreasing ESG risk factor coefficient between the Pre and the Post Covid-19 Crisis periods, might suggest that the American market, conversely to the European one, does not perceive the allocation of capitals to sustainable companies as a hedging strategy when markets are bear. Therefore, even though the ESG coefficient remains positive and significant in both periods, after the Covid-19 Crisis returns become more sensitive to the market risk factor (Mrk – Rf), as well as to the portfolio's exposure to profitable companies (RMW) and value stocks (HML). Overall, the positive but not statistically significant values of the annualized alpha, which are higher in the case of the Fama and French seven-factor model, show that accounting for ESG risks might provide better financial performances.

In the second part of the analysis, I have studied the sensitivity of the returns to the ESG risk factor in the period before and after the introduction of the Paris Agreement on Climate Change, while isolating the Covid-19 Crisis period (see Table 5.15). The estimated ESG coefficient is strictly positive and significant in both the considered time frames, but any particular change is observed after the introduction of the Paris Agreement on Climate Change. Conversely, the most surprising finding is that before January 2016, the returns' sensitivity to the ESG risk factor was higher than the one to the market risk factor (Mkt – Rf)[21]. Therefore, this ETF's portfolio seems to be highly exposed to best ESG rated companies. Overall, the higher sensitivity of returns to the ESG risk factor for the American Real Estate market, compared to the European one, might be due to the greater maturity of the Green Building industry in the U.S., which has been steadily increasing since 2011.

[21] These results are significant also at 1% significance level.

Table 5.15. This table shows the comparison between the results of the performed regression with the Fama and French seven-factor model over the period before the introduction of the Paris Agreement on Climate Change (from the 1st June 2009 to the 31st December 2015), and the period after the introduction of the Paris Agreement on Climate Change and before the Covid-19 Crisis (from the 1st June 2009 to the 31st December 2019). The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Regression Statistics		
	Period: 01/06/2009 - 31/12/2015	*Period: 01/06/2009 - 31/12/2019*
	7 Factor Model	*7 Factor Model*
Adjusted R Square	0.520	0.428
Standard Error	0.0099	0.0097
Observations	1624	2610
Coefficients		
Factors	*7 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000
β Mkt-RF	0.683 *	0.681 *
β SMB	0.210 *	0.108 *
β HML	0.203 *	0.088
β RMW	0.009	0.141 *
β CMA	0.464 *	0.468 *
β WML	0.221 *	0.222 *
β ESG	0.730 *	0.651 *
Annualized Alpha		
Alpha	10.742%	5.357%

To conclude, I have tested the model for multicollinearity. As mentioned in Subsection 5.2.1, the test is done by computing the correlation matrix (see Table 5.16), and the Variance Inflation Factor (VIF), whose values are presented in Table 5.17. As in the case of the European ETF, the independent variable that exhibits the highest correlation with the others is the value factor (HML). Nevertheless, being the VIF always much lower than ten, I can conclude that the model is not affected by multicollinearity, and that all the selected independent variables are not excessively correlated to each other.

Table 5.16. Correlation matrix.

Correlation Matrix							
	Mkt-RF	*SMB*	*HML*	*RMW*	*CMA*	*WML*	*ESG*
Mkt-RF	1						
SMB	0.29868	1					
HML	0.08923	0.270125	1				
RMW	-0.20777	-0.3361	-0.16103	1			
CMA	-0.12327	0.097139	0.704826	0.025725	1		
WML	0.012372	-0.20319	-0.59947	0.01205	-0.38886	1	
ESG	0.234643	-0.04073	-0.03932	-0.01576	-0.02872	0.015867	1

Table 5.17. Variance Inflation Factor (VIF) computed as: $\mathbf{1}/(\mathbf{1}-\boldsymbol{R}^2)$.

Variance Inflation Factor		
	R Square	*VIF*
Mkt-RF	0.21628	1.28
SMB	0.22874	1.30
HML	0.67321	3.06
RMW	0.16381	1.20
CMA	0.54962	2.22
WML	0.38420	1.62
ESG	0.07492	1.08

5.3 Dataset: The Building & Construction industry

5.3.1 Europe

To carry the analysis of a fund investing in the Building & Construction industry in Europe, I have selected the iShares STOXX Europe 600 Construction & Materials UCITS ETF, whose portfolio is particularly exposed to the subsectors Building Products and Engineering & Construction. The geographical focus of the fund are France and Switzerland, with a significant exposure also in Sweden and Ireland. Moreover, this ETF implements a broad market strategy and its portfolio, which tracks the STOXX Europe 600 Construction & Materials Index, exploits a blend investment strategy, thus combining both value and growth stocks.

By checking the value of the Adjusted R Squared (see Tables 5.18 and 5.19), it is possible to observe that the goodness of fit of the Fama and French models applied to this ETF is much higher than the one obtained with the analysis of the ETFs investing in the Real Estate industry. Nevertheless, the results of the performed regressions show that the addition of the ESG risk factor does not improve the model's Adjusted R Squared, and the same effect is found with the addition of the profitability (RMW), the investment (CMA) and the momentum (WML) factors. As a result, the largest proportion of the variation of the returns can be ascribed to the market risk (Mkt - Rf), the size (SMB), and the value (HML) factors.

Moreover, the computed coefficients demonstrate that this fund's returns are particularly sensitive to the market risk factor (Mkt – Rf) whose beta, always lower than one, suggests that this fund's returns are less volatile than the market. While looking at the other coefficients, the two regressions indicate a significant exposure to value stocks of large, capitalized companies, as well as to firms adopting aggressive investment strategies.

Table 5.18. This table shows the results of the regression analysis performed with the Fama and French three-, five-, six- and seven- factor models in the Post Covid-19 Crisis period for the ETF investing in the Building & Construction industry in Europe. The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Period: 01/01/2010 - 30/06/2021				
Regression Statistics				
	3 Factor Model	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.624	0.631	0.632	0.629
Standard Error	0.0087	0.0086	0.0086	0.0087
Observations	2921	2921	2921	2859
Coefficients				
Factors	*3 Factor Model*	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	0.836 *	0.796 *	0.796 *	0.800 *
β SMB	-0.395 *	-0.429 *	-0.435 *	-0.427 *
β HML	0.150 *	0.493 *	0.546 *	0.534 *
β RMW		0.369 *	0.380 *	0.371 *
β CMA		-0.454 *	-0.460 *	-0.441 *
β WML			0.061 *	0.047
β ESG				0.028

Table 5.19. This table shows the results of the regression analysis performed with the Fama and French three-, five-, six- and seven- factor models in the Pre Covid-19 Crisis period for the ETF investing in the Building & Construction industry in Europe. The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Period: 01/01/2010 - 31/12/2019				
Regression Statistics				
	3 Factor Model	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.617	0.624	0.625	0.623
Standard Error	0.0079	0.0078	0.0078	0.0079
Observations	2540	2540	2540	2488
Coefficients				
Factors	*3 Factor Model*	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	0.776 *	0.736 *	0.737 *	0.739 *
β SMB	-0.443 *	-0.470 *	-0.474 *	-0.473 *
β HML	0.066	0.295 *	0.324 *	0.310 *
β RMW		0.110	0.088	0.067
β CMA		-0.480 *	-0.504 *	-0.511 *
β WML			0.062 *	0.058 *
β ESG				0.017

Another important finding from the comparison of the regressions performed with the Fama and French six- and seven-factor models (see Table 5.20), is the completely non-sensitivity of the returns to the ESG risk factor, both in the Pre and in the Post Covid-19 Crisis periods.
The particularly low value of the ESG coefficient (which is lower than 5%), might suggest an exposure of the portfolio to non-best performing companies in terms of sustainability; thus, to firms carrying medium ESG risks. This would also be coherent with the fact that companies operating in the Building & Construction industry are much more exposed to ESG risks than those operating in the Real Estate ones.
Nevertheless, these findings clearly contrast with those obtained with the analysis of the iShares STOXX Europe 600 Real Estate ETF (which are shown in Table 5.8). Indeed, while in that case the ESG coefficient (strictly positive and significant), slightly increases from the Pre to the Post Covid-19 Crisis periods, thus proving a higher sensitivity of returns to the ESG risk factor when markets are bear, the regressions shown in Table 5.20 demonstrate that the returns of this fund are not sensitive to the sustainability characteristics of the portfolio's

holdings, even during market downturns. Conversely, the regression analysis indicates that after the Covid-19 Crisis, returns became more sensitive to the value (HML) and the profitability (RMW) factors, meaning that they might have been driven by the earnings of profitable companies with high book-to-market equity ratios.

Table 5.20. This table shows the comparison between the results of the performed regression with the Fama and French six- and seven-factor models over the Pre Covid-19 Crisis period (from the 1st January 2010 to the 31st December 2019) and the Post Covid-19 Crisis period (from the 1st January 2010 to the 30th June 2021). The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Regression Statistics				
	Period: 01/01/2010 - 31/12/2019	*Period: 01/01/2010 - 31/12/2019*	*Period: 01/01/2010 - 30/06/2021*	*Period: 01/01/2010 - 30/06/2021*
	6 Factor Model	*7 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.625	0.623	0.632	0.629
Standard Error	0.0078	0.0079	0.0086	0.0087
Observations	2540	2488	2921	2859
Coefficients				
Factors	*6 Factor Model*	*7 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	0.737 *	0.739 *	0.796 *	0.800 *
β SMB	-0.474 *	-0.473 *	-0.435 *	-0.427 *
β HML	0.324 *	0.310 *	0.546 *	0.534 *
β RMW	0.088	0.067	0.380 *	0.371 *
β CMA	-0.504 *	-0.511 *	-0.460 *	-0.441 *
β WML	0.062 *	0.058 *	0.061 *	0.047
β ESG		0.017		0.028
Annualized Alpha				
Alpha	3.108%	3.476%	1.971%	2.708%

Finally, the comparison of the coefficients estimated with the Fama and French seven-factor model in the periods before and after the introduction of the Paris Agreement on Climate Change (see Table 5.21), confirms that returns are not sensitive to the ESG risk factor.

Overall, the significant exposure of the portfolio to companies based in Switzerland might have influenced the regressions' results. Indeed, the attention towards green building and sustainable constructions in this country is not as spread as in other geographical areas. Moreover, according to the European Energy Centre, the Building & Construction industry in Switzerland is still based on traditional construction methodologies, and the green building sector is still focused on the construction of energy-efficient structures, while less attention is paid to other issues, such as the selection of sustainable materials and the reduction of waste (European Energy Centre, 2020).

Table 5.21. This table shows the comparison between the results of the performed regressions with the Fama and French seven-factor model over the period before the introduction of the Paris Agreement on Climate Change (from the 1st January 2010 to the 31st December 2015), and the period after the introduction of the Paris Agreement on Climate Change and before the Covid-19 Crisis (from the 1st January 2010 to the 31st December 2019). The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

	Period: 01/01/2010 - 31/12/2015	*Period: 01/01/2010 - 31/12/2019*
Regression Statistics		
	7 Factor Model	*7 Factor Model*
Adjusted R Square	0.650	0.623
Standard Error	0.0084	0.0079
Observations	1491	2488
Coefficients		
Factors	*7 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000
β Mkt-RF	0.728 *	0.739 *
β SMB	-0.433 *	-0.473 *
β HML	0.353 *	0.310 *
β RMW	-0.095	0.067
β CMA	-0.399 *	-0.511 *
β WML	0.121 *	0.058 *
β ESG	0.017	0.017
Annualized Alpha		
Alpha	5.276%	3.476%

To conclude, I have decided to compute the correlation matrix, shown in Table 5.22, and the Variance Inflation Factor (VIF), presented in Table 5.23, in order to check for the presence of multicollinearity. The results show that the selected independent variables are not highly correlated to each other, even though the value factor (HML) exhibits a higher correlation to the other factors. Therefore, I can exclude the presence of multicollinearity from this model.

Table 5.22. Correlation Matrix.

Correlation Matrix							
	Mkt-RF	*SMB*	*HML*	*RMW*	*CMA*	*WML*	*ESG*
Mkt-RF	1						
SMB	-0.60185	1					
HML	0.421713	-0.27158	1				
RMW	-0.29459	0.219557	-0.73995	1			
CMA	0.011153	-0.08864	0.557812	-0.46518	1		
WML	-0.27526	0.213071	-0.56386	0.384557	-0.28045	1	
ESG	-0.02413	0.083319	-0.19641	0.133063	-0.16255	0.146629	1

Table 5.23. Variance Inflation Factor (VIF) computed as: $\mathbf{1/(1-R^2)}$.

Variance Inflation Factor		
	R Squared	*VIF*
Mkt-RF	0.49158	1.97
SMB	0.37791	1.61
HML	0.72595	3.65
RMW	0.55418	2.24
CMA	0.38633	1.63
WML	0.32664	1.49
ESG	0.05335	1.06

5.3.2 North America

For the analysis of the North American region, I have selected the iShares U.S. Home Construction ETF, which is a fund investing entirely in the U.S., with a preponderant exposure to the subsectors Homebuilding and Building Products. Once again, the fund exploits a blend strategy and its portfolio covers many different companies operating in the Construction industry, thus implementing a broad market strategy. Compared to the iShares STOXX Europe 600 Construction & Materials ETF, this fund has a significant lower exposure to carbon intensity, and it exhibits slightly better performances in terms of sustainability.

Comparing the Adjusted R Squared of the performed regressions (see Tables 5.24 and 5.25), it is possible to observe that adding other factors to the Fama and French three-factor model does not dramatically improve its explanatory power. Moreover, the value of the Adjusted R Squared, ranging from 0.44 to 0.53, highlights, again, that the Fama and French multi-factor model does not entirely explain the returns' variation, and that other risk factors should be added. Nevertheless, the results obtained with the performed regressions show that almost all the considered risk factors are significant at 95% confidence level.

Table 5.24. This table shows the results of the regression analysis performed with the Fama and French three-, five-, six- and seven- factor models in the Post Covid-19 Crisis period for the ETF investing in the Building & Construction industry in North America. The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Period: 01/06/2009 - 31/12/2019				
Regression Statistics				
	3 Factor Model	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.444	0.459	0.460	0.465
Standard Error	0.0120	0.0118	0.0118	0.0118
Observations	2666	2666	2666	2666
Coefficients				
Factors	*3 Factor Model*	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	1.001 *	1.075 *	1.069 *	1.077 *
β SMB	0.528 *	0.572 *	0.589 *	0.648 *
β HML	0.061	-0.301 *	-0.237 *	-0.221 *
β RMW		0.158	0.170 *	0.172 *
β CMA		0.834 *	0.815 *	0.796 *
β WML			0.106 *	0.103 *
β ESG				0.131 *

Table 5.25. This table shows the results of the regression analysis performed with the Fama and French three-, five-, six- and seven- factor models in the Pre Covid-19 Crisis period for the ETF investing in the Building & Construction industry in North America. The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Period: 01/06/2009 - 30/06/2021				
Regression Statistics				
	3 Factor Model	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Adjusted R Square	0.506	0.518	0.522	0.526
Standard Error	0.0130	0.0128	0.0127	0.0127
Observations	3043	3043	3043	3043
Coefficients				
Factors	*3 Factor Model*	*5 Factor Model*	*6 Factor Model*	*7 Factor Model*
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	1.064 *	1.107 *	1.096 *	1.105 *
β SMB	0.580 *	0.703 *	0.728 *	0.798 *
β HML	0.077 *	-0.210 *	-0.074	-0.044
β RMW		0.431 *	0.479 *	0.486 *
β CMA		0.526 *	0.482 *	0.443 *
β WML			0.159 *	0.156 *
β ESG				0.136 *

The analysis of the European and the American funds investing in the Building & Construction industry highlight significant differences between the two. Therefore, in Table 5.26 I have decided to summarize the coefficients estimated with the Fama and French seven-factor model for the two funds.

First of all, the effect on the Adjusted R Squared of the extension of the analysis to the Post Covid-19 Crisis period is much higher in the American fund than in the European one. Nevertheless, the most significant differences are related to the values of the coefficients of the market risk (Mkt – Rf), the size (SMB), the value (HML), the investment (CMA) and the sustainability (ESG) risk factors. Indeed, the market risk factor's beta higher than one suggests that the American fund is much riskier than the European ETF. Moreover, the American fund is highly exposed to small, capitalized companies and to growth stocks, and its portfolio's returns are highly sensitive to firms implementing conservative investment strategies.

For the purposes of this thesis, one of the most interesting differences observed between these two funds is the returns' sensitivity to the ESG risk factor. Indeed, while the analysis of the iShares STOXX Europe 600 Construction & Materials ETF demonstrates any sensitivity of the returns to this factor, the regressions performed over the returns of the iShares U.S. Home Construction ETF show a positive and statistically significant ESG coefficient.

Table 5.26. This table shows the comparison between the estimated coefficients with the Fama and French seven-factor model of the European and the American ETFs investing in the Building & Construction industry during the Pre Covid-19 Crisis and the Post Covid-19 Crisis periods. The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

	Europe iShares STOXX Europe 600 Construction & Materials ETF		***North America*** iShares U.S. Home Construction ETF	
	Period: 01/01/2010 - 31/12/2019	*Period: 01/01/2010 - 30/06/2021*	*Period: 01/06/2009 - 31/12/2019*	*Period: 01/06/2009 - 30/06/2021*
Adjusted R Square	0.623	0.629	0.465	0.526
Standard Error	0.0079	0.0087	0.0118	0.0127
Observations	2488	2859	2666	3043
Coefficients				
Alpha	0.000	0.000	0.000	0.000
β Mkt-RF	0.739 *	0.800 *	1.077 *	1.105 *
β SMB	-0.473 *	-0.427 *	0.648 *	0.798 *
β HML	0.310 *	0.534 *	-0.221 *	-0.044
β RMW	0.067	0.371 *	0.172 *	0.486 *
β CMA	-0.511 *	-0.441 *	0.796 *	0.443 *
β WML	0.058 *	0.047	0.103 *	0.156 *
β ESG	0.017	0.028	0.131 *	0.136 *

Moreover, its slightly increasing value from the Pre to the Post Covid-19 Crisis periods might suggest that this portfolio's returns became a little more sensitive to the ESG risk factor during market downturns.

Nevertheless, the overall analysis of the ETFs investing in the Building & Construction industry provides clear evidence of the greater sensitivity of the returns to traditional risk factors. Indeed, as shown in Table 5.26, the independent variables with the highest beta for the American fund are the market risk (Mkt – Rf), the size (SMB), the profitability (RMW) and the investment (CMA) factors.

Moreover, by comparing the results of the two selected industries, the analysis might suggest that returns are more sensitive to the ESG risk factor when the funds' portfolios are highly exposed to best ESG-rated companies. Conversely, their sensitivity seems to be almost neutral in case of exposure to companies characterized by medium ESG risks, as in this case.

Indeed, even though the two ETFs investing in the Building & Construction industry have great sustainability scores (if compared to other funds in the same category), they are more exposed to ESG risks than those investing in the Real Estate industry.

Therefore, the increasing (but not statistically significant) values of alpha shown in Table 5.27, might indicate that the exposure to medium ESG risk companies do not penalize returns. Overall, I can conclude that the Real Estate industry is much more sensitive to the ESG risk factor than the Building & Construction one.

Table 5.27. This table shows the estimated values of the alpha and the annualized alpha in the Post Covid-19 Crisis period for the European and the American ETFs investing in the Building & Construction industry.

	Europe iShares STOXX Europe 600 Construction & Materials ETF		***North America*** iShares U.S. Home Construction ETF	
	6 factor model	*7 factor model*	*6 factor model*	*7 factor model*
α	0.000	0.000	0.000	0.000
Annualized α	1.97%	2.71%	2.88%	3.02%

Finally, the estimated coefficients in the periods before and after the introduction of the Paris Agreement on Climate Change, shown in Table 5.28, clearly demonstrate that the returns' sensitivity to the ESG risk factor was not affected by this global event.

Table 5.28. This table shows the comparison between the results of the performed regression with the Fama and French seven-factor model over the period before the introduction of the Paris Agreement on Climate Change (from the 1st June 2009 to the 31st December 2015), and the period after the introduction of the Paris Agreement on Climate Change and before the Covid-19 Crisis (from the 1st June 2009 to the 31st December 2019). The asterisk (*) indicates a statistically significant coefficient at 5% significance level.

Regression Statistics		
	Period: 01/06/2009 - 31/12/2015	Period: 01/06/2009 - 31/12/2019
	7 Factor Model	7 Factor Model
Adjusted R Square	0.485	0.465
Standard Error	0.0126	0.0118
Observations	1660	2666
Coefficients		
Factors	7 Factor Model	7 Factor Model
Alpha	0.000	0.000
β Mkt-RF	1.071 *	1.077 *
β SMB	0.577 *	0.648 *
β HML	-0.282 *	-0.221 *
β RMW	-0.178	0.172 *
β CMA	1.214 *	0.796 *
β WML	0.144 *	0.103 *
β ESG	0.140 *	0.131 *
Annualized Alpha		
Alpha	5.064%	3.411%

To conclude, the correlation matrix and the estimated VIF (see Tables 5.29 and 5.30), allow me to confirm that the selected independent variables are not highly correlated to each other, and to exclude the presence of multicollinearity from this model.

Table 5.29. Correlation Matrix.

Correlation Matrix	Mkt-RF	SMB	HML	RMW	CMA	WML	ESG
Mkt-RF	1						
SMB	0.294982	1					
HML	0.086164	0.274268	1				
RMW	-0.20034	-0.33366	-0.15869	1			
CMA	-0.1263	0.102739	0.706109	0.023876	1		
WML	0.008119	-0.21052	-0.60327	0.008446	-0.39033	1	
ESG	-0.17687	-0.33139	-0.16798	0.117863	-0.02757	0.125138	1

Table 5.30. Variance Inflation Factor (VIF) computed as: $1/(1-R^2)$.

Variance Inflation Factor		
	R Squared	*VIF*
Mkt-RF	0.15766	1.19
SMB	0.27252	1.37
HML	0.67647	3.09
RMW	0.16163	1.19
CMA	0.55227	2.23
WML	0.38843	1.64
ESG	0.12870	1.15

5.4 A focus on Alpha

In this section I want to briefly discuss the value of the intercepts computed using the Fama and French three-, five-, six-, and seven-factor models for the European and the American ETFs, both in the Pre and in the Post Covid-19 Crisis periods.

First of all, in quantitative finance the value of the intercept of a linear regression model is called *Jensen's Alpha*, which is a statistical measure used to analyse the financial performance of a security or a portfolio. More specifically, its value allows the investor to understand whether the applied investment strategy generates an abnormal return. Therefore, a positive alpha demonstrates that the asset generates a return on the investment, while a negative value is synonym of bad financial performances.

Nevertheless, the meaning of the intercept's value in asset pricing models and, specifically, in the Fama and French model, can slightly differ from its traditional concept. Indeed, according to Fama & French (2015), the model is formulated such that the value of alpha (the intercept) is zero when the model's risk factors capture all the expected returns' variation.

Panel A in Table 5.31 shows the estimated values of alpha for the European and the American ETFs investing in Real Estate, in both the Pre and the Post Covid-19 Crisis periods. These values, being computed with the regression of the funds' daily excess returns (dependent variable) and the daily risk factors (independent variables), are expressed on a daily basis, and they are all not significant at 95% confidence level. In order to have a clearer understanding of their values, I have decided to convert them to an annual base (see Table 5.31, Panel B). The conversion has been made considering 252 trading days, as reported in equation (5.1):

$$\alpha_{annualized} = [((1 + \alpha_{daily})\char`^252) - 1] \tag{5.1}$$

The low value of the Adjusted R Squared and the statistical insignificance of all the estimated alpha would suggest that the applied Fama and French models do not capture all the variation of the returns in the case of the selected ETFs. Therefore, I have decided to perform the Gibbons-Ross-Shanken (GRS) test on Matlab, which is used to verify whether the estimated values of alpha are not significantly different from zero, thus if the risk factors used in the Fama and French models capture all the returns' variation of the selected funds.
The GRS F-test is computed according to the regression-equation reported in (5.2):

$$FGRS = \frac{T}{N} * \frac{T-N-L}{T-L-1} * \frac{\hat{\alpha}' * \hat{\Sigma}^{-1} * \hat{\alpha}}{1 + \bar{\mu}' * \hat{\Omega}^{-1} * \bar{\mu}} \sim F\ (N, T-N, L), \tag{5.2}$$

where:

T *is the number of observations in the performed regression,*

N *is the number of estimated intercepts,*

L *is the number of factors for which the predicted values are computed,*

$\hat{\Sigma}$ *is the TxN covariance matrix of the residuals,*

$\hat{\alpha}$ *is a Nx1 vector of the estimated intercepts from the performed regression,*

$\hat{\Omega}$ *is the unbiased estimation of the factors' covariance matrix,*

$\bar{\mu}$ *is a Lx1 vector of the sample means of the factors' predicted excess returns.*

Therefore, the GRS F-test is used to verify the following hypotheses:

H_0: $\hat{\alpha}_1 = \hat{\alpha}_2 = \hat{\alpha}_n = 0$,

and

H_1: $\hat{\alpha}_1, \hat{\alpha}_2, \dots, \hat{\alpha}_n \neq 0$,

where H_0 is the null hypothesis, according to which the real values of alpha are all equal to zero and, consequently, the model can perfectly explain the variation of the returns; while H_1 is the alternative hypothesis, according to which the real values of alpha are not equal to zero and, thus, the model can not fully explain the variation of the returns. Moreover, if the real value of alpha is zero, also the GRS statistic (FGRS) should tend towards zero (Erdinç, 2017).

Table 5.31. The table summarizes the statistics of the ETFs investing in the Real Estate industry. Panel A shows the estimated values of the intercept (alpha) with the Fama and French three-, five-, six-, and seven-factor models, for the European and the American ETFs. Panel B shows the annualized value of the estimated alphas. Panel C summarizes the values of the Adjusted R Squared of the performed regressions.

Real Estate Industry				
Panel A				
	Pre Covid-19 Crisis Period		Post Covid-19 Crisis Period	
	iShares STOXX Europe 600 Real Estate ETF	iShares Cohen & Steers REIT ETF	iShares STOXX Europe 600 Real Estate ETF	iShares Cohen & Steers REIT ETF
α - 3 factor model	0.000	0.000	0.000	0.000
α - 5 factor model	0.000	0.000	0.000	0.000
α - 6 factor model	0.000	0.000	0.000	0.000
α - 7 factor model	0.000	0.000	0.000	0.000
Panel B				
	Pre Covid-19 Crisis Period		Post Covid-19 Crisis Period	
	iShares STOXX Europe 600 Real Estate ETF	iShares Cohen & Steers REIT ETF	iShares STOXX Europe 600 Real Estate ETF	iShares Cohen & Steers REIT ETF
Annualized α - 3 factor model	2.71%	3.97%	0.62%	1.40%
Annualized α - 5 factor model	3.90%	2.36%	0.00%	0.14%
Annualized α - 6 factor model	3.35%	2.16%	0.08%	0.19%
Annualized α - 7 factor model	6.78%	5.36%	3.34%	2.83%
Panel C				
	Pre Covid-19 Crisis Period		Post Covid-19 Crisis Period	
	iShares STOXX Europe 600 Real Estate ETF	iShares Cohen & Steers REIT ETF	iShares STOXX Europe 600 Real Estate ETF	iShares Cohen & Steers REIT ETF
Adjusted R Square - 3 factor model	0.435	0.348	0.461	0.453
Adjusted R Square - 5 factor model	0.440	0.361	0.465	0.461
Adjusted R Square - 6 factor model	0.441	0.372	0.465	0.463
Adjusted R Square - 7 factor model	0.502	0.428	0.526	0.490

Panel C in Table 5.32 shows the results of the GRS test performed on the alpha estimated with the six- and the seven-factor models for the ETFs investing in the Real Estate industry.

The p-values of the GRS test (pGRS) allow me to reject the null hypothesis in five out of eight cases, thus confirming that the Fama and French six- and seven-factor models do not fully capture the returns' variation. Conversely, in the case of the American ETF, the GRS test seems to prove that in the Post Covid-19 Crisis period the real value of alpha is equal to zero, as the high p-value does not allow me to reject the null hypothesis. Nevertheless, this result contrasts with the value of the Adjusted R Squared of the performed regressions (see Table 5.31), and even the GRS F-value does not tend towards zero. Therefore, I cannot conclude that the Fama and French model fully explain the returns' variation of the American ETF, and further investigations would be necessary.

Table 5.32. This table summarizes the results of the GRS F-test performed on the ETFs investing in the Real Estate industry. Panel A shows the daily values of alpha estimated with the Fama and French six- and seven-factor models in the Pre and in the Post Covid-19 Crisis periods. Panel B shows the annualized values of the estimated alpha. Panel C shows the GRS test's statistics.

Real Estate Industry				
	Pre Covid-19 Crisis Period		***Post Covid-19 Crisis Period***	
	iShares STOXX Europe 600 Real Estate ETF	iShares Cohen & Steers REIT ETF	iShares STOXX Europe 600 Real Estate ETF	iShares Cohen & Steers REIT ETF
Panel A				
α - 6 factor model	0.000	0.000	0.000	0.000
α - 7 factor model	0.000	0.000	0.000	0.000
Panel B				
Annualized α - 6 factor model	3.35%	2.16%	0.08%	0.19%
Annualized α - 7 factor model	6.78%	5.36%	3.34%	2.83%
Panel C				
FGRS - 6 factor model	4.3265	2.4487	3.2076	1.6303
pGRS - 6 factor model	0.0002	0.0230	0.0038	0.1346
FGRS - 7 factor model	0.0909	2.2959	3.1111	1.9023
pGRS - 7 factor model	0.9988	0.0248	0.0028	0.0652

I have performed the same test on the European and the American ETFs investing in the Building & Construction industry, whose results are presented in Tables 5.33 and 5.34.

The two selected ETFs present in both periods daily alpha which tend towards zero and, even though the values of the Adjusted R Squared are all higher than those observed for the Real Estate industry, their value does not allow me to state that the applied versions of the Fama and French model can entirely explain the variation of the returns. Indeed, the GRS p-value (pGRS) shown in Panel C of Table 5.34, confirm that in five out of eight cases I can reject the null hypothesis, proving that the selected risk factors do not perfectly explain the returns' variation.

To conclude, for the three observations whose p-value (pGRS) is higher than 0.05, which does not allow me to reject the null hypothesis, I think that further investigation would be needed, as the values of the Adjusted R Squared contrast with the results of the GRS test.

Table 5.33. The table summarizes the statistics of the ETFs investing in the Building & Construction industry. Panel A shows the estimated values of the intercept (alpha) with the Fama and French three-, five-, six-, and seven-factor models, for the European and the American ETFs. Panel B shows the annualized value of the estimated alphas. Panel C summarizes the values of the Adjusted R Squared of the performed regressions.

Building & Construction Industry				
Panel A				
	Pre Covid-19 Crisis Period		Post Covid-19 Crisis Period	
	iShares STOXX Europe 600 Construction & Materials ETF	iShares US Home Construction ETF	iShares STOXX Europe 600 Construction & Materials ETF	iShares US Home Construction ETF
α - 3 factor model	0.000	0.000	0.000	0.000
α - 5 factor model	0.000	0.000	0.000	0.000
α - 6 factor model	0.000	0.000	0.000	0.000
α - 7 factor model	0.000	0.000	0.000	0.000
Panel B				
	Pre Covid-19 Crisis Period		Post Covid-19 Crisis Period	
	iShares STOXX Europe 600 Construction & Materials ETF	iShares US Home Construction ETF	iShares STOXX Europe 600 Construction & Materials ETF	iShares US Home Construction ETF
Annualized α - 3 factor model	3.30%	5.81%	3.45%	5.12%
Annualized α - 5 factor model	3.60%	3.39%	2.42%	2.78%
Annualized α - 6 factor model	3.11%	3.30%	1.97%	2.88%
Annualized α - 7 factor model	3.48%	3.41%	2.71%	3.02%
Panel C				
	Pre Covid-19 Crisis Period		Post Covid-19 Crisis Period	
	iShares STOXX Europe 600 Construction & Materials ETF	iShares US Home Construction ETF	iShares STOXX Europe 600 Construction & Materials ETF	iShares US Home Construction ETF
Adjusted R Square - 3 factor model	0.617	0.444	0.624	0.506
Adjusted R Square - 5 factor model	0.624	0.459	0.631	0.518
Adjusted R Square - 6 factor model	0.625	0.460	0.632	0.522
Adjusted R Square - 7 factor model	0.623	0.465	0.629	0.526

Table 5.34. This table summarizes the results of the GRS F-test performed on the ETFs investing in the Building & Construction industry. Panel A shows the daily values of alpha estimated with the Fama and French six- and seven-factor models in the Pre and in the Post Covid-19 Crisis periods. Panel B shows the annualized values of the estimated alpha. Panel C shows the GRS test's statistics.

Building & Construction Industry				
	Pre Covid-19 Crisis Period		***Post Covid-19 Crisis Period***	
	iShares STOXX Europe 600 Construction & Materials ETF	iShares US Home Construction ETF	iShares STOXX Europe 600 Construction & Materials ETF	iShares US Home Construction ETF
Panel A				
α - 6 factor model	0.000	0.000	0.000	0.000
α - 7 factor model	0.000	0.000	0.000	0.000
Panel B				
Annualized α - 6 factor model	3.11%	3.30%	1.97%	2.88%
Annualized α - 7 factor model	3.48%	3.41%	2.71%	3.02%
Panel C				
FGRS - 6 factor model	4.2267	2.4487	3.2445	1.6303
pGRS - 6 factor model	0.0003	0.0230	0.0035	0.1346
FGRS - 7 factor model	2.4864	1.6761	3.2917	0.2645
pGRS - 7 factor model	0.0152	0.1102	0.0017	0.9675

5.5 Comparison of the risk-return profiles of the selected ETFs

The last part of this chapter is dedicated to the evaluation of the financial performances of the selected ETFs. In order to evaluate their risk-return profiles, I have decided to compare each fund to its official benchmark index and to another ETF belonging to the same category, but with a lower sustainability score. Indeed, the comparison of each fund only to its benchmark index would not provide enough information about its financial performances, as the benchmark index usually performs much better than the single fund, having a larger and more diversified portfolio.

In Table 5.35 I have summarized the information about the sustainability characteristics of the previously analysed ETFs, and those of the funds characterized by the lower ESG score. Comparing the ETFs to those with lower sustainability performances, allow me to analyse whether the portfolios' exposed to more sustainable companies provided a better protection from losses during bear markets.

I have decided to use four different financial indicators. The first is the Average Monthly Return, computed on a yearly basis as the geometric mean of monthly returns.

Table 5.35. This table summarizes the sustainability characteristics of the previously analysed ETFs and those of the ETFs selected for the comparison of the financial performances.

ETF	ESG Morningstar score (0-50)		Fossil Fuel Involvement (0-100)	Carbon Risk Score (0-100)	Weighted average carbon intensity (tCO_2e / \$m sales)	Green Revenues	Historical Sustainability Score Percent Rank	MSCI ESG Fund Rating (AAA-CCC)	MSCI ESG Quality Score (0-10)
	Current	Historical							
iShares STOXX Europe 600 Real Estate UCITS ETF (DE)	12.27	12.59	0.00	N.A.	Moderate carbon intensity	19.20%	6/1144	AAA	8.41
Amundi FTSE EPRA Europe Real Estate UCITS ETF	13.18	14.24	4.00	N.A.	Moderate carbon intensity	5.00%	10/1144	AA	N.A.
iShares Cohen & Steers REIT ETF ICF	13.45	14.08	0.00	11.22	Moderate carbon intensity	15.80%	15/1144	A	6.20
iShares Core US REIT ETF	14.98	15.45	0.00	12.21	Moderate carbon intensity	15.10%	55/1144	BB	3.90
iShares STOXX Europe 600 Construction & Materials UCITS ETF (DE)	22.74	23.34	0.00	N.A.	Very high carbon instensity	14.40%	24/150	AA	8.09
Lyxor STOXX Europe 600 Construction & Materials UCITS ETF	23.73	23.74	0.00	N.A.	Moderate carbon intensity	0.60%	19/50	A	N.A.
iShares U.S. Home Construction ETF	22.80	22.30	0.00	15.67	Low carbon instensity	10.70%	47/238	A	6.10
Invesco Dynamic Building & Construction ETF	26.02	26.22	0.00	N.A.	Moderate carbon intensity	7.20%	49/150	AA	N.A.

The decision to use the geometric mean instead of the arithmetic ones, is derived by the fact that the former accounts for the effect of compounding, and it is usually considered a better measure of the financial performances of a portfolio.

The second indicator is the standard deviation of monthly returns, which measures the dispersion of data from the mean. In finance, the standard deviation is used as a measure of risk, as its value can provide useful information about the historic volatility of a portfolio's returns. Thus, it is important to remember that a higher standard deviation is synonym of higher risk. Finally, the third and the fourth indicators are skewness and kurtosis. The former is used to analyse whether the returns deviate from the normal distribution. Indeed, a positive skewness suggests that the investors are more exposed to small, recurrent losses and that there is a probability of receiving few but large positive returns. On the contrary, a negative skewness suggests an exposure to frequent, small returns and the probability of observing few but large losses (Corporata Finance Institute, 2021). Finally, the kurtosis is used to analyse whether a given distribution exhibits heavy tails. In finance, this is an important statistic, as it provides information about the riskiness of an investment, by measuring the probability of observing extreme positive and negative events. Being the kurtosis of a normally distributed dataset equal to three, an excess kurtosis closed to zero indicates a *mesokurtic* distribution, and it means that the data are normally distributed. On the contrary, a *leptokurtic* distribution relates to a positive excess kurtosis, and it suggests that the probability of extreme events on both tails is high, making the investment risky. Finally, a negative excess kurtosis, which is referred to a *platykurtic* distribution, means that there is a low probability of observing extreme events; thus, the investment is considered safer for the investor (Corporate Finance Institute, 2021).

The following tables summarize the values of the previously mentioned financial indicators. In each table the "Benchmark index" column indicates the estimated indicators of the official ETFs' benchmark indexes, while the "ETF" column represents the estimated indicators of the previously analysed funds. Finally, the "Other ETF" column shows the estimated indicators of the ETF with the lower sustainability score. The years marked in grey represent recession periods, according to the OECD Recession Indicators.

Starting from the Real Estate industry, I have decided to compare the iShares STOXX Europe 600 Real Estate ETF to its benchmark index, which is the STOXX Europe 600 Real Estate Index, and to the Amundi FTSE EPRA Europe Real Estate ETF.

The observed values of the standard deviation (see Table 5.36) suggest that the iShares STOXX Europe 600 Real Estate ETF is slightly riskier than the other ETF. Moreover, the average monthly returns show that in most of the observed years the fund was underperforming, if compared to other ETF and to its benchmark index.

Nevertheless, the average monthly return registered in 2020, thus during the Covid-19 crash, shows that the iShares STOXX Europe 600 Real Estate ETF performed slightly better than the Amundi FTSE EPRA Europe Real Estate ETF, given the same standard deviation. The slightly lower losses recorded by this fund might be partially due to its portfolio's sustainability characteristics, considered that the Fama and French seven-factor model (see subsection 5.2.1) proved a positive and statistically significant sensitivity of the returns to the ESG risk factor, which also increased after the Covid-19 Crisis period.

Table 5.36. This table shows the average monthly returns computed on an annual basis and the standard deviation of the STOXX Europe 600 Real Estate Index, the iShares STOXX Europe 600 Real Estate ETF, and the Amundi FTSE EPRA Europe Real Estate ETF. The years marked in grey indicate a recession period.

iShares STOXX Europe 600 Real Estate ETF						
Year	Average Monthly R(t)			Standard Deviation		
	Benchmark Index	ETF	Other ETF	Benchmark Index	ETF	Other ETF
2021	1.37%	1.12%	1.48%	3.5%	3.6%	3.1%
2020	-0.77%	-0.87%	-0.99%	8.1%	8.2%	8.2%
2019	2.01%	1.85%	2.08%	3.7%	3.6%	3.4%
2018	-0.92%	-1.12%	-0.70%	3.3%	3.3%	3.0%
2017	0.83%	0.54%	0.99%	2.7%	2.9%	2.3%
2016	-0.46%	-0.72%	-0.53%	4.8%	5.0%	4.7%
2015	1.17%	1.03%	1.46%	5.9%	5.8%	5.7%
2014	1.79%	1.59%	1.85%	2.9%	3.0%	2.4%
2013	0.73%	0.15%	0.75%	3.8%	3.6%	4.3%
2012	2.21%	2.10%	2.24%	2.9%	2.7%	3.0%
2011	-0.75%	-0.98%	-1.14%	5.1%	5.0%	5.3%
2010	1.14%	0.96%	1.00%	5.3%	5.4%	5.1%

Finally, the negative excess kurtosis shown in Table 5.37, suggests that this fund's returns are characterized by a platykurtic distribution. Furthermore, the lower excess kurtosis of the iShares STOXX Europe 600 Real Estate ETF during the Covid-19 crash (in 2020) with respect to the other fund, might indicate a lower exposure to extreme events.

Table 5.37. This table shows the skewness, the kurtosis and the excess kurtosis computed for the STOXX Europe 600 Real Estate Index, the iShares STOXX Europe 600 Real Estate ETF, and the Amundi FTSE EPRA Europe Real Estate ETF. The years marked in grey indicate a recession period.

iShares STOXX Europe 600 Real Estate ETF									
Year	Skewness			Kurtosis			Excess Kurtosis (Kurtosis -3)		
	Benchmark Index	ETF	Other ETF	Benchmark Index	ETF	Other ETF	Benchmark Index	ETF	Other ETF
2021	-0.60	-0.80	-0.40	-1.86	-1.16	-1.30	-4.86	-4.16	-4.30
2020	-1.43	-1.42	-1.44	3.87	3.85	4.18	0.87	0.85	1.18
2019	0.89	0.88	0.71	1.75	1.51	1.45	-1.25	-1.49	-1.55
2018	-0.02	-0.13	0.06	-0.72	-0.69	-0.74	-3.72	-3.69	-3.74
2017	-0.14	-0.01	-0.08	-0.43	-0.74	-0.20	-3.43	-3.74	-3.20
2016	0.24	0.22	0.10	-1.31	-1.26	-1.39	-4.31	-4.26	-4.39
2015	1.06	1.13	1.06	0.35	1.00	0.28	-2.65	-2.00	-2.72
2014	-0.09	0.02	-0.39	-0.67	-0.84	-0.40	-3.67	-3.84	-3.40
2013	-0.37	-0.47	-0.29	-0.80	-0.98	-1.05	-3.80	-3.98	-4.05
2012	0.32	0.01	0.26	-1.76	-1.85	-1.70	-4.76	-4.85	-4.70
2011	-0.10	-0.04	-0.12	-0.59	-0.49	-0.77	-3.59	-3.49	-3.77
2010	0.03	-0.36	-0.08	-1.41	-0.61	-1.36	-4.41	-3.61	-4.36

For what concerns the American market, I have decided to compare the iShares Cohen & Steers REIT ETF with its benchmark index, the Cohen & Steers Realty Majors Index, and another ETF with a lower sustainability score, which is the iShares Core U.S. REIT ETF.

The average monthly returns in Table 5.38 show that the iShares Cohen & Steers REIT ETF performed much better than the other ETF, especially during the last recession period. Indeed, it generated lower losses than the iShares Core U.S. REIT ETF during the Covid-19 Crisis period, and in the last four years it also exhibited a lower standard deviation. Even though many other variables might have contributed to its financial performances, the analysis done with the Fama and French seven-factor model (see subsection 5.5.2), suggests that this fund's returns are highly sensitive to the ESG risk factor. Therefore, its superior exposure to sustainable companies might have contributed to the lower losses recorded during the last recession period.

Table 5.38. This table shows the average monthly returns computed on an annual basis and the standard deviation of the Cohen & Steers Realty Majors Index, the iShares Cohen & Steers REIT ETF, and the iShares Core U.S. REIT ETF. The years marked in grey indicate a recession period.

iShares Cohen & Steers REIT ETF						
Year	Average Monthly R(t)			Standard Deviation		
	Benchmark	ETF	Other ETF	Benchmark	ETF	Other ETF
2021	3.99%	3.81%	3.70%	3.8%	3.6%	2.8%
2020	-1.13%	-1.38%	-1.69%	6.1%	6.3%	8.0%
2019	2.10%	1.85%	1.82%	3.8%	3.8%	3.9%
2018	0.23%	-0.07%	-0.43%	5.1%	5.1%	5.5%
2017	-0.66%	-0.95%	-0.94%	2.3%	2.4%	2.4%
2016	0.65%	0.28%	0.50%	4.3%	3.9%	3.8%
2015	1.42%	1.11%	0.91%	7.3%	7.3%	6.9%
2014	3.63%	3.30%	2.95%	3.5%	3.7%	3.2%
2013	-0.49%	-0.78%	-0.75%	3.9%	3.9%	4.0%
2012	1.07%	0.79%	0.84%	3.5%	3.5%	3.2%
2011	1.09%	0.81%	0.65%	5.4%	5.5%	4.6%
2010	2.78%	2.48%	2.22%	4.9%	5.0%	4.3%

Finally, in most of the observed years the fund exhibits a positive skewness and a platykurtic distribution (see Table 5.39). Moreover, in 2020 the positive excess kurtosis, which indicates a higher exposure to tail risk, is still lower than the one of the other ETF with the worst sustainability score.

Table 5.39. This table shows the skewness, the kurtosis and the excess kurtosis computed for the Cohen & Steers Realty Majors Index, the iShares Cohen & Steers REIT ETF, and the iShares Core U.S. REIT ETF. The years marked in grey indicate a recession period.

iShares Cohen & Steers REIT ETF									
Year	Skewness			Kurtosis			Excess Kurtosis (Kurtosis - 3)		
	Benchmark	ETF	Other ETF	Benchmark	ETF	Other ETF	Benchmark Index	ETF	Other ETF
2021	0.16	0.06	-0.70	-1.87	-1.89	-1.31	-4.87	-4.89	-4.31
2020	-1.22	-1.24	-1.71	3.51	3.67	4.74	0.51	0.67	1.74
2019	1.04	1.00	1.42	1.02	1.08	3.15	-1.98	-1.92	0.15
2018	-0.68	-0.68	-0.44	-0.94	-0.89	-1.01	-3.94	-3.89	-4.01
2017	1.63	1.69	1.38	3.58	3.96	3.28	0.58	0.96	0.28
2016	0.32	0.27	0.09	-1.71	-1.75	-1.80	-4.71	-4.75	-4.80
2015	-0.02	0.06	0.05	-0.45	-0.43	-0.71	-3.45	-3.43	-3.71
2014	0.90	0.70	0.09	2.26	1.93	0.25	-0.74	-1.07	-2.75
2013	-0.13	0.04	-0.03	-1.30	-1.43	-1.53	-4.30	-4.43	-4.53
2012	-0.29	-0.32	-0.19	-1.57	-1.25	-1.34	-4.57	-4.25	-4.34
2011	0.36	0.22	0.29	-0.74	-0.90	-1.06	-3.74	-3.90	-4.06
2010	0.12	-0.03	0.10	-0.72	-0.72	-0.96	-3.72	-3.72	-3.96

For what concerns the Building & Construction industry, I start the analysis of the risk-return profile from the European ETF, the iShares STOXX Europe 600 Construction & Materials, which is compared to its benchmark index (the STOXX Europe 600 Construction & Materials Index), and to another ETF characterized by a lower sustainability score (the Lyxor STOXX Europe 600 Construction & Materials ETF). In this case, the two funds do not exhibit huge differences in terms of sustainability, and it is important to remind that the analysis done with the Fama and French seven-factor model (see subsection 5.3.1), showed that this fund's returns were not sensitive to the ESG risk factor.

First of all, Table 5.40 highlights that this fund significantly underperformed during the observed years. Moreover, it also exhibits a higher standard deviation, which makes it much riskier than the other fund and its benchmark index. The riskiness of the iShares STOXX Europe 600 Construction & Materials ETF is also confirmed by the higher negative skewness (see Table 5.41), which indicates a greater probability of suffering from huge losses and being exposed to extreme, negative events.

Table 5.40. This table shows the average monthly returns computed on an annual basis and the standard deviation of the STOXX Europe 600 Construction & Materials Index, the iShares STOXX Europe 600 Construction & Materials ETF, and the Lyxor STOXX Europe 600 Construction & Materials ETF. The years marked in grey indicate a recession period.

iShares STOXX Europe 600 Construction & Materials ETF						
Year	Average Monthly R(t)			Standard Deviation		
	Benchmark	ETF	Other ETF	Benchmark	ETF	Other ETF
2021	3.28%	3.07%	3.16%	3.7%	4.4%	4.0%
2020	-0.18%	-0.22%	-0.09%	8.5%	9.8%	8.6%
2019	2.87%	2.89%	2.95%	3.6%	3.9%	3.7%
2018	-1.55%	-1.76%	-1.61%	3.4%	3.6%	3.5%
2017	0.82%	0.61%	0.85%	2.7%	2.8%	2.7%
2016	0.91%	0.69%	0.88%	3.9%	3.8%	4.0%
2015	1.43%	1.30%	1.52%	5.6%	5.4%	5.4%
2014	0.55%	0.40%	0.54%	3.4%	3.4%	3.4%
2013	1.89%	1.61%	1.94%	3.9%	3.6%	3.8%
2012	1.47%	1.28%	1.50%	5.0%	5.2%	5.0%
2011	-1.58%	-1.92%	-1.86%	6.3%	6.2%	6.7%
2010	0.39%	0.22%	0.19%	6.6%	6.6%	6.5%

Table 5.41. This table shows the skewness, the kurtosis and the excess kurtosis computed for the STOXX Europe 600 Construction & Materials Index, the iShares STOXX Europe 600 Construction & Materials ETF, and the Lyxor STOXX Europe 600 Construction & Materials ETF. The years marked in grey indicate a recession period.

iShares STOXX Europe 600 Construction & Materials ETF									
Year	Skewness			Kurtosis			Excess Kurtosis (Kurtosis - 3)		
	Benchmark	ETF	Other ETF	Benchmark	ETF	Other ETF	Benchmark Index	ETF	Other ETF
2021	1.26	0.56	0.99	2.51	2.13	2.23	-0.49	-0.87	-0.77
2020	-0.65	-0.85	-0.64	1.39	1.62	1.42	-1.61	-1.38	-1.58
2019	-1.00	-1.00	-0.84	1.43	1.31	0.96	-1.57	-1.69	-2.04
2018	-0.23	-0.54	-0.29	-0.64	-0.50	-0.58	-3.64	-3.50	-3.58
2017	0.16	0.20	0.04	-0.98	-0.90	-1.08	-3.98	-3.90	-4.08
2016	-0.56	-0.71	-0.58	0.45	-0.25	0.21	-2.55	-3.25	-2.79
2015	0.06	0.12	0.05	-1.30	-1.17	-1.24	-4.30	-4.17	-4.24
2014	0.33	-0.22	0.39	0.95	0.70	1.01	-2.05	-2.30	-1.99
2013	-0.34	-0.04	-0.46	-0.09	0.20	0.06	-3.09	-2.80	-2.94
2012	-0.47	-0.27	-0.44	-0.49	-1.11	-0.42	-3.49	-4.11	-3.42
2011	0.39	0.40	0.36	0.27	0.31	0.21	-2.73	-2.69	-2.79
2010	-0.14	-0.09	-0.01	-0.82	-0.90	-0.71	-3.82	-3.90	-3.71

To conclude, for the American market I have compared the iShares U.S. Home Construction ETF to its benchmark index (the Dow Jones U.S. Select Home Builders Index) and to another ETF with a lower sustainability score (the Invesco Dynamic Building & Construction ETF).

Looking at the estimated financial indicators in Table 5.42, it is possible to observe that the iShares U.S. Home Construction ETF performed much better than the other fund, especially during the last five years. Nevertheless, the value of the standard deviation suggests that this fund is also a bit riskier than the Invesco Dynamic Building & Construction ETF, and this would explain the higher returns.

It is not surprisingly to see that, in some years, the standard deviation of this ETF is higher than the one of the benchmark index, as the analysis performed with the Fama and French seven-factor model (see subsection 5.3.2), highlights a market risk factor's beta higher than one, both in the Pre and in the Post Covid-19 Crisis periods. Moreover, as this fund's returns are slightly sensitive to the ESG risk factor, the portfolio's exposure to more sustainable companies might have positively contributed to its overperformance.

Table 5.42. This table shows the average monthly returns computed on an annual basis and the standard deviation of the Dow Jones U.S. Select Home Builders Index, the iShares U.S. Home Construction ETF and the Invesco Dynamic Building & Construction ETF. The years marked in grey indicate a recession period.

iShares US Home Construction ETF						
Year	Average Monthly R(t)			Standard Deviation		
	Benchmark	ETF	Other ETF	Benchmark	ETF	Other ETF
2021	4.20%	4.20%	3.68%	6.8%	6.8%	5.1%
2020	1.21%	1.20%	1.09%	14.8%	14.9%	12.1%
2019	3.50%	3.48%	2.99%	5.0%	5.0%	4.8%
2018	-2.69%	-2.69%	-2.70%	4.8%	4.9%	5.7%
2017	2.81%	2.82%	0.73%	4.5%	4.3%	4.0%
2016	0.36%	0.37%	1.58%	5.5%	5.6%	6.3%
2015	1.28%	1.29%	1.72%	7.2%	7.2%	6.9%
2014	1.45%	1.45%	0.79%	6.2%	6.2%	3.7%
2013	1.00%	0.97%	1.75%	5.3%	5.4%	4.7%
2012	4.75%	4.77%	3.01%	3.4%	3.3%	3.2%
2011	-0.58%	-0.61%	-0.42%	8.2%	8.3%	6.4%
2010	1.38%	1.36%	1.30%	8.9%	8.9%	6.8%

Overall, the analysed ETF exhibits a negative skewness lower than the Invesco Dynamic Building & Construction ETF, thus proving that investors are less exposed to the probability of suffering few but large losses. Moreover, the results in Table 5.43 show that, even though the kurtosis of the iShares U.S. Home Construction ETF is high and positive, it is almost half the one of the other fund, thus suggesting a lower exposure to tail risk.

Table 5.43. This table shows the skewness, the kurtosis and the excess kurtosis computed for the Dow Jones U.S. Select Home Builders Index, the iShares U.S. Home Construction ETF and the Invesco Dynamic Building & Construction ETF. The years marked in grey indicate a recession period.

iShares US Home Construction ETF									
Year	Skewness			Kurtosis			Excess Kurtosis (Kurtosis - 3)		
	Benchmark	ETF	Other ETF	Benchmark	ETF	Other ETF	Benchmark Index	ETF	Other ETF
2021	0.97	0.97	0.71	1.24	1.19	-0.39	-1.76	-1.81	-3.39
2020	-0.95	-0.94	-1.82	2.41	2.45	4.61	-0.59	-0.55	1.61
2019	0.39	0.34	-0.51	1.00	0.91	-0.19	-2.00	-2.09	-3.19
2018	-0.24	-0.17	-0.37	-1.50	-1.51	-0.65	-4.50	-4.51	-3.65
2017	0.12	0.12	0.18	-1.17	-0.87	0.06	-4.17	-3.87	-2.94
2016	-0.25	-0.21	1.11	-0.12	-0.10	1.92	-3.12	-3.10	-1.08
2015	-0.73	-0.72	-0.19	-0.66	-0.73	-1.47	-3.66	-3.73	-4.47
2014	-0.36	-0.37	0.40	-0.82	-0.88	0.26	-3.82	-3.88	-2.74
2013	-0.42	-0.40	-0.75	-0.61	-0.65	0.34	-3.61	-3.65	-2.66
2012	-0.51	-0.41	-0.34	-0.31	-0.42	2.32	-3.31	-3.42	-0.68
2011	0.50	0.52	0.86	-0.15	-0.15	0.82	-3.15	-3.15	-2.18
2010	-0.51	-0.47	-0.07	0.02	-0.02	0.47	-2.98	-3.02	-2.53

Findings and conclusion

The empirical analysis presented in Chapter 5 highlights that the sensitivity of the returns to the ESG risk factor is both geographical and sectoral dependent. Indeed, my analysis shows that the returns of the ETFs investing in the Real Estate industry are much more sensitive to the sustainability risk factor than those investing in the Building & Construction ones, which are extremely receptive to traditional risk factors, such as the market risk premium, the size, and the value factors.

This difference might be due to the higher attention of the economic actors in the Real Estate industry towards sustainability, as well as to the impact of the introduction and the diffusion of Energy Performance Certificates, which, as discussed in Subparagraph 2.2.2, significantly affect real assets' prices, while also increasing the attention of consumers to the sustainability characteristics of real assets.

Conversely, for what concerns the Building & Construction industry, the higher sensitivity of the returns to the sustainability factor of the American fund than the European one, might be due to the different and higher maturity of the Green Building industry in the U.S., even though the considerably high exposure of the European fund to the Swiss market, which is still characterized by a more traditional approach to construction techniques, might have affected this result.

Another interesting finding related to the analysis of the Real Estate industry in Europe is that, after the Covid-19 Crisis, returns become more sensitive to the sustainability characteristics of the portfolio's holdings. This result would confirm the findings of Sharma et al. (2021) and Singh (2020), who proved that after the global pandemic investors have increased their attention towards sustainable investments, which have been recognized as defensive securities during market downturns.

Neverthless, the analysis of the selected ETFs shows that the Fama and French multi-factor model does not capture the whole variation of the returns.

This might be due to the specific characteristics of the selected funds. Indeed, all of them target very specific industries and geographical areas, thus having a portfolio which is not well diversified, and which is also highly exposed to procyclical industries. Therefore, other risk factors should be investigated to study the returns' variation of these funds. For example, for the Real Estate industry it might be interesting to analyse the impact of the macroeconomic risk factors related to changes in interest rates and per capita household income.

Finally, the comparison of the risk-return profiles of these funds does not show dramatic differences between those characterized by high and low ESG scores. Nevertheless, the higher kurtosis of the low ESG-scored funds investing in the Real Estate industry, confirm the findings of the report published by Allianz Global Investors (2019), where it is said that the portfolios exposed to low ESG-scored companies exhibit higher tail risk.

Overall, both the American ETFs exhibit better financial performances if compared to the ETFs with the worse sustainability scores. In particular, the iShares Cohen & Steers REIT ETF is characterized by a lower risk exposure and, looking at the performances of the last four years, it seems to provide better protection from losses. Furthermore, the financial indicators computed for the iShares U.S. Home Construction ETF confirm the findings of Pavlova & de Boyrie (2021) and Lesser et al. (2016), who found that high ESG scored ETFs during the Covid-19 crisis and, more generally, during bear market periods, perform as well as the market. Conversely, if compared to the other ETF, the iShares U.S. Home Construction fund exhibits higher returns and a lower exposure to tail risk.

All this considered, my analysis shows that the sustainability characteristics of the selected funds might have partially influenced their financial performances. Moreover, the values of the annualized alpha computed with the Fama and French seven-factor model, which are greater than those estimated with the six-factor model, suggest that accounting for ESG risks and having an investment portfolio represented by high ESG-rated companies, might provide better financial performances.

To conclude, even though these results cannot be applied homogeneously to all the industries and geographical areas, they allow me to conclude that environmental, social and governance issues represent nowadays important factors of risk, able to explain a proportion of the variation of the returns of an investment.

Therefore, these findings, together with the increasing awareness of investors towards the potential risks related to the allocation of capitals to non-sustainable industries, suggest that in the future, the analysis of the financial performances of an investment should also consider the ESG risk factor among the independent variables that affect its risk-return spectrum.

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