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Green investments: study of the sector and performance analysis

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Abstract

Climate change is a fundamental concern that poses serious threats to the ecosystems in which we live, causing ripercussions to environment and society. The sustainability transition embraces different disciplines, including finance. The thesis studies the development of the market that started with the engagement of governments and international institutions but it is constantly growing in the private sector. The study continues with a review of the existing literature on green finance, examining the main characteristics of both green equity and green bonds compared with conventional securities. We conclude with a performance analysis of a sample of green ETF compared to conventional ETF.

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Chapter 1

The background of green finance

1.1 Introduction

Climate change is a fundamental concern that poses serious threats to the ecosystems in which we live, causing ripercussions to environment and society.

The continuous growth of the world population, the scarcity of resources and the environmental pressures are major determinants, thus the role of human activity in the current climate trend is undeniable

Among human activities the burning of fossil fuels, that generates energy, heat, powers transportation and industrial processes, releases carbon dioxide and other greenhouse gases making them the primary contributors to global warming and climate change. In fact, those non-renewable fuels supply about 80% of the world's energy. It is well known that greenhouse gases are naturally present in the atmosphere and they are necessary in order to absorb the solar heat and prevent the warmth from escaping into space. Consider that without greenhouse gases in the atmosphere Earth's average surface temperature would be -18° C, rather than the present average of +15° C.

The problem is that sustained economic growth since the Industrial Revolution has increased the percentage of greenhouse gases in the atmosphere from 280 ppm (parts per million) to 413 ppm corresponding to a +47.5% (NASA's Climate Resource Center, 2020) leading to more heat retention and to a subsequent increase in surface temperatures.

As a result, since the late 19th century the global average surface has risen about 0.9° C. But this is not the only impact on Earth, that is why global warming and climate change are not synonyms. Climate change embraces other consequences than an increase in temperatures, such as rising sea levels due to melting ice sheets and glaciers, the acidification of oceans, the increasing frequency of extreme events like floods and droughts, not to mention the impact it is having and it will have on society and the threats to biodiversity and ecosystems.

Governments and supranational organizations have recognized the need to consider climate change policies, aimed to reach a sustainable development that could help alleviating poverty. The sustainability transition embraces different disciplines, including finance.

This first chapter starts with an historical excursus of the main climate change policies adopted internationally and an illustration of the *European Emission Trading System* (EU ETS) that can be considered one of the first forms of *green finance*, this is followed by an explanation of what is included in the framework of green finance, its development also in the private sector and the existing regulations in the market.

1.2 Recognition of the problem of climate change by international institutions

Global attention to climate change and its dangerous consequences emerged with full force with the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 (also known as Rio Summit). The event gave birth to many initiatives that are still considered central to most debates addressing climate change. In this occasion, the Common but Differentiated Responsabilities Principle (CBDR) emerged, giving the definition of developed and developing countries and it was then the pillar of the Kyoto Protocol (1997) since it establishes that all countries have shared obligations to address environmental destruction but at the same time it denies the equal responsabilities of all of them.

In fact, developed countries contributed more to climate change and should have more responsabilities than developing countries – it is the 'polluter-pays principle'. At an ethical level, it recognizes the correlation between higher levels of development and greater contribution to climate change so it is an expression of equity in international law. Moving on in time this distinction will receive criticism, expecially from developed countries.

The Rio Summit also led to the adoption of the international environmental treaty called United Nations Framework Convention on Climate Change (UNFCCC), whose objective was to "reduce greenhouse gases concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system" (United Nations, 1992).

The convention divided ratifying countries into three main groups - Annex I Parties, Annex II Parties and Non-Annex I Parties (by exclusion) and each one have the responsabilities described below:

- *Annex I Parties* are developed countries and the category includes both industrialized countries that were part of the OECD (Organisation for Economic Co-operation and Development) in 1992 and parties with economies in transition at the time, namely the Russian Federation, the Baltic States and several Eastern Europe States. They were asked to adopt national policies and take corresponding measures for the mitigation of climate change;
- *Annex II Parties* are developed countries with special financial responsabilities towards developing countries and consist in OECD members excluding the economies in transition of Annex I Parties. They are required to support climate change activities in developing and economies-in-transition countries by providing both financial and technological resources;
- *Non-Annex I* Parties are mostly developing countries that were considered the most vulnerable to the economic impact of climate change measures to be adopted.

Anyway, despite the subdivision explained above, every part of the Convention is subject to the commitment to fight climate change and is required to do an inventory of their own greenhouse gases emissions. Moreover they periodically have to submit a record called National Communication describing the actions undertaken for the Convention to be implemented.

The UNFCCC enters into force two years later, in 1994, and as of 2020 it has been ratified by 197 countries that meet on a yearly basis at the Conference of the Parties (COP) but the most important step was two year later, in 1997, at the COP 3 in Kyoto, Japan.

In Kyoto the parties adopted the Kyoto Protocol that commits countries to specific greenhouse gases emission reduction targets. It is an extension of the 1992 UNFCCC in fact both are based on the same principles and they share the same institutions.

The Kyoto Protocol is considered a significant first step for climate change for three main reasons: first it is legally binding under international law meaning that signatory nations that do not comply with the targets receive a penalty, then it establishes specific targets to be implemented within a certain period and, finally, it introduces three market-based mechanisms in order to help the involved parties in meet their targets.

It entered into force some years later, in 2005, when Russia and Canada ratify the Protocol and the threshold of fifty-five Parties belonging to the Annex I category and accounting for at least 55% of the total carbon dioxide emissions in 1990 was reached.
The United States at first signed the Protocol but the Senate declined to ratify it. The reason was that commitments would harm the US economy and at the same time those commitments were not mandated for developing countries whose greenhouse gases emissions were going to increase exponentially in the next decades.
According to the Protocol Annex I parties are legally bound to limit or reduce their greenhouse gases emissions[1] on an average between 6% and 8% below 1990 levels. Non-Annex I parties representing developing nations are simply required to report their emissions. Always following the CBDR principle developed nations were addressed with a heavier burden.
In order to meet the objectives of the Protocol, Annex I parties had to implement appropriate policies and measures for the emissions reduction in their respective countries. For this purpose three different mechanisms were introduced, as previously anticipated, aiming to help involved countries: the *International Emission Trading* (IET), the *Clean Development Mechanism* (CDM) and *Joint Implementation* (JI).
Clean Development Mechanism and Joint Implementation are "project based mechanisms", meaning that they generate emission reductions from projects. They also stimulate sustainable development through technology transfer and investment and encourage developing countries to contribute to emission reduction efforts (UNFCCC, 1998). The Clean Development Mechanism enables Annex I parties to implement emission reduction projects in developing countries; the emission saving generated through it generates Certified Emission Reduction units that can be credited to the developed country account. On the contrary what falls under the scope of Joint

[1] The Kyoto Protocol covers the emissions of the six main greenhouse gases listed in Annex A:
- carbon dioxide (CO_2),
- methane (CH_4),
- nitrous oxide (N_2O),
- hydrofluorocarbons (HFCs),
- perfluorocarbons (PFCs),
- and sulphur hexafluoride (SF_6).

The maximum amount of emissions that a Party to the Protocol may emit is measured as the equivalent in carbon dioxide. Individual targets for each Party are listed in the Kyoto Protocol's Annex B.

Implementation are projects carried out jointly by two developed countries in order to obtain an emission reduction: it results in Emission Reduction Units.

International Emission Trading is probably the most well known and it can be considered an early stage of the current *green finance*: it is a 'cap-and-trade' system, where the cap represents the maximum amount of emissions units assigned to a country. Moreover the cap is reduced over time, with the consequence that total emissions fall. Targets of the Kyoto Protocol are expressed as levels of assigned amounts, or allowed emissions over the 2008 – 2012 commitment period.

Initially the Kyoto Protocol had just one commitment period going from 2008 to 2012. Starting from 2009 the purpose of the COPs became to reach an ambitious climate agreement for the period post 2012 with the aim to engage the Non-Annex I countries too. They will get to this only some years later with the Paris Agreement.

The next important COP was in Doha, Qatar, in 2012, where the Kyoto Protocol was renewed for a second commitment period from 2012 to 2020. But it needs to be underlined that the Doha Amendment was significantly limited by the absence of the US and Canada (that withdrew in 2011) and by the fact that developing countries, included China and India, still had no additional commitments.

At the end of the second commitment period the Kyoto Protocol will be substituted by the Paris Agreement, the world's first comprehensive climate deal. It builds upon the UNFCCC and has been negotiated during the COP21 in Paris.

Differently from the Kyoto Protocol that entered into force eight years later, the Paris Agreement become effective in November 2016, when 55 countries representing at least 55% of global emissions ratified it. As of today 188 parties of the 197 parties to the Convention ratified it. Here too the US withdrew from the Agreement and this decision bacame effective in November 2020.

The main aim of the Agreement is to keep the increase in global average temperature below 2° C above pre-industrial levels, and to pursue efforts in order to limit the increase to 1.5° C, predominantly by reducing greenhouse gases emissions as soon as possible.

Under the Paris Agreement, there is no differentiation between developed and developing nations and there is no target to achieve by a specific date. Each country have to plan and regularly reports its contribution to the global warming, the aim is to go beyond previously set targets.

1.3 IET and its main implementation: the EU ETS

International Emission Trading is one of the three flexibility mechanisms set by the Kyoto Protocol. Since committed parties have accepted targets to limit emissions, a new commodity was created to be traded into the "carbon market", taking the name from carbon dioxide that is the pricipal greenhouse gas.

The IET works on a "cap-and-trade" principle: the cap is set for every country, it determines the maximum amount of emissions that are allocated in one year and it is divided into units of AAUs (Assigned Amount Units) - one AAU corresponds to the allowance to emit 1 metric tonne of CO2.

Because different countries have different emissions, reduction targets and the cost of achieving those reductions also differ, allowances can be traded among the partecipants. So each partecipant is obliged to surrender enough allowances to cover all their emissions.

In fact, Article 17 of the Kyoto Protocol allows countries with surplus emission units (emissions assigned but not used) to keep them for future needs or to sell the excess capacity to countries over their targets. On the contrary if a country does not succed in reaching the imposed target the emission units can be purchased on the market, otherwise heavy fines are imposed.

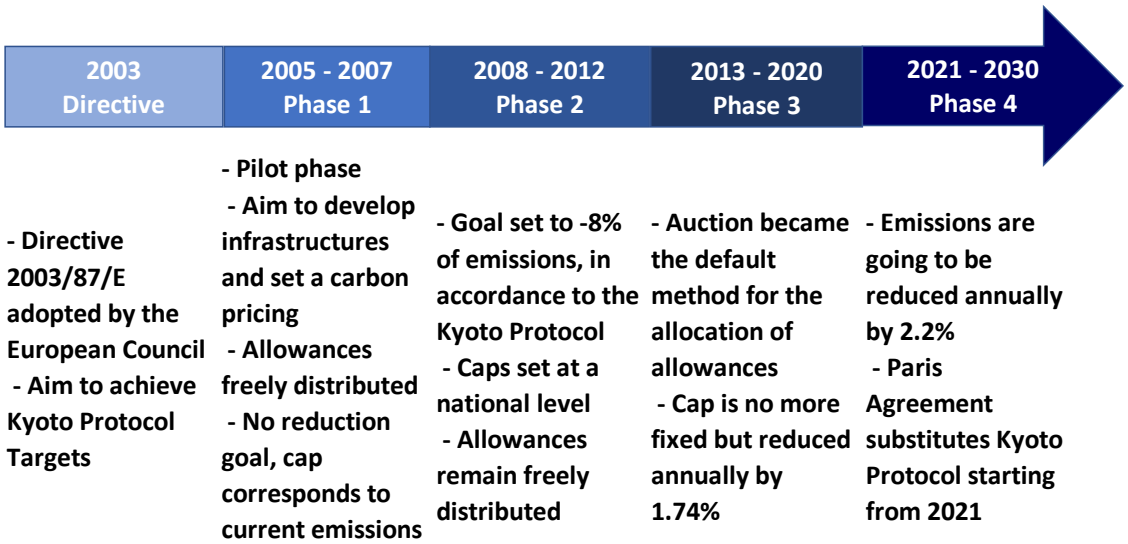
Under this mechanism allowances to emit, usually a ton of carbon dioxide, are either auctioned off or distributed among emitters on the basis historical use. Trade exists as long as marginal abatment costs differ between countries. So high marginal abatment costs firms will buy permits from low marginal abatment costs firms until the demand equals the supply (Tietenberg, 2010).

Each transfer of ownership is validated by the UNFCCC.

The first international carbon market was the EU Emission Trading System (EU ETS). The European Council adopted the ETS directive in 2003 (Directive 2003/87/EC) and in 2005 it became operational, in order to help member states in achieving their targets in the Kyoto Protocol in a cost-effective way. It is also the main policy instrument for the EU for reaching its climate objectives.

Figure 1.1 briefly resumes EU ETS phases from the adoption to the current phase.

Figure 1.1: Summary of EU ETS phases



Despite the European Union initiative stood as an example and was followed closely by other countries and regions, EU ETS remains the biggest, involving 31 countries. EU ETS was born to be the implementation tool to the Kyoto Protocol but, actually, it is independent from it.

EU ETS industry sector coverage increased in time as long as allowances included new gases. The biggest are: energy-intensive industry sectors (i.e., oil refineries, steel work, production of iron, cement, paper, chemicals, etc.), civil aviations, industries producing acids, industries producing aluminium. It needs to be underlined that the aviation sector is subject to lower reductions with respect to the other sectors involved.

The system is proudly considered by the European Union the cornerstone of its strategy to combat climate change, anyway the carbon market theme in general but in particular the EU ETS have been debated a lot.

The main criticism was directed to the free allocation of allowances leading to windfall profits, moreover the system seemed to rewarding high emitters instead of providing incentives for innovation and investments in the low carbon technologies. This was true in the early phase of the EU ETS but many changes has been made since its implementation.

Lately criticism went to the oversupply of allowances and the low price levels of them.

The first phase of the EU ETS, from 2005 to 2007, was a pilot period with the objective to develop infrastructures and set a carbon pricing. The cap was not set to achieve substantial emission reductions, in fact it was determined by the quantity of National Allocation Plans (NAP) where each member state specified its planned emissions in accordance with existing emission targets.

In its beginning the system only covered CO_2 emissions and allowances were freely distributed, in fact as already explained the first trading period showed an excess supply of allowances and windfall profits to companies.

During the second phase (2008 – 2012) the system had the goal to achieve reductions of greenhouse gases in accordance with the Kyoto Protocol, representing a -8%. What has remained unchanged with respect to the first phase is the mostly free allocation of allowances and the decentralization of the system since caps were set at a national level. Moreover in the second phase emission of N_2O (nitrous oxide) were covered too.

In a decentralized system each nation had to allocate its allowances and monitor them, so that the role of the Commission was reduced to supervise them. Since this system was considered too time-consuming and led to disparities between the partecipants, starting from the third period the cap was set at european level and the allocation was based on harmonised rules.

In Phase 3 (2013 – 2020) auction became the default method for the allocation of allowances, instead of free allocation, and began to cover a third gas: perfluorocarbons (PFC) used in aluminium production. The exception to the auction method is for industries subject to carbon leakage[2] that continue to receive a percentage of allocations for free during the third phase. It is established by the commission that revenues from auctions must be used for investments related to climate change measures.

It needs to be underlined that while in the two initial phases the cap (and so the allowances number) was fixed, starting from 2013 it is reduced annually by 1.74%. This helped to reduce a 20% reduction in 2020 compared to the 1990 levels – considering that the EU ETS covers approximately 45% of emissions in Europe. According to the EU

[2] The term refers to the situation that may occur if, for reasons of costs related to climate policies, businesses were to transfer production to other countries with laxer emission constraints. This could lead to an increase in their total emissions. (ec.europa.eu/clima/policies)

ETS directive during the fourt phase (2021 – 2030) emissions are going to be reduced annually by 2.2%.

Beside the criticism the EU ETS achieved its objectives with a 24% emission reduction compared to 1990, and the benefits of emission trading have been recognised by other countries in the following years[3].

1.4 The increasing engagement of the private sector

In parallel with the preparation of the COP 21, the UN was also involved in setting up 17 Sustainable Development Goals (SDGs) for the period 2015 – 2030 by which they made it clear once again that protecting the planet is essential for the needs of present and especially future generations and limiting climate change will be essential in order to realise this objective.

They represented a prosecution of the previous Millennium Development Goals (MDGs) that were to be reached in 2015, but including new areas such as climate change, innovation, sustainable consumption and economic inequality among other priorities.

Those new goals were set to guide the transition towards a sustainable and inclusive economy, being conscious that sustainable development does not mean just the need for a reduction of greenhouse gases and the consequent transition to a low-carbon economy. In fact

sustainable economy is inevitably the cointegration of three aspects: economic, social and environmental. The 17 goals are listed in Table 1.1, where this cointegration is clearly expressed.

Since significant levels of financing are needed to achieve sustainable development, not just the intervention of institutions and governments is needed but also the one of the private sector such as banks and investment funds.

During the last decade green finance and *Social Responsible Investments* (SRI) emerged, sustained by a strong demand from investors. It became clear that capital could be used also to solve extra financial issues in addition to generating profits.

[3] A few examples are represented by the NZL ETS (New Zeeland) in 2008, the TMG ETS in Japan in 2010, the CA ETS in California in 2013 and the Korea ETS in 2015.

Table 1.1: Classification of development goals by category

#	Goal description	Environment related	Social related	Economy related
SDG 1	End poverty in all its forms everywhere		✓	
SDG 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	✓	✓	
SDG 3	Ensure healthy lives and promote well-being for all at all ages		✓	
SDG 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all		✓	
SDG 5	Achieve gender equality and empower all women and girls		✓	
SDG 6	Ensure availability and sustainable management of water and sanitation for all	✓	✓	✓
SDG 7	Ensure access to affordable, reliable, sustainable and modern energy for all	✓	✓	✓
SDG 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	✓	✓	✓
SDG 9	Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation	✓		✓
SDG 10	Reduce inequality within and among countries			✓
SDG 11	Make cities and human settlements inclusive, safe, resilient and sustainable	✓		✓
SDG 12	Ensure sustainable consumption and production patterns	✓		✓
SDG 13	Take urgent action to combat climate change and its impacts	✓		
SDG 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	✓		
SDG 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss	✓		
SDG 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels		✓	
SDG 17	Strengthen the means of implementation and revitalise the global partnership for sustainable development	✓	✓	✓

In this context financial markets can accelerate the transition to a more sustainable economy. Undeniably funding is a requirement for reaching a sustainable economy and the allocation of funding in green products on one side can help reaching the most ambitious environmental targets, on the other side can reduce vulnerability to climate-related risks.

The first step is to allocate investments to sustainable corporates and projects in order to accelerate the transition to a low carbon economy.

A good example is represented by *green bonds*: they are used by issuers in order to finance specific projects targeted at creating positive environment impact. At the same time investors have the assurance that the proceeds are used to these scopes (they are typically related to sectors such as renewable energy, energy efficiency, sustainable management of natural resources, sustainable infrastructures). Moreover green bonds differentiate from other green or climate related financial product since they are defined

and regulated by specific *Green Bond Principles* (GBP), representing the leading framework of the category. The principles promote integrity in the market giving guidelines that recommend transparency, disclosure and reporting; they also define the main processes for projects evaluation and give advice on the use and management of proceeds. GBP are widely used by external green certification agencies that value the alignment of the bond with the core components of the Principles.

Anyway guidelines such the GBP emerged just for the category of bonds, so far there are not operational standards that are binding or need to be followed for labelling a specific security or product (e.g. in the case of green funds, green loans, green indices) as green. The aspect will be discussed more in detail in the next sections.

The European Union has always had a strong focus on sustainable development. To confirm this, the European Commission[4] in 2018 promoted a plan of necessary actions with the aim of standardizing communication, methodologies and standards within the framework of sustainable finance. More specifically the Action Plan has the following objectives:

- reorient capital flows towards sustainable investment in order to achieve sustainable and inclusive growth;
- manage financial risks stemming from climate change, resource depletion, environmental degradation and social issues;
- foster transaparency and long-termism in financial and economic activity.

The European Commission also recognized the central role of the financial system in this new reality in which we are increasingly facing the consequences of climate change and resource-depletion. In fact it can be part of the solution towards a greener and more sustainable economy.

As supported by specialists reorienting capital to more sustainable investments, an overall shift in how the financial system works is required. Clearly the necessary condition for sustainable finance to develop is a taxonomy – or a classification system.

[4] For more detailed informations please refer to: European Commission (2018), *Action Plan: Financing Sustainable Growth.*

1.5 A better definition of "greenity" in finance

So far we discussed about *green finance* (also denominated environmental finance or climate finance – more oriented to climate change mitigation or climate change adaption), *sustainable finance* and *social resposible investments*.

Sustainable finance and SRI are synonims, for a better understanding of the field covered it will be useful to explain that in the process of resources allocation also ESG-E factors are taken into account – in addiction to financial aspects. ESG-E stands for environmental, social, governance and ethics, those factors are measured differently among rating companies since the evaluation methods used consider a wide range of factors, the boundaries of which are still uncertain because of the absence of a universal taxonomy. Some of the standards to consider in order to determine if an investment is a SRI, for example, can be the following:

- *environmental factors*: use of renewable energy, commitment to waste reduction and greenhouse gases reduction, exclusion of companies who own a nuclear power plant;
- *social factors*: respect of human rights conventions, exclusion of companies discriminating workers (because of sex, race, religion, disability), exclusion of companies exploiting workers or child labour;
- *governance factors*: number of indipendent directors into the board of directors, transparency in remuneration policies, commitment in tackling corruption;
- *ethical factors*: exclusion of companies producing or selling alcohol, tobacco, weapons or fur, making profits from gambling or pornography, testing cosmetics on animals.

Sustainable finance (or SRI) embraces all the financial instruments supporting the achievement of all the SDGs, while green finance is part of it because it is focused on the environment sphere.

This thesis will be focused on green finance but it is important to understand that green finance is a subset of sustainable finance since they can both be measured by environmental, social, governance and ethical factors. Talking about green assets, environmental factors will have a greater importance in the evaluation compared to a generic sustainable investment.

Many rating agencies[5] in the past years have specialized in evaluating assets labelled as sustainable or green, in order to provide reliable informations to investors. Those organizations also have the aim to promote homogeneity and transparency in the emerging asset class.

But it is undeniable that rating agencies adopt different definitions of ESG performance, or ratings can differ because agencies adopt different approaches to measuring ESG performance. This is due to the lack of a taxonomy for the sector.

Heterogeneous is the adjective that better describes green finance so far. A commonly accepted definition of what in green does not exist because there are different interpretations. Financial institutions themselves still not have a common eligibility criteria. In the longer term the lack of a universal definition and standards can lead to the risk of greenwashing and so harm the credibility of the market. Greenwashing can take many forms and it is not specifically linked to green finance, it consists in conveying a false impression or misleading informations about the environmental interest of a company with the main purpose of increasing profits (it is very common in the consumer goods industry).

In general, the process of defining green finance involves two separate aspects: the first regards the sectors or activities eligible, the second is more about the operational standards to follow in order to label a specific security, product or service as green.

The first point implies a deep analysis of the impacts of each sector or activity on the environment, including their contribution to climate change mitigation. For example while some sectors can be easily considered as green (e.g., renewable energy), for others the evaluations is not so straightforward (e.g., in the case of hybrid vehicles).

The second point, in the case of securities, concerns the processes of evaluation and selection of the projects to be financed, the managing of proceeds and the characteristics of the reporting.

And finally it needs to be understood if an activity is considered green for the use of proceeds, for the activities carried out or both.

Accurate industry guidelines have been defined so far only for some categories of securities, like green bonds, as anticipated.

[5] Examples of ESG rating agencies are Standard & Poor's, Fitch and Moody.

1.6 EU Taxonomy: Where do we stand?

In accordance with the *Action plan* the European Commission published the EU Regulation 2019/2088 on sustainability-related disclosures in the financial services sector (i.e., Sustainable Finance Disclosure Regulation, SFDR). The Regulation was then followed by the EU 2020/852 that aims to establish a framework to facilitate sustainable investment (i.e., Taxonomy Regulation), amending 2019/2088.

Both are cornerstones of the Action Plan. We are going to explain briefly: which are the parties involved, the product classification imposed by the regulation and the link between the SFDR and the taxonomy.

The SFDR introduced ESG disclosure requirements for financial market partecipants or providing SFDR products, and financial advisors or advising on SFDR products.

Financial market partecipants refer to: fund managers, insurance-based investment product providers, pension product providers, so basically any type of asset manager.

The regulation aims to limit the risk of greenwashing by financial markets partecipants, providing more transparency on sustainability factors in a standardised way. Once it will be implemented all financial market partecipants in the EU will have to disclose on ESG issues, with additional requirements for those products promoting ESG characteristics or having sustainable investment objectives. In this way final investors will easily understand how both ESG and sustainability impact on their investments.

In fact diverging measures adopted so far on sustainability related investments and divergent disclosure standards made it difficult for investors to compare financial products and may distort their investment decisions. SFDR was made in order to reduce those asymmetries.

The regulation is going to have a massive impact on the financial markets because while the legal initiatives relate directly only to legal entities based in the EU, they also have a direct impact on entities outside the EU in the case in which they are selling financial products (and manifactures too) to EU clients.

The ESG disclosure requirements to existing and potential investors can be pursued via various channels: website, periodic reports, precontractual documents. The reports transparency is required to be focused on the following issues: sustainability risks, principal adverse impacts (PAI) and ESG approach positioning.

Sustainabilty risks

The likely impacts of sustainability risks on the financial returns of financial products must be assessed in a sistematic way, including the increasing risks related to climate change in the due diligence and reasearch processes, on a mandatory basis. On the other side financial advisors should disclose how they take sustainability risks into account for a specific financial product before providing the advice, regardless of the sustainability preferences of the end investor.

Principal adverse impacts (PAI)

Asset managers also have to assess the PAI of investment decisions based on sustainability factors. Technical standards proposes a template of 50 key performance indicators on which the PAI are based, of these 32 are mandatory and the others are optional. Obviously the indicators cover environmental, social and governance (ESG) issues.

ESG approach positioning

Sustainable financial market have six key strategies of investing in ESG assets (negative screening, positive screening, ESG integration, impact investing, engagement and thematic investment) because if asset managers are required to provide transparency on the investment methods used, the risk of greenwashing reduces.

In practical terms, asset managers can no longer affirm they have sustainable financial products without demonstrating that their investment decision process, risk management and product disclosures are fully aligned with the SFDR principles.

Finally every product will be classified into on of the following categories:

- *Article 9* (or dark green) which applies to products that have sustainable investments as their objectives;
- *Article 8* (or light green) which covers financial products that promote environmental or social characteristics, or companies following good governance practices as part of the investment strategy;

- *Article 6* (or grey) which applies to products that do not integrate any kind of sustainability into the investment process or are explicitly labelled as non-sustainable.

The regulation on SFDR and the Taxonomy are two different concepts but highly correlated. The first aims to provide ESG discosure requirements in order to harmonise the rules at EU level, so that different financial products of different member states can be compared effectively with respect to their environmental, social and governance risks and sustainable investment objectives. On the other side the Taxonomy Regulation, amending and supplementing SFDR, establishes the criteria for determining whether an economic activity qualifies as environmentally sustainable and the degree to which an investment is environmentally sustainable.

The environmental objectives to which an economic activity has to contribute substancially to (at least one or more) in order to be considered 'environmentally sustainable' are mentioned in *Article 9* of the Regulation 2020/852:

a) climate change mitigation;
b) climate change adaption;
c) the sustainable use and protection of water and marine resources;
d) the transition to a circular economy;
e) pollution prevention and control;
f) the protection and restoration of biodiversity and ecosystems.

Other points of inclusion are that an economic activity does not have to significantly harm any of the environmental objectives listed in Art. 9 and it is carried out in compliance with certain minimum safeguards established by international institutions such as the OECD Guidelines for Multinational Enterprises, the UN Guiding Principles on Business and Human Rights and the ILO's Fundamental Principles and Rights at Work.

Regarding its implementation, the SFDR was published in the Official Journal in 2019 but the majority of the new disclosure obligations are going to be implemented starting from 10 March 2021 (Level 1 of the Regulation). Anyway SFDR is supplemented with further details in the Regulatory Technical Standards (RTS – Level 2 of the Regulation), which application will be delayed since so far RTS are in draft. Therefore the revised compliance date for the Level 2 Regulation is going to be 1 January 2022.

On the other side the Taxonomy Regulation was published in 2020 and it is going to be implemented partially in January 2022 with regard only to its climate change mitigation and climate change adaptation objectives and in January 2023 it going to become fully enforceable with respect to all its objectives.

1.7 The diffusion of green financial instruments

From the EU ETS and passing through the launch of the first green bond by the European Investment Bank in 2007, the green financial market continued growing rapidly globally. Today the major investors in sustainable assets are Europe, that manages the highest proportion with nearly half of the total sustainable investing assets, followed closely by the United States (see Figure 1.2).

Just looking at Europe and just at green funds (so focusing on the "E" of ESG factors) in 2020 they exceeded by €71 billion previous years results, corresponding to a +120% growth. A good indicator of the appeal of green funds is also the increasing number of green funds outstanding that amounts to 340 in 2020.

Figure 1.2: Proportion of Global Sustainable Investing Assets by Region in 2018 (Global Sustainable investment review 2018)

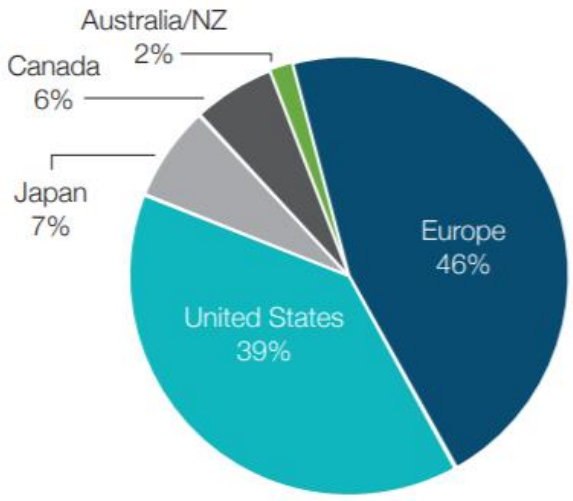
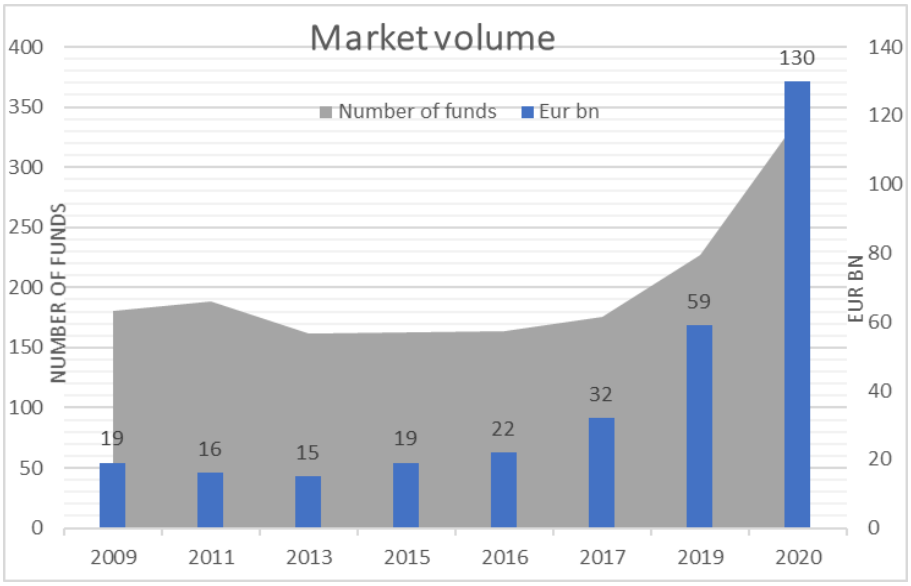


Figure 1.3: Green funds in Europe: market volumes (Author's elaboration from Novethic 2020)



The green funds considered by Novethic, as illustrated in Figure 1.3, are mainly funds focused on environmental temathics (renewable energy, water and energy efficiency), followed by low carbon funds that select companies with the objective of reducing their carbon emissions, or in a transition phase, and finally by funds based on green bonds. Obviously a fund can combine multiple approaches.

Clearly institutional investors dominate the market and the incresing trend of the green market has been driven mainly by them. But as underlined in the Action Plan for sustainble finance to become mainstream a strong engagement of retail investors is necessary.

Interest by retail investors in climate, sustainable and green initiatives has been growing steadily in time. This was due to the awareness of the impacts of global warming that is encouraging people in changing attitudes and behavior, having also impacts in what they decide to invest into. Investors are more and more likely to support companies in transition or with a high level of transparency – in this matter companies offering ESG scores are very useful because they offer the opportunity to invest in accordance with sustainability preferences.

From the 2018 Eurosif report, that tracks every two years the evolution in sustainable investments by type of investor, a positive trend in favour of the retail sector emerges: starting from 2013 where retail investors represented 3.40% (vs. 96.60% of institutional investors), we jump to a 30.77% of retail investors in 2017 that represents an increase in demand of +800%.

Those encouraging data are also due to the work done by the European Commission with respect to the topic of the legislative framework.

The challenges of climate change and the importance of environmental and social factors are strongly linked. This is why the retail sector has the potential to become increasingly important in sustainable finance.

Chapter 2

Literature review

2.1 Motivations that lead to green investments

The expansion of green finance of recent years was primarly driven by endogenous elements such as the perception of the climate risk raising and the related opportunities. In the case in which the main commitment of the Paris Agreement was not respected, climate-related extreme events will become more frequent causing economic losses in multiple sectors and consequently social problems.

It has been estimated that, between 1980 and 2019, events like storms, floods, heatwaves, cold waves and droughts, just in Europe, caused economic losses for 446 billion Euro that is near to 3% of the GDP of the countries analized[6]. Not to mention that pollution will have significative negative health impacts, and health care costs are going to increase in the next years due to the increase in diseases associated.

Going green would slowly reduce economic losses and at the same time will help the economic development.

When it comes to make an investment, both retail and institutional investors should consider that, for the same level of risk, returns from activities supporting carbon-intensive projects or that do not sufficiently consider climate risks could be negatively affected.

In fact the consequences of climate heating will imply, among other problems: damages to companies assets, lower land productivity, lower supply of raw materials resulting in rising costs.

If companies do not adopt new production methods in order to reduce their environmental impact because they are not aware of the importance of che climate change topic, in a longer horizon it will result in financial losses or underperformances.

[6] Data provided by the European Environment Agency (2020).

Also consider that we will face more and more stringent regulations in order to comply with international agreements. Companies that did not committed will have economic losses caused by heavy penalties.

As of today companies that decided to adopt a green approach or are in transition are increasing in number, and so is the quantity of investments funds integrating and ESG thematic approach.

It is conceivable that in the next years new methods of production and products will be introduced with the aim of reducing the impact on climate change. Inevitably the first movers are going to have a competitive advantage over the ones that move in this direction in a second phase.

2.2 The main green finance products and services

The financial industry started innovating its offering following the recognition of the environment risks related to climate change. As a consequence financial markets worldwide began a transition to green and sustainable businesses, promoting the emerging products and creating dedicated listings for the sector. The main categories are represented by green equities and green bonds.

The category of green equity products mainly include stocks of sustainable companies, green equity indices and green equity funds. Equity indices can focus on specific sectors (like renewable energy, water management, green technology, carbon efficiency) or represent the wider green sector. Usually indices are more transparent and easy to compare. In addition they represent a benchmark for investment decisions of both institutional and retail investors and there are exchange traded funds (ETFs) and derivatives connected to the trend of those indices.

Green equity funds can adopt a passive strategy that consists in taking green indices and ETFs as a benchmark or an active strategy with the purpose to outperform a benchmark index.

Green bonds are fixed income securities issued by governments, corporations or banks, to raise capital for an environmental project. The use of proceeds is in fact what distinguishes a green bond from a regular one. At the same time the buyers have the

assurance that the issuance proceeds are used for these ends. As already mentioned GBP represents the framework for defining a green bond.

In their turn green bonds can be categorised into different forms. Corporate green bonds behave like standard ones, and the buyer can have recourse to the issuer in case of default on interest payments or principal repayment. In the case of project green bonds the repayment is directly dependent on the future cash-flows generated by the initiative, so the investor has direct exposure to the risks associated with the project.

Green bonds can also take the form of asset-backed securities (ABS), that are in fact debt instruments. Assets are pooled and transferred to a SPV that issues securities backed on those assets. ABS are considered 'green' when the underlying assets are portfolios of green assets such as mortgages or lease receivables.

Of course Indices and funds are hybrid instruments since they can invest both in equity and debt instruments.

2.3 Screening strategies

Green an more in general SRI funds use different screening strategies to filter for socially responsible companies, thus integrating ESG non financial approaches into the research, analysis and selection processes of securities of a portfolio.

The classification of the seven screening strategies provided by Eurosif in the *Eurosif Market Study 2016* are briefly reported below:

1. *Negative screening*

It is the most intuitive strategy, consisting in excluding certain sectors or companies from the investment universe. For the purposes of SRI 'sin' sectors including weapons, tobacco, animal testing and carbon intensive industries are excluded.

2. *Norms-based screening*

The screening of investments is made according to the compliance with international standards and norms based on ESG issues. The UN Guiding Principles on Business and Human Rights and the OECD Guidelines for Multinational Enterprises, to name a few.

3. *Best in class*

Investors select best performing investments choosing between the ones having the best ESG scores in a particular sector. In the case of green funds the investments

selected would be the ones with higher environmental scores. It is also called positive screening.

4. *Sustainability themed investment*

This strategy allows investors to choose within a wide variety of themes, all linked to sustainability and issues related to ESG. Some examples can be the focus on renewable energy, the reduction of CO_2 emissions, human rights or health.

5. *ESG integration*

Consists in the explicit inclusion of ESG considerations into the traditional financial analysis. The strategy aims to identify the potential impact, both positive and negative, of ESG issues on company financial aspects, influencing the investment decision.

6. *Engagement*

It is based on the active involvement of shareholders through engagement and voting of companies based on ESG issues.

7. *Impact investing*

Impact investments are made into companies, organisations and funds with the intention to generate social and environmental impact alongside a financial return.

The screening methods described above are based on a theoretical vision of SRI investments. More strategies can be applied simultaneously.

2.4 The belief of underperformance

Literature concerning green investments is limited compared to the research about SRI. Anyway since green investments are part of the larger category of SRI, the theories and the empirical research in the latter will also apply to green investments, to an extent.

Those studies provide several analysis of performance with varying results. In fact, researches draw different conclusions about the question of the outperformance of sustainable, or green investments, over conventional ones.

In talking about green or responsible finance it is relevant to introduce also behavioral aspects into the analysis.

Social responsible investors could be influenced by their idealism in addition to considerations about the mean and variance, and this aspect is not taken into account in the modern portfolio theory by Markowitz (1952).

Several studies tried to first investigate why investors decide to hold social responsible investments[7]. One can jump to the conclusion that is simply because some investors have pro-social preferences and social responsible investing is a way to stay true to their values. But on the other side there are other factors to consider, for example the risk-return expectations for SRI, or the diversification of their portfolio, or investors may want to create a positive social image of themselves.

A wide spread idea is the one that investors are willing to accept lower returns for their investments if they are linked to sustainable economic activities.

Riedl et al. (2017) argue that social preferences play an important role for investors in SRI funds, while financial motives appear to have less importance. To prove that, they conducted a research on a sample of Dutch mutual funds investors and find that pro-social preferences represent the major factor determining the likelihood to hold SRI equity funds. Since all types of investors were part of the study (both social responsible and neutral) also financial reasons emerged to represent a key factor in social investing, and investors expecting SRI funds to underperform are less likely to invest in a socially responsible way. Lastly they found that most responsible investors are willing to accept lower financial returns if the investment is coherent with their social preferences, evidenced by the fact that they expect SRI to have lower returns than conventional funds and to pay higher fees.

The fear of the underperformance of sustainable investments compared to conventional ones has slowed down the spread of SRI. Investors may think SRI result in lower revenues because of the higher informative and management costs they require. Moreover the old economic theory seems not to support a possible overperformance of sustainable investments.

Arguments against the overperformance can be found in the portfolio theory by Markowitz (1959) arguing that a restriction of the investment universe leads to a lower diversification and so to a sacrificed performance compared to an unrestricted universe. This is the case of sustainable investments that represent a reduced set of the investment opportunities since assets belonging to 'sin' sectors are excluded a priori.

[7] Theoretical contributions highlighting the importance of a good social reputation created by a positive social image via social signaling are Glazer et al. (1996) and Ellingsen et al. (2008). Empirical evidence was provided by Fehrler et al. (2013).

Markowitz states that a subset cannot have a better performance with respect to the entire investment universe.

We must also consider that the portfolio theory by Markowitz was not supported by reasearch in the SRI field. From one side, while sustainable investing could represent a lower risk diversification, on the other side it could represent an increase of risk-adjusted returns since sustainable companies have a competitive advantage over their competitors.

In this respect, several studies also focused on the relationship between corporate social-environment performance and corporate financial performance. Ortiz-de-Mandojana et al. (2016) have investigated the short and long-term benefits of sustainable business practices. They concluded that companies adopting responsible social and environment policies result in lower financial volatility, higher sales growth and higher chances of survival over a fifteen-years period. Instead they did not find differences in short-term profits. Porter et al. (1995) and Dixon-Fowler et al. (2013) as well, found a positive relationship between corporate environment performance and corporate financial performance, while Busch et al. (2016) found no clear indication of a negative relationship or trade-off between the two variants.

Moving to studies on performance Renneboog et al. (2008) conducted a literature review on SRI funds and they found that SRI funds do not perform better or worse than conventional ones in a statistically significant manner. In fact, even though sustainable funds can overperform compared to a benchmark, studies do not find sufficient evidence to conclude that the overall performance of conventional and sustainable funds differ in a significant way. But Bauer et al. (2005) analyzed the performance of SRI funds in the United States and in the United Kingdom to find evidence that their average performance was different - and better - from that of conventional funds.

Alessi at al. (2019) findings highlight that halving the exposure to carbon-intensive sectors, losses would be reduced by 30%.

To this extent Auer (2016) research on the European market, with data from 2004 to 2012, highlighted that just by excluding unrated stocks (using negative screening) from a representative european stock universe, investors can outperform a passive investment in a diversified European stock benchmark portfolio in terms of higher risk-adjusted returns. On the contrary, an excess of screening, using positive screening, that

aims to select the best-in-class stocks, can cause portfolios to underperform the benchmarks because of a greater loss of diversification. The conclusion is that investors in order to maximize their risk-adjusted returns should consider ESG ratings without reducing excessively the investment universe.

If we look at the literature based on the performance of the subset of green investments, Ibikunle et al. (2017) conducted a comparative analysis of the financial performance of European green, black and conventional mutual funds over the 1991-2014 period. Initially green funds underperformed with respect to black and conventional funds. But after 2012 the green funds risk-adjusted return profile improved and began to significantly overperform the black ones, while no difference in the performance of the green and the conventional ones could be discerned.

Climent and Soriano (2011) also found an initial underperformance of green founds compared to conventional and SRI, but in a subsequent period the performance was the same.

This demonstrates that the increase of environmental risks led to a decrease in returns for companies disregarding those risks, while green or in transition companies achieved increasing returns. An important aspect to consider is that the number of green companies grew in the last years, allowing funds to choose between a larger number of companies, thus increasing diversification.

It can be concluded that, from existing literature, there is no empirical research that establishes definitively that investing in green or SRI results in a better performance than conventional investments. In most cases SRI effectively performed better but it is difficult to statistically discern the better performance due to SRI itself from the possible other variables influencing an investment performance.

The belief of sistematically underperformance of SRI investments, instead, seems to be rejected.

2.5 Green bonds and the negative green premium

Considerations coming from literature differ substantially depending on whether green equity or green fixed income securities are considered.

Fatica et al. (2019) studied the pricing of green bonds at issuance to find that there are significant differences in how the market prizes green bonds among the different types of issuer.

In fact the market prizes climate risk by associating a 'greenium' (i.e., a negative risk premium) to environmentally friendly activities. They found that the greenium results in a price advantage for the issuer and a lower remuneration for investors, ceteris paribus. The price advantage compensates in part the borrower additional costs incurred to meet the disclosure and reporting requirements that are usually associated with the issuance of green securities.

Fatica et al. (2019) used for their analysis a sample of green bond issued from 2007 to 2018 to find that the negative premium is not always present but it depends on the issuer. They found a premium if the green bond is issued by supranational institutions or corporates, with a subsequent lower remuneration for investors. Instead, they found no evidence of a price advantage for green bonds issued by financial institutions.

This heterogeneity can be motivated by the immediate association of non-financial institutions and corporates with the greeness of the projects sponsored, resulting in a more transparent perception in the use of proceeds.

On the contrary it may be difficult for some activities like financial institutions to signal to the market their engagement toward green activities, generating an information asymmetry with investors.

Those findings are consistent with Zerbib (2019) that also wanted to identify the yield differential, called green bonds premium, between green bonds and conventional ones. It was found to exist and to be negative.

The negative green premium is affected by two factors:

- the lower risk associated with green bonds and
- the excess investment demand in the sector compared with the insufficiently large volume of issuances.

Zerbib highlights that barriers at the issuer's level for the expansion of the market are represented by the higher labeling costs (external reviews and monitoring of the use of proceeds) and reputational costs if commitments are not achieved.

2.6 Considerations on the liquidity of green bonds

The term liquidity indicates the frequency at which securities are traded in the market: therefore a security is liquid if it is traded with higher frequency, on the contrary it is illiquid if it is traded with lower frequency.

Higher bid-ask spreads, trading costs and information asymmetry usually cause illiquidity in the market.

The above considerations plus the fact that there is a shortage of green bonds because the supply of green bonds is unsufficient to meet the high demand of investors, as reported by Zerbib (2017), suggest a potential liquidity risk in the green bonds market.

But literature on the topic suggests the opposite. Wulandari et al. (2018) studied how liquidity risk affects the yield spread between green bonds and conventional bonds, arguing that liquidity risk is negligible for green bonds.

Bachelet et al. (2019) examined a sample of green bonds compared with their "brown" counterparts to find that green bonds result to have higher yields, lower variance and are more liquid. The role of the issuer is crucial since green bonds issued by domestic or supranational institutions were significantly more liquid than "brown bonds" and had a negative premia before correcting fot their lower volatility. On the contrary if the issuer is private green bonds have much narrower liquidity and volatility advantage with respect to brown counterparts. In summary the issuer's reputation is essential to reduce information asymmetries and also to produce more convenient financing conditions.

2.7 The phenomenon of asymmetric volatility

In the pre-Markowitz era financial risk was considered as a correcting factor of expected return (Szegö, 2004) and for this reason investors focused on securities granting them the highest expected returns. Investors following this rule would select just one stock: the one maximizing their expected returns.

Instead Markowitz identified risk as a major determinant of investments and proposed to measure the risk associated with the return of investments by the deviation from the mean of the return distribution, namely the variance. Starting from this he eleborated the mean-variance returns theory based on the principle of the maximization of expected returns keeping the variance constant, and the minimization of variance keeping expected returns constant.

It is well known that the measure used to express risk is the standard deviation (σ), defined as the square root of the variance (σ^2) which in turn is the expected value of the squared deviations from the expected return. Volatility is a measure of uncertainty because the higher the average value of the squared deviations, the higher the volatility in outcomes will be.

But the standard deviations does not distinguish between downsides and upsides, it treats both as deviations from the mean. Clearly investors are concerned about the downside risk of the market and not the potential upsides. But volatility seems to react differently to a big price increase and a big price drop, with the latter having a greater impact: this is called *asymmetric volatility*.

The phenomenon of asymmetric volatility has been widely discussed in finance literature, see for example Black (1976) and Christie (1982) that were the first documenting that negative price drops lead to a higher volatility reaction than positive shocks in the stock market. That is because returns and volatily are negatively related and the relation is more evident for negative returns.

For a better undestanding of the process let us think about a large positive return shock, it increases volatility causing a decrease in prices, dampening the initial positive return shock. Now let us think about a a large negative return shock, it also causes volatility to increase and price decreases, amplifying the initial negative return shock.

So volatility is asymmetric because it dampens positive returns and amplifies negative returns. This is reflected in their distribution, in fact returns tend to be negative skewed, while volatility typically shows positive skewness.

Starting from the fact that return dynamics of financial products typically show asymmetric volatility, Park et al. (2020) in their research checked whether green bonds have the same property.

They used the S&P 500 Index to represent conventional stock market and the S&P Green Bond Select Index to reflect the green bond market to check the volatilities for asymmetry. The results confirmed that stock market followed the typical form of asymmetric volatility, responding more sensitively to bad news than to good news.

In the case of green bond sample volatility was also asymmetric since it reacted differently to negative and positive shocks, but it resulted more sensitive to positive return shocks than the stock sample. This may be due to the high growth involving all

eco-friendly financial activities in the last years, leading investors to “view them hopefully and react strongly to minor pieces of good news, increasing volatility”, Park et al. (2020).

From this research green bonds have been found to have slightly different characteristics than conventional bonds in terms of volatility.

Chapter 3

Theoretical framework

3.1 Portfolio theory and performance indicators

The chapter is provided to illustrate the methodologies and technical tools useful for the performance analysis conducted in Chapter 4.

The first section is dedicated to explain the fundamental principles of the portfolio theory, follows an overview of the performance indicators used, namely the Jensen's Alpha, the Sharpe ratio, the Traynor ratio and the Sortino ratio.

3.1.1 Portfolio Return and Expected Value

The term *portfolio* in finance refers to any combination of financial assets held by an investor. When making an investment, while the initial capital is well-known, the amount to be returned is uncertain. In fact, returns are random and can be described in probabilistic terms.

Supposing an investor has a given amount of capital to invest X_0, he can select amounts X_{0i} where $i = 1,2, \dots, n$, such that $\sum_{i=1}^{n} X_{0i} = X_0$, where X_{0i} represents the amount invested in the i-th asset.

Consider that, if the investor decides to invest in more than one security, this results in fractions of the total investment, such that:

$$X_{0i} = w_i X_0, \qquad i = 1,2, \dots, n,$$

where w_i is the weight of each asset i included in the portfolio, that is its purchase cost. As a consequence the weighted sum of every investment corresponds to the initial amount of capital invested,

$$\sum_{i=1}^{n} w_i = 1. \tag{3.1}$$

Let R_i be the total return of asset i, the total amount of money generated at the end of the period by the i-th asset is $R_i X_{0i} = R_i w_i X_0$. So the overall total return of the portfolio is:

$$R = \frac{\sum_{i=1}^{n} R_i w_i X_o}{X_0} = \sum_{i=1}^{n} w_i R_i. \tag{3.2}$$

Equivalently, since $\sum_{i=1}^{n} w_i = 1$, we have:

$$r = \sum_{i=1}^{n} w_i r_i. \tag{3.3}$$

From these considerations it follows that both the total return (R) and the rate of return (r) of a portfolio are equal to the weighted sum of the corresponding individual asset returns, as expressed by equations (2) and (3).

Since future returns of assets are uncertain, it means that expected returns are random and can be described by a probability distribution. In particular the concept of density[8] is used to represent the probabilities associated to a random variable.

The expected value, or mean, of a random variable x is a real number given by the sum of the products of each value of the random variable by the respective probability and can be defined as:

$$E(x) = \sum_{i=1}^{n} x_i p_i. \tag{3.4}$$

$E(x)$ is often denoted as $\bar{x}$.

[8] Let $p(x)$ denote a probability density function, where $p(x)dx$ represents the probabability that the random variable has a value in the range $[x, x + dx]$.

3.1.2 Variance, covariance and diversification

Variance or standard deviation in finance expresses the risk that the asset that the investor decided to put into the portfolio deviates from the mean and so returns could be higher or lower than expected.

Covariance is also an important issue when talking about portfolio theory, because when considering two or more random variables, the covariance expresses their mutual dependence, that is their jointly variability.

If the covariance is positive it means that two variables tend to move in the same direction, if it equals zero means that they are not correlated and finally when the covariance is negative the two variables tend to move in inverse directions.

For example, assuming that a portfolio is composed by two stocks of companies belonging to the same sector, it is reasonable to think that there is a positive covariance between them because if the sector is going well probably both stocks are going to have increasing prices. The same if the sector is going into a declining phase: both stocks are probably going to have declining prices.

On the contrary if the variables are not correlated it means that one variable does not give any additional information on the other and if one changes there is no impact on the other. This assumes importance if the variables are represented by assets composing a portfolio, in fact when considering a new asset for a portfolio it is necessary to consider its relation, in terms of covariance with respect to other assets in the portfolio.

Let x and y be two random variables with expected values $\bar{x}$ and $\bar{y}$, their covariance is expressed by σ_{xy} and is defined as

$$cov(x, y) = \sigma_{xy} = E[(x - \bar{x})(y - \bar{y})]. \tag{3.5}$$

When we know the covariance between two random variables we can also compute the variance of the sum of the variables.

Portfolios composed of a limited number of assets are more risky, investing in more securities can help reduce the overall portfolio variance, if returns are negatively correlated. This is the effect of diversification. Conversely, if correlation is positive it is more difficult to reduce variance. Diversification only reduces non-systematic risk, in

fact even investing in a large number of assets, risk cannot be eliminated because all assets are affected by the common macroeconomic factors, this is called systematic risk. Note that the covariance is not limited, so the linear correlation coefficient is used. It is defined as:

$$\rho_{xy} = \frac{\sigma_{xy}}{\sigma_x \sigma_y} \tag{3.6}$$

and $|\rho| \leq 1$. According to Markowitz, investors can benefit from diversification when the correlation coefficient is lower than one. In the case of a perfect negative correlation it is possible to construct a zero-variance portfolio.

3.1.3 Optimal portfolios and mean-variance frontier

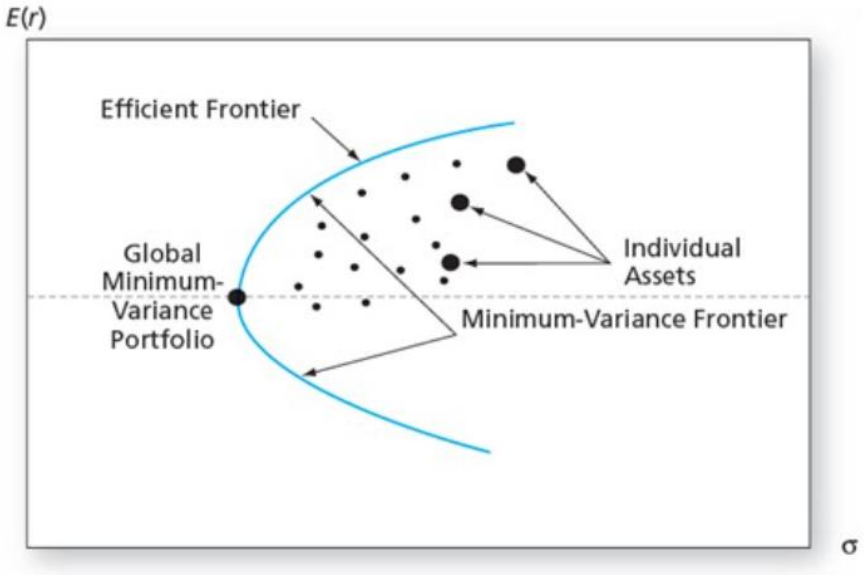
Markowitz study (1959) is direct to analyze the behavior of risk-averse investors, that prefer to maximize expected returns holding variance constant or alternatively minimizing variance holding expected returns constant. Based on this proposition he developed the *minimum-variance frontier* of risky assets, that is a graph representing a set of portfolios that minimize variance for a given portfolio expected return (Bodie *et al.*, 2014).

The efficient frontier is constructed by computing the minimum variance portfolio for any expected return. Let us assume we have n assets whose expected rates of return are $\overline{r_1}$, $\overline{r_2}$,…,$\overline{r_n}$ and the covariances are σ_{ij} for $i, j = 1,2, \dots, n$. The portfolio is composed by a set of n weights w_i with $i = 1,2, \dots, n$ that sum to 1. The solution to the portfolio selection problem is given by fixing the mean value at some arbitrary point $r_P = \pi$. It follows that the problem is formulated as follows:

$$\begin{aligned} &min_{x_1,\dots,x_N} \quad \sigma_P^2 \\ &s.t. \quad \begin{matrix} r_P = \pi \\ \sum_{i=1}^{n} w_i = 1 \end{matrix} \end{aligned} \tag{3.7}$$

The solution of this problem allows to obtain all the points of the minimum-variance frontier that will have the shape of a hyperbola starting from the global minimum-variance portfolio. Figure 3.1 gives a representation of the minimum-variance frontier.

Figure 3.1: The minimum-variance frontier of risky assets (Source: Bodie et al. (2014), 'Investments')



Notice that the upper portion of the frontier provides the best risk-return combinations, therefore it is called efficient frontier. In fact, for any portfolio lying on the lower portion of the frontier there is a portfolio with the same standard deviation and a greater expected return above it. Hence this lower part of the minimum-variance frontier is said to be inefficient because for any risky level we are interested only in the portfolio with the higher expected return.

3.1.4 Utility functions

The mean-variance criterion used in the Markowitz portfolio problem states that risky assets are associated to higher expected returns in the market. It follows that a portfolio is more attractive to investor when it is associated with higher returns and lower risk.
However, because of the inverse relationship between the two features, the choice of the optimal portfolio is not straightforward. He choice depends upon the degree of risk aversion that is highly subjective and the optimal portfolio is the one that maximizes the expected utility for the investor.
Utility functions are a useful tool conceived with the objective to rank competing portfolios based on risk and return considerations. A higher utility produces greater wealth and it is associated with portfolios offering more attractive risk-return profiles.

The only utility function which is coherent with the mean-variance approach provided by Markowitz is the concave and quadratic utility function. Concave because it captures the principle of risk aversion and quadratic because it only depends on the first two moments (namely mean and variance) of a distribution. The quadratic utility function can be defined as:

$$U(x) = ax - \frac{1}{2}bx^2. \tag{3.8}$$

Where U is the utility value, $a > 0$ and b is the coefficient representing the degree of risk aversion of the investor, thus with $b > 0$. In fact the amount by which the variance of a risky portfolio lowers the utility level depends on b that represents the risk one is willing to undertake and we will have $b = 0$ for risk neutral investors and $b < 0$ for risk lover investors. After having assessed the degree of risk aversion for the investor, the following dominance criterion is applied: portfolio A is said to dominate portfolio B in the mean-variance sense if $E(r_A) \geq E(r_B)$ and $\sigma_A \leq \sigma_B$, with at least one of the two inequalities satisfied in the strong form. It follows that the choice to hold a riskier portfolio must be compensated with higher expected returns. All portfolios lying on the same indifference curve are equally attractive for the investor because they deliver the same utility level.

Finally, $\frac{1}{2}$ is a factor of scaling convention. The utility function here considered is strictly increasing and concave, with $U' > 0$ and $U'' < 0$ and any other derivative with order higher than the second equal to zero.

The utility function changes in the case in which green preferences are taken into consideration, because preferences for green securities can affect investors' investment decisions.

Some individuals are willing to accept lower expected returns if the portfolios are endowed with some green assets since it is the green feature itself that provides the investor with a higher utility value. Therefore, having to choose between a green or a brown instrument with the same expected return, ceteris paribus, an investor with green preferences will always choose to invest in the green one.

3.1.5 The Jensen's Alpha

The Jensen's Alpha owes its name to the economist that first introduced it, it is a performance measure quantifying the excess returns earned by the portfolio compared to theoretical expected returns coming from the *Capital Asset Pricing Model* (CAPM).

The CAPM was developed in 1964 by Sharpe and built on the diversification and modern portfolio theory by Markowitz. The model gives a precise prediction of the relationship between the risk of an asset and its expected return, and it also provides a benchmark rate of return for the evaluation of possible investments (Bodie *et al.*, 2014).

The CAPM is based on a series of simplifying assumptions both on the market and on investors allowing to, in fact, simplify the analysis but obviously they ignore many real world complexities. They result in an admittedly unrealistic world. Those assumptions are summarized below:

1) investors are price takers, thus security prices are not affected by their own trades, and there is perfect competition in the market;
2) the investment orizon is just one period and all investors plan for one identical holding period, ignoring what might happen at the end of it;
3) investments only involve publicly traded assets and agents can both lend and borrow at the risk-free rate;
4) there are no taxes on returns and transaction costs;
5) all investors are rational al mean-variance optimizers, using the Markowitz portfolio selection model;
6) information is free and available to all investors, moreover they all analyze securities in the same way and share the same economic view resulting in the same efficient frontier and an unique optimal risky portfolio.

On the basis of those assumptions the CAPM was built in order to represent the relationship between expected return and systematic risk, represented by beta (β), because when a portfolio is well diversified only systematic risk that is undiversifiable is left. The traditional formula of the CAPM, representing the Security Market Line can be written as follows:

$$E(r_i) = r_f + \beta_i(E(r_M) - r_f), \tag{3.9}$$

where $E(r_i)$ is the expected return on asset i, r_f is the risk-free rate of return and $E(r_M)$ is the expected return of the market. The risk-free rate of return subtracted from the market expected return gives what is called risk premium. Finally, β_i is the Beta of the security i that represents the sensitivity of the that security's return to the market return. Beta is the standardized measure of systematic risk and thus it is considered while calculating the expected return of a risky asset. It is defined by the formula:

$$\beta_i = \frac{\rho_{i,M}}{\sigma_M^2}, \tag{3.10}$$

so it is calculated by dividing the product of the covariance of the security returns and the market return by the variance of the market returns. The market portfolio consists of all traded assets, the proportion of each stock in the market portfolio equals the ratio between its market capitalization and that of the entire market.

The market has $\beta = 1$, while if $\beta > 1$ it implies that the asset is riskier than the market as a whole (and thus $E(r_i) > E(r_M)$), on the contrary in the case in which $\beta < 1$ the asset is less risky than the market as a whole (and $E(r_i) < E(r_M)$).

After that all the elements for the computation have been explained, the Jensen's Alpha can be introduced. It is represented as follows:

$$\alpha = (r_i - r_f) - \beta_i(r_M - r_f), \tag{3.11}$$

where r_i denotes the average return of the portfolio or the investment that needs to be analyzed, r_f is the average return of the risk-free activity, β_i represents the beta of the portfolio or investment i with respect to the market, and r_M is the average rate of return of the market for the considered period of the time series.

The Jensen's Alpha gives the abnormal return of a portfolio or an investment over the theoretical expected return of the CAPM that is risk-adjusted.

It is based on the concept that the higher the investment risk, the greater the expected return. In fact, Jensen's Alpha is going to have positive values in the cases in which the investment return is higher than the risk-adjusted return.

The rate of return of the market can be well represented using benchmark indices. The Jensen's Alpha is often used by managers to monitor the mutual funds performance and evaluate if they are beating the returns offered by the market.

As evidenced by the CAPM and by the portfolio principles, risk and return are closely related variables. For this reason in order to evaluate the efficiency of an activity in remunerating each unit of risk, measures of risk-adjusted returns are used. In the following sections three other performance indices will be presented.

3.1.6 The Sharpe Ratio

The Sharpe Ratio was named after William Sharpe, who developed it in 1966 as a measure of performance for mutual funds and is also known as the reward-to-volatility ratio. The measure divides average investment excess return over the sample period by the standard deviation of returns of the risky investment over the same period. It is computed as follows:

$$Sharpe\ Ratio = \frac{(r_i - r_f)}{\sigma_i}, \tag{3.12}$$

where r_i is the average return of the portfolio or the investment that needs to be analyzed, r_f is the average return of the risk-free activity for the considered period, thus the numerator is represented by the risk premium, all divided by the standard deviation σ_i (i.e., its volatility) referred to the investment or portfolio to analyze.

The historical data used for the computation should cover a long enough time period in order to rely on a high confidence interval.

It represents the additional amount of return that the investor receives for its portfolio of investments, compared to the risk-free, per unit of increase in risk.

The investor would prefer to obtain a higher Sharpe Ratio, the higher the result, the better the portfolio risk adjusted performance, while a negative result means that the portfolio underperformed its benchmark (the risk-free activity). Thus, it ranks investments by their excess return over the risk-free activity.

The advantage of this performance measure is that is a standardized measure and it is computable from any series of returns, so it can be used to compare different asset classes in a rapid and intuitive way.

But it also has some limitations: first, this measure assumes that the distribution of portfolio returns is normal, so moments with an order higher than two, such as kurtosis or skewness, does not exist. In presence of asymmetry and fatter tails, standard deviation is not an effective measure of risk.

The second limitation is that the Sharpe Ratio fails to distinguish between upside and downside fluctuations because the standard deviation is a measure of volatility, not risk, and upsides and downsides are here considered equally bad for investors which is not true.

However, despite the criticism, because of its simplicity the Sharpe Ratio remains one of the most widely used methods for the evaluation of the efficiency of an investment.

It is often used together with other risk-adjusted indicators, in order to obtain a more complete analysis.

3.1.7 The Sortino Ratio

The Sortino Ratio is a variation of the Sharpe Ratio and it was named after economist F. A. Sortino (2001). It has in fact the same structure with the numerator represented by a performance measure (i.e., the risk premium) and the denominator by one of risk. The main difference is that while the Sharpe Ratio penalizes both upsides and downside, and investors are only concerned with downward volatility, the Sortino Ratio only takes into account the downside deviation giving a more realistic picture. Downside deviations are those falling below a user-specified target rate of return.

The first step in the calculation of the downside deviation to choose the Target Downside Deviation (TDD) In order to define the value constituting the boundary between the upward and the downward risk. The investor would consider downward risk all returns that fall below a minimum acceptable return representing the threshold, it is common that this minimum acceptable return corresponds to the risk-free activity. The TDD is measured taking into consideration all the cases in which the investment performed worst than the target, across the time series:

$$TDD = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\min(0; r_i - r_T))^2}\,, \tag{3.13}$$

where r_i is the return of the i investment being analyzed, r_T is the target return and n is the number of observations of the time series.

The TDD gives the variability of returns under the target return, it can also be tailored to specific objectives. It can be adjusted to fit the risk profiles of different investors having different levels of minimum acceptable risk.

The Sortino Ratio takes an asset or portfolio return and subtracts the risk-free rate, and then divides the risk premium by the asset target downside deviation:

$$Sortino\ Ratio = \frac{(r_i - r_f)}{TDD}\,, \tag{3.14}$$

What differentiates the Sortino Ratio from the Sharpe Ratio is the denominator of the formula: the first uses the downside deviation while the latest uses the standard deviation. Using one ratio rather than the other can reverse the convenience of an investment over another. In fact, the two ratios focus on different elements so analysts usually use both in order to have a more comprehensive view.

The main criticism concerning the Sortino Ratio also applies to the Sharpe Ratio: the calculation of returns and volatility is based on historical data for both, thus the obtained values are not completely reliable to make predictions about the future behavior of portfolios. In any case in this thesis we are going to analyze and compare historical data without making forecasts about their future performance.

3.1.8 The Treynor Ratio

The Treynor Ratio was introduced by Jack Treynor (1965), its equation is as follows:

$$Treynor\ Ratio = \frac{(r_i - r_f)}{\beta_i}\,, \tag{3.15}$$

where r_i is the return of the investment or portfolio, r_f is the risk-free asset return and β_i is the beta of the i activity with respect to the market.

The measure is similar to the Sharpe and the Sortino Ratios lately presented, with the only difference that instead of the standard deviation or the downward deviation it uses as a denominator the beta of the portfolio representing systematic risk.

It means that the total risk of the portfolio is excluded, assuming that the investor is managing a well-diversified portfolio.

The result interpretation is simple: the higher the ratio is, the better the portfolio performed. The indicator can be negative for two reasons: first, the risk-free return is higher than the portfolio return and second, the beta is negative. This last situation means that the portfolio has an optimal performance compared to the market trend.

Chapter 4

Data performance analysis

4.1 Selection principles

The main purpose of this thesis is to test whether green financial products can overperform standard financial products, in the light of the growing interest for the environmental sphere which has expanded to involve finance.

In Chapter 2 it was concluded that no empirical research establishes definitively the overperformance or underperformance of green investments over conventional brown ones.

The analysis that follows involves the computation of the performance measures illustred in Chapter 3, namely: the Jensen's Alpha, the Sharpe Ratio, the Sortino Ratio and finally the Treynor Ratio, for ten ETFs, five of them labelled as green and the other five not specifically labelled, thus considered as standard. In this way we can compare the results given by the performance indices chosen for the two categories and evaluate if there is one overperforming the other.

ETFs market had a high development over the past year; ETFs are very similar to mutual funds because they are both collective investments vehicles. The main difference between them is that ETFs allow investors to trade index portfolios on an intraday basis like a stock.

The dataset analyzed is composed uniquely by ETFs because they are listed in stock markets and they are more liquid and cost less than mutual funds in terms of management fees. Moreover, they usually have a passive management and they track the performance of a benchmark so they are more significant.

Once decided the financial instrument, the next step was the data selection: first, only accumulating ETFs were selected, since they automatically reinvest dividends in the fund instead of paying them to investors.

The sample was restricted to ETFs having a fund size equal to or greater than 300 million euro because a large fund size ensures the liquidity of the security. Fund size becomes a

key factor in determining the investment horizon of an investor. We know that investors with preferences in green financial instruments usually have long time horizons (long-terminsm has also been fostered by the European Union Action Plan, see 1.3) but most green ETFs have been constructed in very recent times.

Finally ETFs were selected also taking into consideration the Morningstar Sustainability Rating that are expressed using a five-globe system indicating whether the investment is at the bottom (one globe) or at the top (five globes) of its industry group rating.

ESG scores are developed by Sustainalytics, global leader in ESG screening that measures the degree to which a company's economic value may be at risk driven by ESG issues. Consider that ESG issues that are material vary across different industry groups and companies.

Each fund's ESG score is based on its underlying companies' disclosure and performance. Each company in the fund is graded on a scale from 0 to 100 relative to other firms in the same industry peer group. Lower is better, because 0 indicates no unmanaged ESG risk, while 100 represents the highest level of ESG risk. Morningstar assigns the Portfolio Sustainability Score on the condition that at least 67% of the companies in the fund have a ESG Risk Rating.

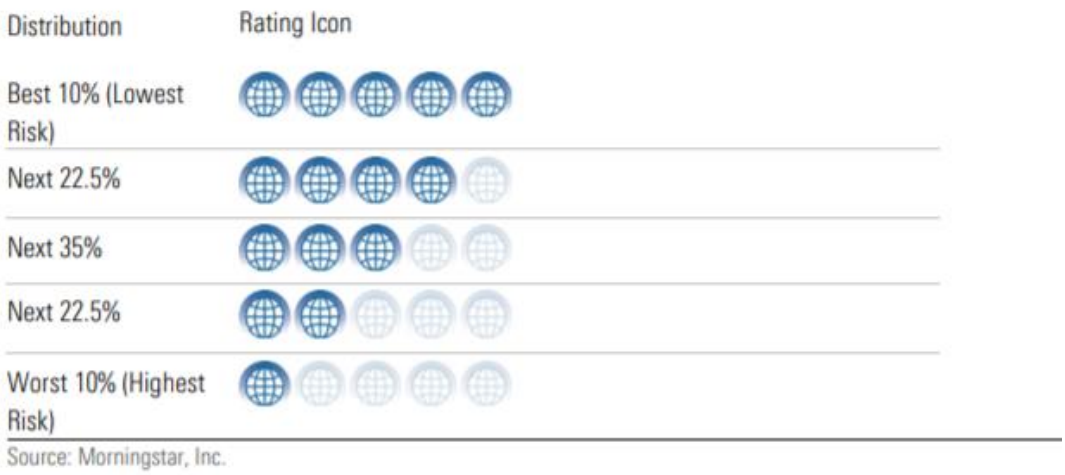
At this point Morningstar computes the Historical Portfolio Sustainability Score that is the weighted average of the last 12 months. Historical scores are not equal weighted since more recent portfolios are weighted more heavily than more distant ones (Morningstar, 2019). Taking as a base the Historical Portfolio Sustainability Score, funds are assigned absolute category ranks within the Morningstar Global Categories as illustrated in Figure 4.1.

Obviously the performance comparison between green and standard ETFs takes into account historical time series covering the same period of time. This sample period covers a twenty-four months trading period starting on April 1st , 2019 and ending on April 1st , 2021.

The sample covers both European and North-America stock markets and benchmarks cover both stocks and bonds.

To discern between green ETFs and standard ones to include in the comparative analysis of the two categories the criteria of the Morningstar Rating together with the green labelling have been used.

Figure 4.1: Morningstar Sustainability Ranking (Morningstar, Inc.)



The sample of the five green ETFs have sustainable investment as their objective and promote ESG characteristics. It is important to underline that not only funds defining themselves as sustainable operate in a socially responsible manner; in fact there also exist funds obtaining excellent scores of the Sustainable Rating without promoting ESG characteristics. On the contrary there also exist funds with the green label that have as their primary objective the sustainability values protection, that obtain a low Sustainability Rating.

Moreover, the Sustainability rating is not available for ETFs (and equivalently funds, stocks, bonds) having less of a 12 month trading history.

4.1.1 The green labelled sample

The green labelled sample includes the following five ETFs, for which are reported in Table 4.1 the name, the ISIN identification code and the Sustainability Rating.

Then, the objectives and the characteristics of each one are briefly presented. All the selected ETFs have a high Sustainability Rating of four or five globes and have sustainable investment as their objective from the prospectus.

Table 4.1: Sample of the green label ETFs for the analysis

Ticker	ISIN code	ETF	Sustainability Rating
BLGBFEA	IE00BD0DT685	iShares Green Bond Index Fund (IE) Flexible Acc	
XZEU	IE00BFMNHK08	Xtrackers MSCI Europe ESG UCITS ETF 1C	
CLIM	LU1563454310	Lyxor Green Bond (DR) UCITS ETF	
XZMU	IE00BFMNPS42	Xtrackers MSCI USA ESG UCITS ETF 1C	
LCEU	LU1377382368	BNP Paribas Easy Low Carbon 100 Europe UCITS ETF	

The five ETFs composing the green labelled sample cover both the bond and the stock market and benchmarks are based both on European and Nort-American markets.

iShares Green Bond Index Fund (IE)

The fund invests mostly in fixed income securities such as bonds, the proceeds of which are used to fund projects with direct environmental benefits. The aim is to achieve a return on the investment that reflects the return of the Bloomberg Barclays MSCI Green Bond Index, representing the fund benchmark. All the purchased bond composing the ETF have received a long term credit rating that meets a specified level of creditworthiness. In the case in which the rating is downgraded the funds sells the position. Fund size is 3,139 million euro.

Xtrackers (IE) Plc - Xtrackers MSCI Europe ESG UCITS ETF 1C

The ETF fully replicates the MSCI Europe Low Carbon SRI Leaders Index that reflects the performance that, in turn, is based on the MSCI Europe Index which reflects the performance of large and medium listed companies in developed market countries in Europe. In order to be included in the index, companies must display high ESG performance and low current and potential carbon exposure, relative to their peers. Companies part of 'sin' sectors with a high potential for negative ESG impact (alcohol, gambling, tobacco, nuclear power) are excluded a priori. Fund size is 352 million euro.

Lyxor Green Bond (DR) UCITS ETF

The ETF aims to track the Solactive Green Bond EUR USD IG Index, representative of the green bond market issued both in euro and in USD by sovereign nations, supranational institutions, banks and companies. Only instruments classified as green bonds by the Climate Bond Initiative are eligible for inclusion in the index. Fund size is 569 million euro.

Xtrackers MSCI USA ESG UCITS ETF 1C

The ETF tracks the performance of the MSCI USA Low Carbon SRI Leaders Index that only includes companies having low carbon exposure and high ESG performance. Fund size is 3,369 million euro.

BNP Paribas Easy Low Carbon 100 Europe UCITS ETF

Replicates the performance of the Low Carbon 100 Europe PAB Index, including fluctuations. Moreover, the ETF maintain the tracking error with the index below 1%. Fund size is 863 million euro.

4.1.2 The standard sample

The standard sample includes five ETFs replicating the main european and north-american indices. Table 4.2 reports, as for the green ones, the name, the ISIN identification code and the Sustainability Rating.

Follows a brief decription is provided for each one, giving informations about their benchmarks.

Table 4.2: Sample of the standard ETFs for the analysis

Ticker	ISIN code	ETF	Sustainability Rating
CSSPX	IE00B5BMR087	iShares Core S&P 500 UCITS ETF	
SPY4	IE00B4YBJ215	SPDR S&P 400 US Mid Cap UCITS ETF	
SMEA	IE00B4K48X80	iShares Core MSCI Europe UCITS ETF	
CSSX5E	IE00B53L3W79	iShares Core EURO STOXX 50 UCITS ETF	
EXS1	DE0005933931	iShares Core DAX UCITS ETF (DE)	

Also ETFs composing the non-green labelled sample, in line with the green sample, have benchmarks tracking both the European and the North-America financial markets.

iShares Core S&P 500 UCITS ETF

The ETF fully replicates the S&P 500 Index that is a capitalization-weighted index index of the 500 largest companies listed on stock exchanges in the USA. It is a stock market index. The fund size is 47,772 million euro.

SPDR S&P 400 US Mid Cap UCITS ETF

The ETF fully replicates the S&P MidCap 400 Index that is a stock market index for the US mid-cap equity sector. In order to be included in the index, a stock must have a merket capitalization between 3.2 and 9.8 billion USD. The benchmark is an accurate measure for mid-sized companies. The fund size is 1,340 million euro.

iShares Core MSCI Europe UCITS ETF

The ETF tracks the the performance of an index composed of large and mid cap companies from fifteen developed countries in Europe: the MSCI Europe Index. Fund size is 6,650 million euro.

iShares Core EURO STOXX 50 UCITS ETF

The ETF tracks the performance of the Eurostoxx 50 Index that is composed by stocks of the fifty largest companies in the Eurozone (reviewed annually). Fund size is 4,180 million euro.

iShares Core DAX UCITS ETF (DE)

The ETF benchmark is the DAX 30, including the thirty most highly capitalized companies trading in the Frankfurt stock market. Fund size is 7,285 million euro.

4.2 Graphic representation

A graphic representation of the data used for the analysis will be given, in order to better understand their trend in time.

Data representations for the trend of prices are going to be categorized into the sample of five green labelled ETFs and the sample of five standard ETFs. Despite indicators are computed on returns, in order to have a comprehensive picture of the securities both the trend of prices and the trend of daily percentage returns will be presented.

Figure 4.2 and figure 4.3 represent the price trend of the green labelled and of the standard sample respectively. Other than the price of ETFs the first noticeable element in both samples is the price drop corresponding to the beginning of the Covid-19 pandemic that started to spread the last week of February 2020.

For all samples, the decreasing trend started the last week of February 2020 and lasted until the last week of March 2020. Starting from this minimum price point the increasing trend began. In March 2021 ETFs in both samples recovered and exceeded pre-Covid levels, along with the decrease in contagion and the acceleration of the vaccination campaign.

Figure 4.4 and Figure 4.5 give the representation of the daily returns of the green labelled and of the standard sample respectively. Also in this case the graphs of all samples provide strong evidence of the fall corresponding to the Covid-19 pandemic outbreak, followed by strong fluctuations during the subsequent months of lockdown and slowdown of non-essential businesses.

Figure 4.2: Price trend of the sample of green labelled ETFs

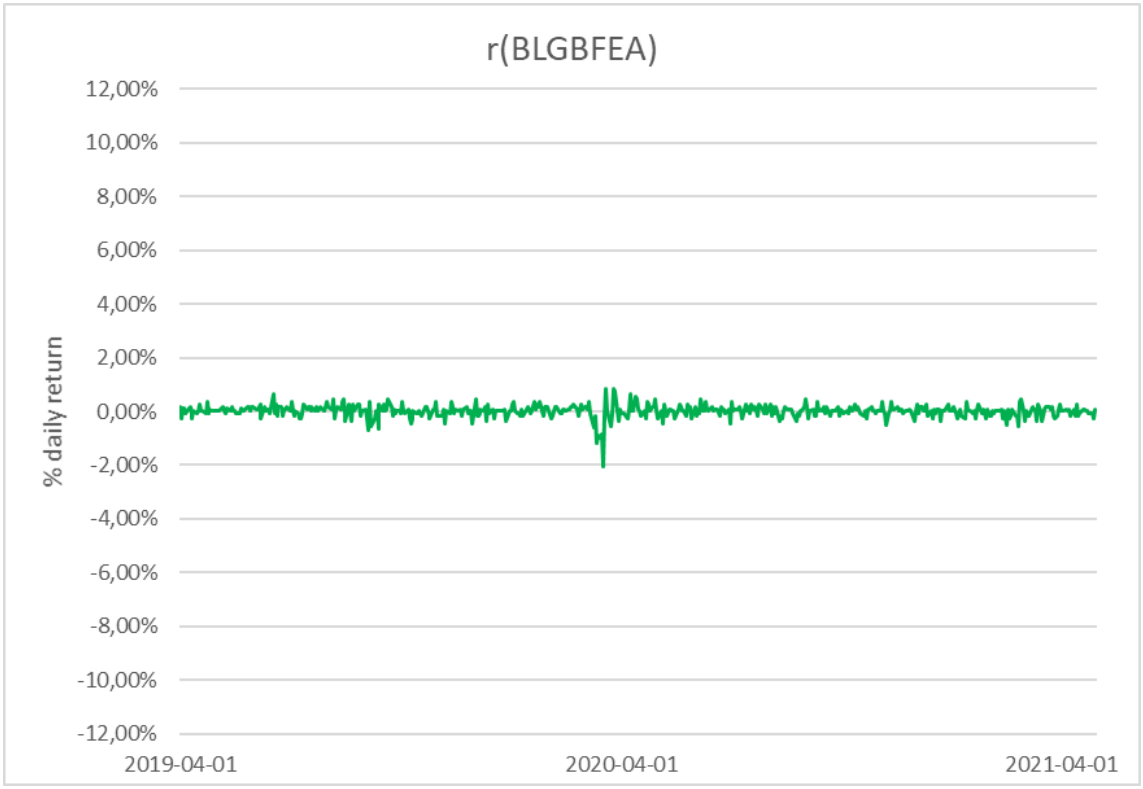
For all the ETFs considered the daily returns in the first half of the time series, from April 2019 to February 2020, did not have significant peaks or drops with limited deviations from the mean. Starting with the beginning of the pandemic ETFs reach maximum and minimum peaks of ±10% in March and April 2020. In the second half of the time series (from May 2020 to March 2021) in which the pandemic continued but governements eased restrictions to support economic recovery, ups and downs are stronger.

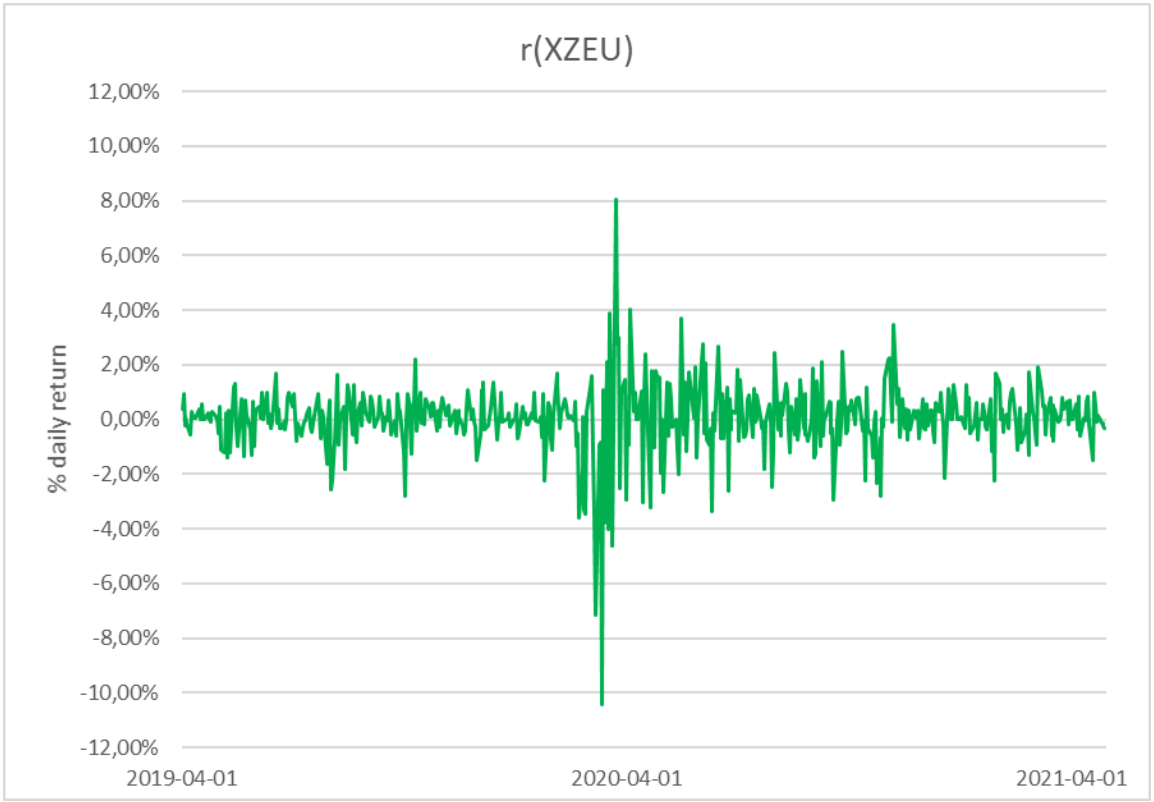
Figure 4.3: Price trend of the sample of standard ETFs

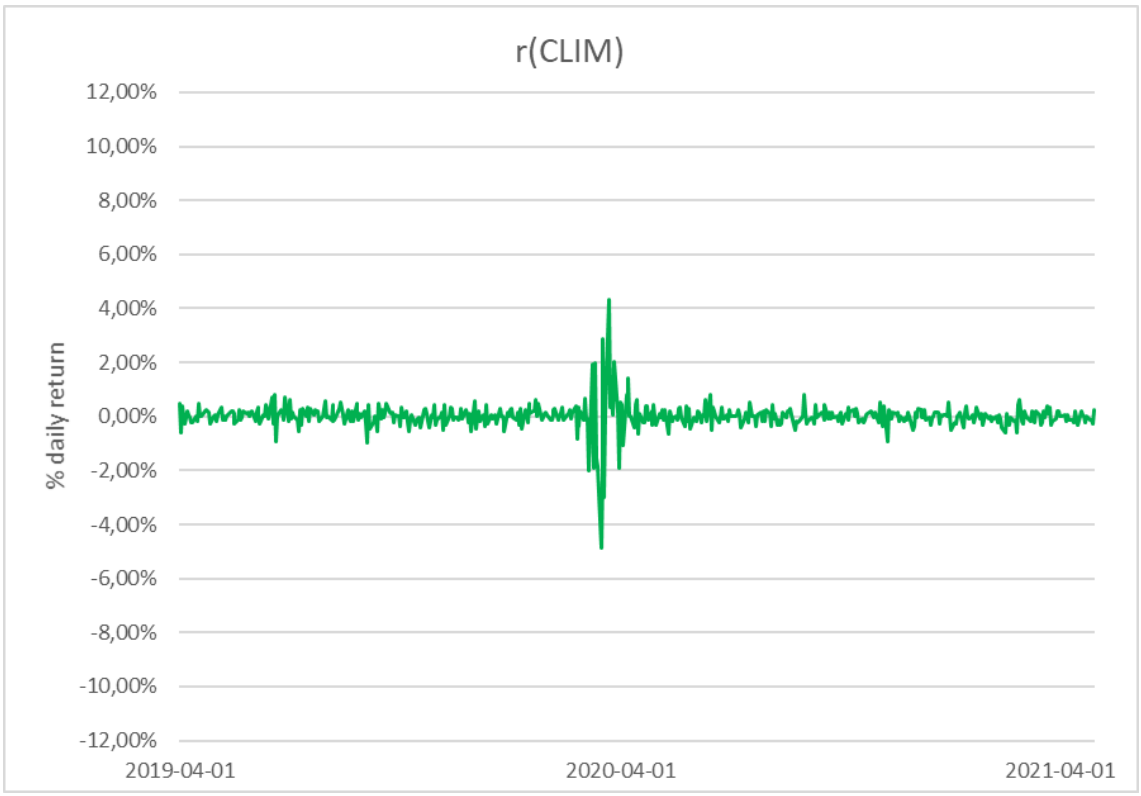
Looking at the graphs to compare green and standard ETFs, daily returns show a similar pattern. The element that differentiates green ones is that fluctuations in returns are moderate while in the other sample seems to be more accentuated.

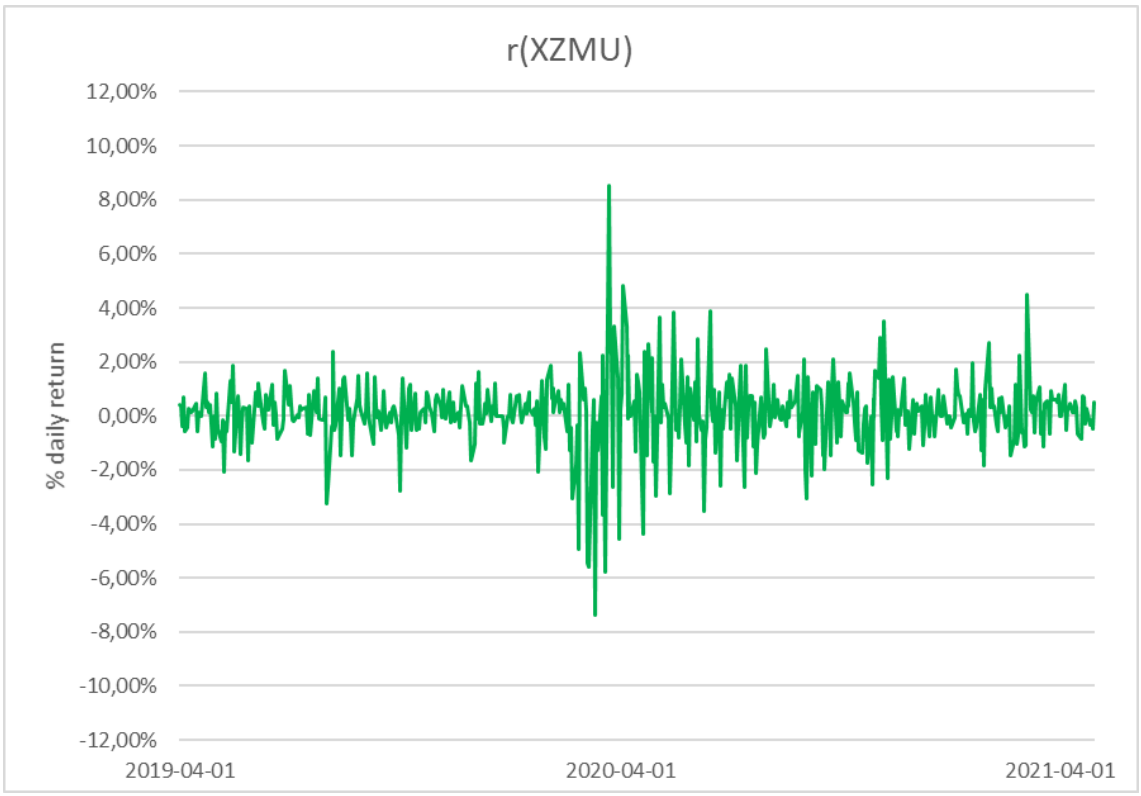
Considering the green ones: BLGBFEA and CLIM returns, excluding the days of the pandemic outblreak, always fluctuate around ±1%. The other three ETFs part of the sample, namely XZEU, XZMU and LCEU, fluctuate around ±2% with some peaks around ±4%. The standard sample reaches peaks around ±6% and thus, from the graph analysis, seems to have a higher volatility.

Figure 4.4: Daily returns of green labelled ETFs






r(CLIM)
12,00%
10,00%
8,00%
6,00%
4,00%
2,00%
0,00%
-2,00%
-4,00%
-6,00%
-8,00%
-10,00%
-12,00%
% daily return
2019-04-01
2020-04-01
2021-04-01


r(XZMU)
12,00%
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% daily return
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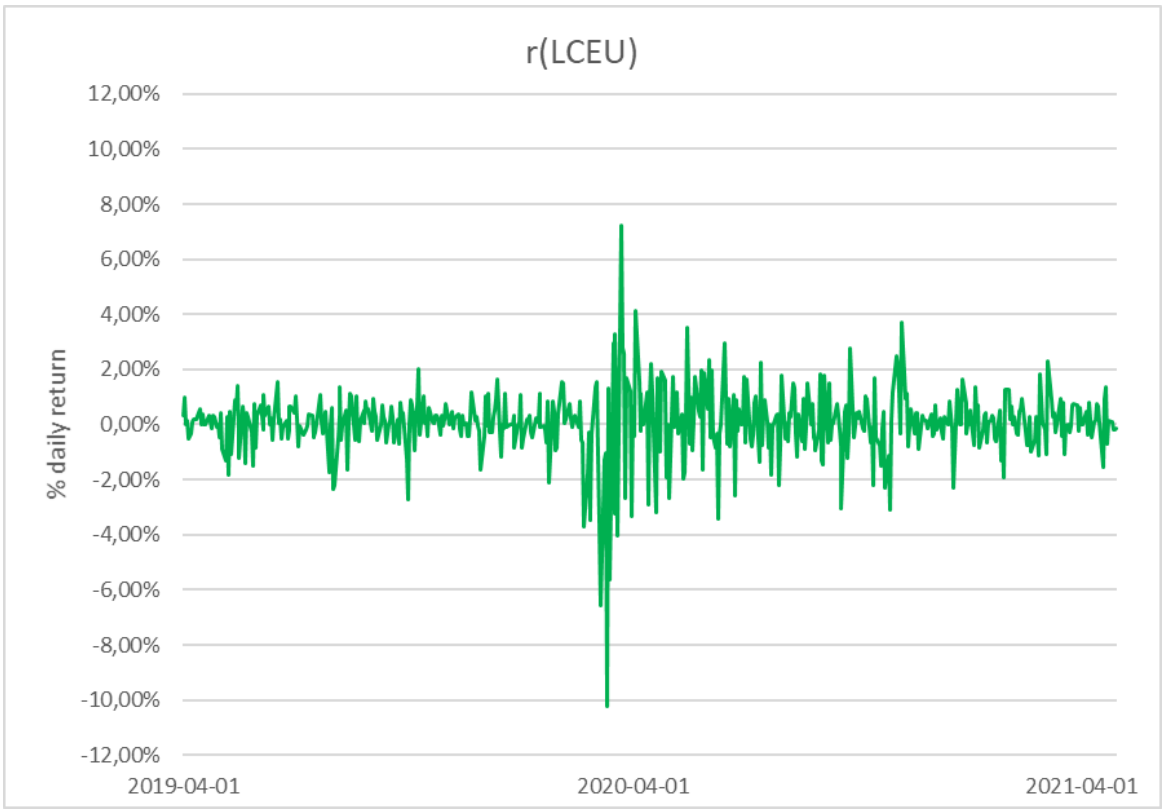
2020-04-01
2021-04-01


r(LCEU)
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-4,00%
-6,00%
-8,00%
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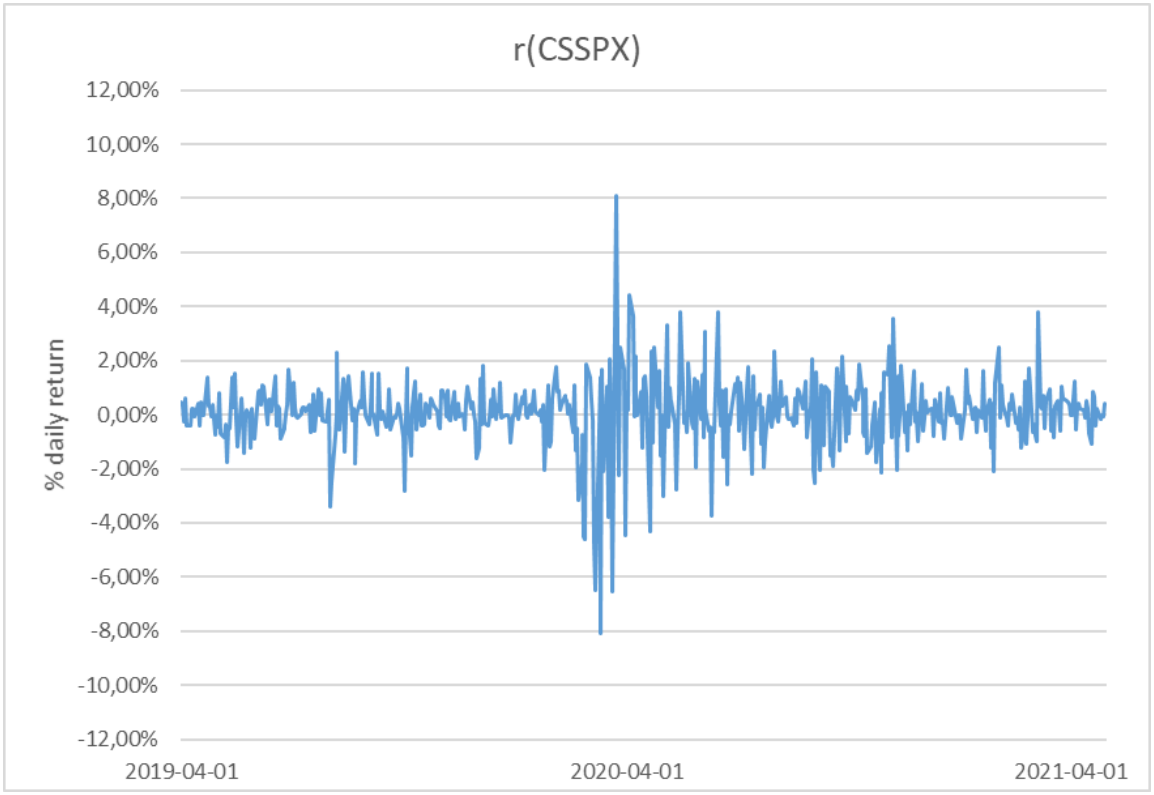
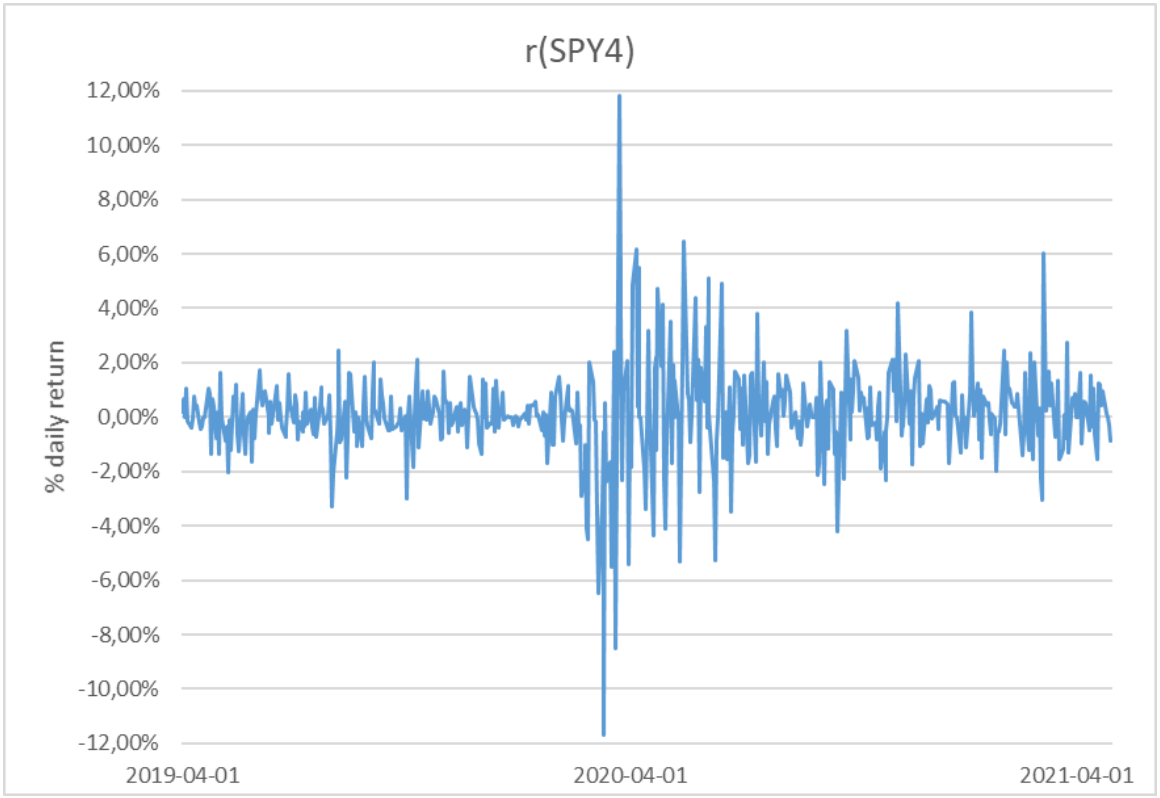
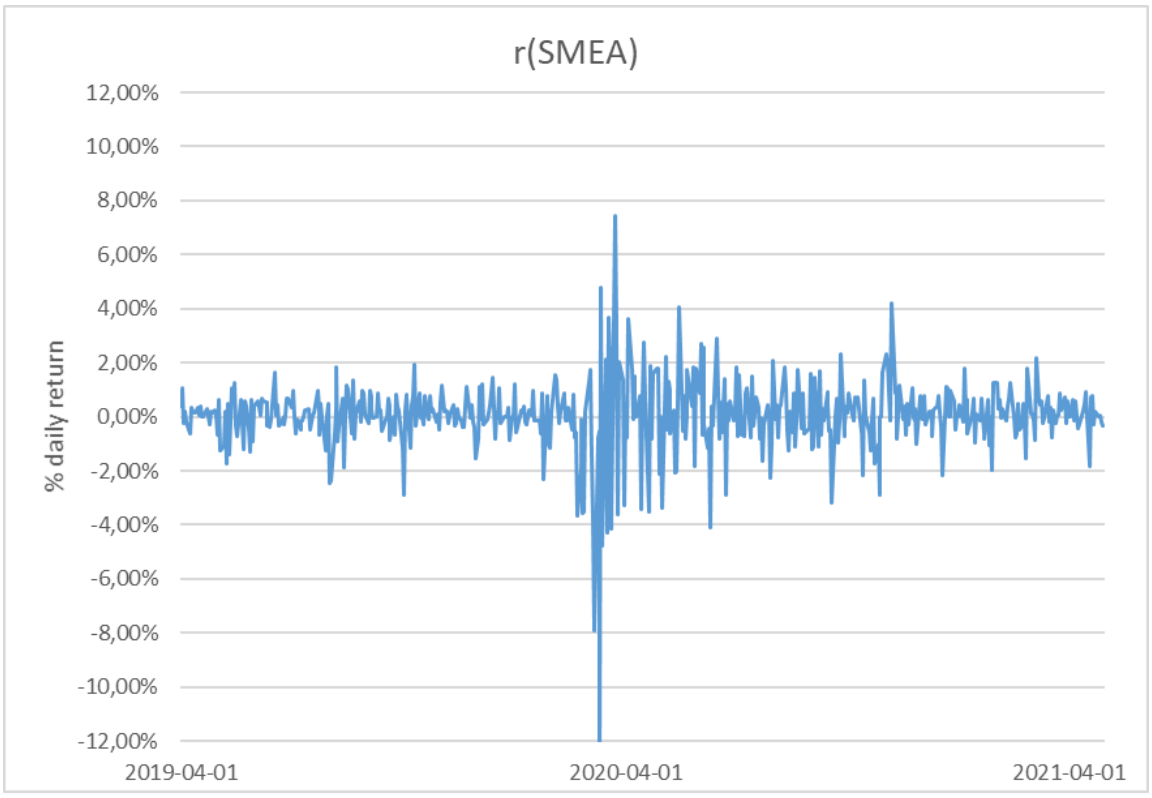
-12,00%
% daily return
2019-04-01
2020-04-01
2021-04-01

Figure 4.5: Daily returns of standard ETFs






r(SMEA)
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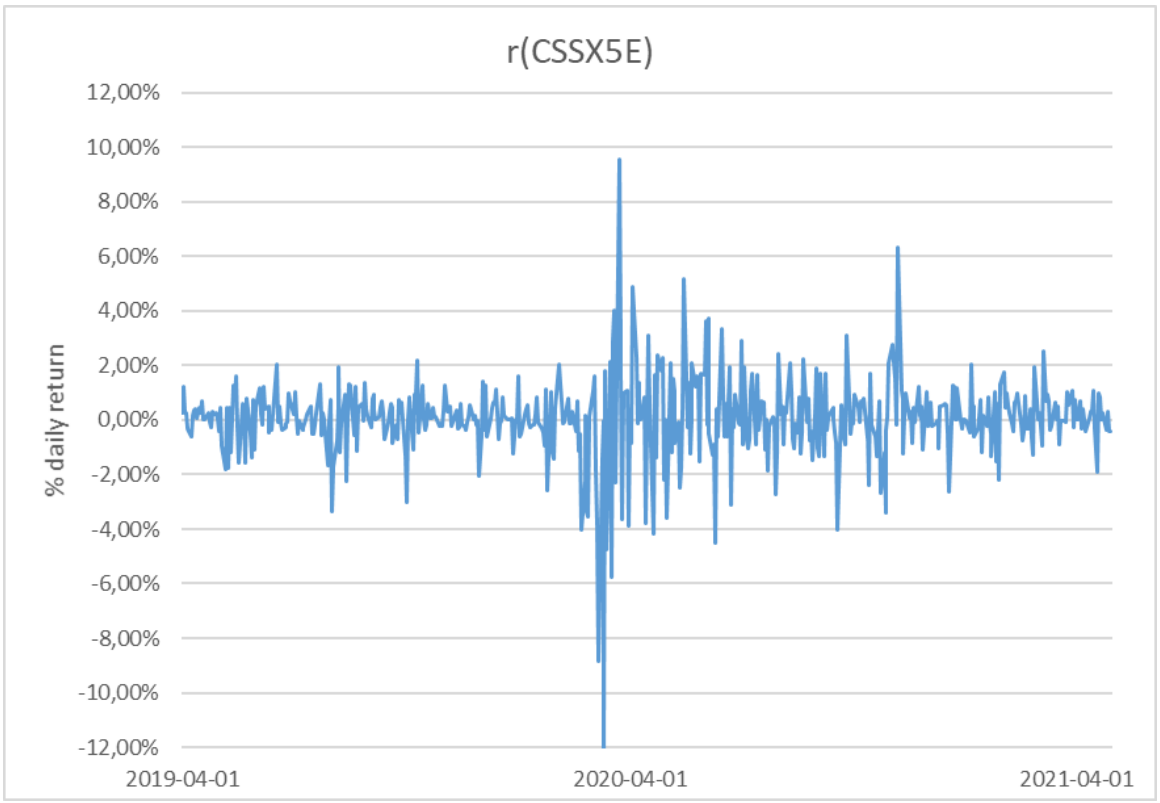
% daily return
2019-04-01
2020-04-01
2021-04-01


r(CSSX5E)
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4,00%
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-2,00%
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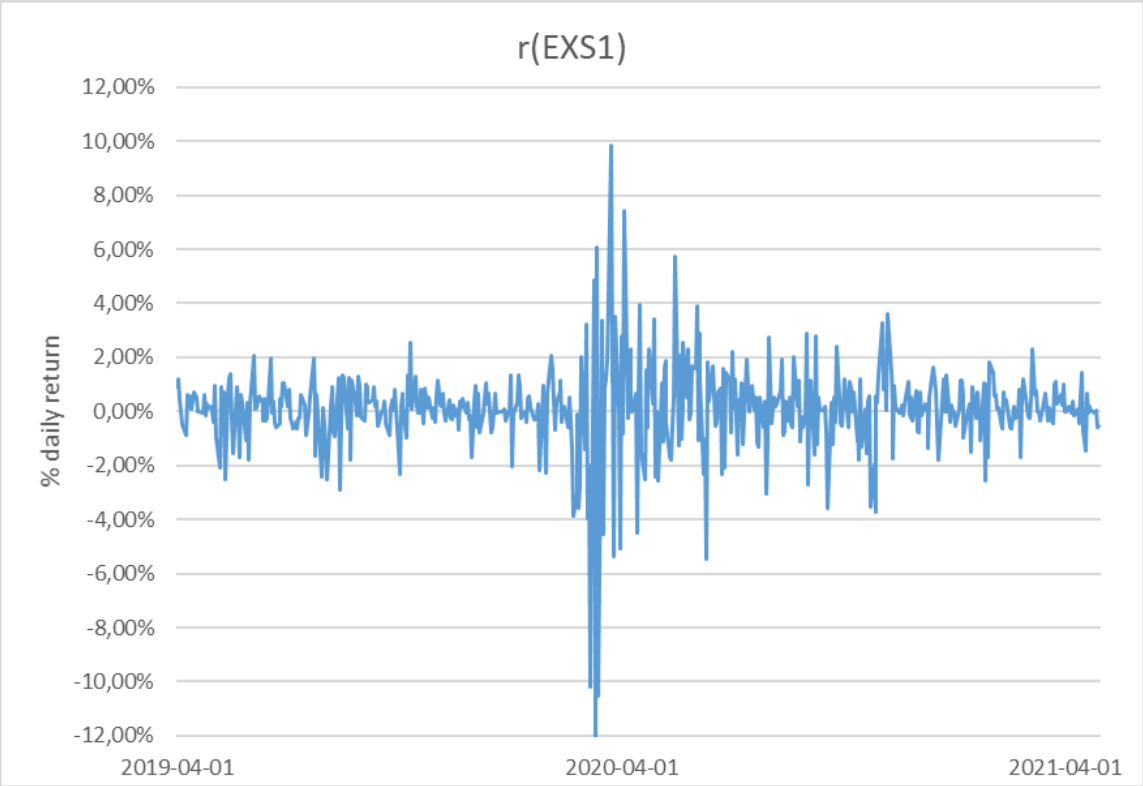
-8,00%
-10,00%
-12,00%
% daily return
2019-04-01
2020-04-01
2021-04-01



4.3 Benchmark and risk-free rate hypothesis

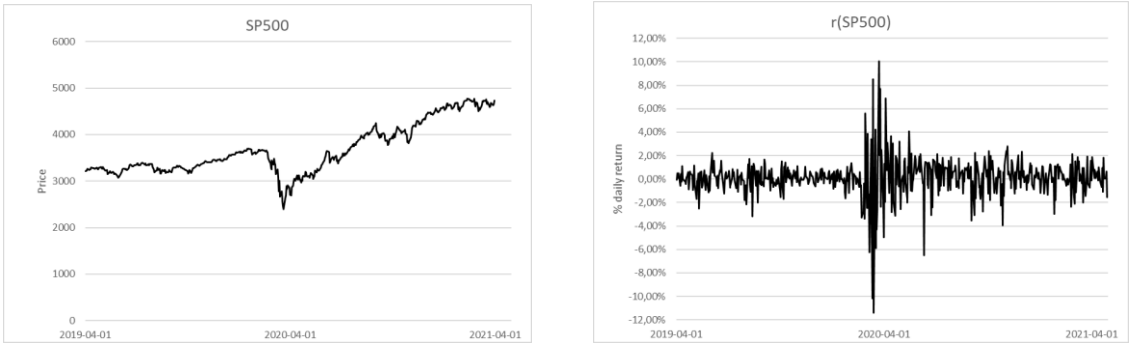
In order to determine the ratios of the performance analysis, the benchmark used is the Index S&P 500, while a Overnight Indexed Swap rate (OIS) of 0.04% represents the risk-free rate. The lattest is supposed to be fixed for the entire 2 years peiod.

Figure 4.6 represents the price trend and the returns for the benchmark for the same time period of the sample. The first noticeable thing is that as of March 2021 the S&P 500 increased its price of more than +30% compared to pre-pandemic prices. Looking at the daily return trend of the period it is line with the ETFs of the standard sample.

The samples follow both North-American and European benchmarks so the Index S&P 500 was considered to be the most appropriate basis for comparing their performance since it represents well the overall stock market.

For what concerns the risk-free rate chosen for the analysis, OIS rate represent a good proxy. In fact, at this historic moment, short-term government bonds have a rate equal to zero,or even a negative rate.

Figure 4.6: Price trend of the Index S&P 500



OIS are interest rate swaps over a given term (from months to years) that allows financial institutions to swap an overninght interest rate for a fixed short-term interest rate. The overnight rate used is tipically the rate for overninght lending between banks that is the EONIA for euro.

Moreover, the OIS is a component of a key measure of health in the banking system: the LIBOR – OIS spread is considered to represent an important measure of risk and liquidity in the money market. If low (it is usually around 0.01%) it indicates higher liquidity in the market, while a higher spread indicates a decreased willingness to lend by major banks, as happened during the 2007 financial crisis.

4.4 Descriptive statistics

Table 4.3 presents the descriptive statistics of all sample variables. Daily data of all ETFs and the benchmark index have been retrieved from Bloomberg and refer to the period ranging from April 2019 to April 2021 (24 months data).

As perceived from the daily returns graphs illustrated in the previous section, non-green labelled ETFs have on average higher standard deviations values, that are expressed annually) than the green labelled ones. In fact, if compared to the standard deviation of the benchmark index of 0.2556, none of the green ETFs have a higher value, on the contrary SPY4 and CSSX5E that are part of the standard sample have exceeding standard deviations if compared to the sample, where EXS1 also have a lower return.

Table 4.3: Descriptive statistics of sample variables

	annualized r(i)	annualized sd(i)	cov(i,j)	var(i)	β	annualized TDD
BLGBFEA*	0.0320	0.0384	0.0000	0.0000	0.0019	0.0291
XZEU*	0.1056	0.2016	0.0001	0.0002	0.5392	0.1545
CLIM*	0.0280	0.0801	0.0000	0.0000	0.0542	0.0611
XZMU*	0.2016	0.2138	0.0001	0.0002	0.5188	0.1564
LCEU*	0.0800	0.2009	0.0001	0.0002	0.5395	0.1554
CSSPX	0.1737	0.2104	0.0001	0.0002	0.5344	0.1568
SPY4	0.1858	0.2749	0.0002	0.0003	0.6302	0.1938
SMEA	0.0817	0.2211	0.0002	0.0002	0.6111	0.1748
CSSX5E	0.1102	0.2414	0.0002	0.0002	0.6316	0.1827
EXS1	0.1320	0.2667	0.0002	0.0003	0.8983	0.2039
SP500	0.1841	0.2556	0.0003	0.0003	1.0000	0.1884

(*) denotes green labelled ETFs

Just one of the green, namely XZMU, have a standard deviation slightly higher than the standard one with the lowest, the CSSPX: 0.2138 versus 0.2104, with a corresponding annual return of 20.16% versus 17.37% of the non-green one, proving to be the one performing better.

Looking at returns they are in line with risk, thus on average non-green labelled ETFs have higher returns on the considered period but just one. If compared to the benchmark, also in this case SPY4 have a slightly higher annual return since the benchmark one corresponds to 18.41%.

In the green sample, except for XZMU that compared to the SP500 have both lower standard deviation and higher return, the other four ETFs included in the sample have returns ranging from 2% to 10%.

Table 4.4 also reports the TDD, used as the denominator in the Sortino Ratio, that was computed considering only deviations lower than zero. Obviously TDD values are lower than SD values for all the sample variables, confirming that none of the green sample variables have a TDD higher than the benchmark, while considering the non-labelled sample only SPY4 have a worst value, fully in line with the previous analysis.

Descriptive statistics include the computation of the covariance and the variance for each ETF, in order to obtain betas. Clearly the benchmark have a beta equal to 1 because its covariance and variance correspond. None of the ten ETFs have a beta >1, indicating

that there is no ETF more volatile than the benchmark in the sample. Standard ETFs have on average higher betas (ranging from 0.53 to 0.89) while the green ones have much lower values, ranging from 0.00 to 0.54.

4.5 Performance analysis results

The descriptive statistics discusses in the previous paragraph were used for the computation of the performance ratios. Table 4.4 reports the obtained results.

Performance indicators results appear to be in line with the considerations made analyzing the descriptive statistics.

Jensen's Alpha clearly corresponds to zero for the benchmark, while if it has a positive value it means that the security has earned excess returns compared to the benchmark. On the contrary negative values mean that the benchmark is a better investment. The percentage indicates the percentage by which the portfolio under or over performed the benchmark on a risk-adjusted basis. On the basis of these considerations, three over five of non-green labelled ETFs have a negative Jensen's Alpha, while just one of the green sample underperforms the benchmark. All of them resulted to have a bad performance compared to their risk. The ETF with the higher Jensen's Alpha, equal to 10.60%, is XZMU, a green one, followed by CSSPX (7.51%) and SPY4 (6.97%).

Table 4.4: Performance ratios of the sample variables

	Jensen's Alpha	Sharpe Ratio	Sortino Ratio	Treynor Ratio
BLGBFEA*	3.1244%	0.8218	1.0851	16.6476
XZEU*	0.6163%	0.5219	0.6810	0.1951
CLIM*	1.7595%	0.3439	0.4506	0.5081
XZMU*	10.5954%	0.9413	1.2868	0.3879
LCEU*	-1.9518%	0.3961	0.5120	0.1475
CSSPX	7.5123%	0.8237	1.1048	0.3243
SPY4	6.9674%	0.6744	0.9566	0.2942
SMEA	-3.0911%	0.3678	0.4652	0.1331
CSSX5E	-0.6241%	0.4548	0.6007	0.1738
EXS1	-3.3348%	0.4936	0.6456	0.1465
SP500	0.0000%	0.7187	0.9750	0.1837

(*) denotes green labelled ETFs

Moving to the result of the next index, the greater a security Sharpe Ratio, the better is its risk-adjusted performance. Since the S&P500 resulted to have a 0.72, only ETFs with a higher Sharpe Ratio result are considered to perform better.

In the standard sample there is just one ETF over performing the benchmark, namely the CSSPX with a Sharpe Ratio of 0.82, while there are two green ETFs better than the S&P500 during the historical time series considered: the XZMU with 0.94 and he BLGBFEA with 0.82.

Sortino Ratio and Treynor Ratio results just confirm the ranking given by the Sharpe Ratio, in fact they are computed in a very similar way, the only difference is the risk measure in the denominator of the formula that is the TDD for Sortino and beta for Treynor.

Let us concentrate on the BLGBFEA results: it has a very high Traynor Ratio, consequence of the ETF very low beta that is 0.0019, so near to zero. We know that the risk-free rate have a beta equal to zero. BLGBFEA obtained higher values in performance ratios because of its low risk which corresponds a return of 3.20% anyway.

To conclude, the analysis here conducted does not seem to deliver strong evidence of the fact that there is one category between the two considered samples that overperform the other in absolute terms.

In fact, in the standard sample the CSSPX is the only ETF resulting to obtain better results than the benchmark, but it could be given by the fact that the ETF really replicates the S&P500 Index. In the green-labelled sample there are two ETFs that sistematically overperformed the benchmark: the BLGBFEA that we have already discussed and the XZMU.

Considering underperforming ETFs there were three in the standard sample (SMEA, CSSX5E and EXS1) and one (LCEU) in the green sample.

4.6 Performance analysis of the data during the Covid-19 period

In this section the same descriptive statistics and the same performance ratios were computed from the second half of the data sample, that coincides with the spread of the Covid-19 pandemic.

The further analysis emerges from a recent study by Klioutchnikov et al. (2021) that highlights that the recent pandemic outbreak rose attention to green finance as an

economic mechanism for creating healthy living environments. The study bring attention to the participation of green finance in the economic recovery after the crisis resulted from the pandemic, in fact Covid-19 have increased the overall awareness about the fragility of the environment that have already been factored into green finance.

The same topic is discussed by Broadstock et al. (2020) that examined the ESG performance during the market-wide financial crisis triggered by the Covid-19 pandemic. The analysis was conducted over the chinese financial market with the aim to demonstate that high-ESG portfolios overperformed low-ESG portfolios during the pandemic period. Moreover they demonstrated that ESG performance mitigates financial risk during financial crisis, but ESG performance is attenuated in 'normal' times because it assumes more importante during crisis periods.

Daily data of all ETFs and the benchmark index for the following analysis refer to the period ranging from April 2020 to April 2021 (12 months data). The month of March 2020 that was characterized by falling price and excessively high volatily was voluntarily excluded from the analysis in order to not affect the results.

The aim is to analyze if the results here obtained invert the results and the considerations made for the 24 months sample.

Table 4.5: ***Descriptive statistics of sample variables during the Covid-19 pandemic, daily data from April 2020 to April 2021***

	annualized r(i)	annualized sd(i)	cov(i,j)	var(i)	β	annualized TDD
BLGBFEA*	0.0392	0.0305	0.0000	0.0000	-0.0007	0.0206
XZEU*	0.3881	0.1806	0.0001	0.0001	0.5184	0.1222
CLIM*	0.0260	0.0485	0.0000	0.0000	0.0190	0.0383
XZMU*	0.5230	0.2092	0.0001	0.0002	0.5752	0.1377
LCEU*	0.3622	0.1843	0.0001	0.0001	0.5104	0.1257
CSSPX	0.5071	0.2006	0.0001	0.0002	0.5810	0.1322
SPY4	0.9204	0.2826	0.0001	0.0003	0.7454	0.1750
SMEA	0.4094	0.1901	0.0001	0.0001	0.5374	0.1304
CSSX5E	0.5073	0.2274	0.0001	0.0002	0.6541	0.1490
EXS1	0.6111	0.2361	0.0002	0.0002	0.9025	0.1562
SP500	0.6271	0.2082	0.0002	0.0002	1.0000	0.1427

(*) denotes green labelled ETFs

Table 4.6: ***Performance ratios of sample variables during the Covid-19 pandemic, daily data from April 2020 to April 2021***

	Jensen's Alpha	Sharpe Ratio	Sortino Ratio	Treynor Ratio
BLGBFEA*	3.9229%	1.2726	1.8837	-54.0264
XZEU*	6.2772%	2.1466	3.1738	0.7478
CLIM*	1.3669%	0.5272	0.6672	1.3478
XZMU*	16.2104%	2.4983	3.7939	0.9086
LCEU*	4.1862%	1.9631	2.8777	0.7088
CSSPX	14.2492%	2.5256	3.8328	0.8720
SPY4	45.2755%	3.2551	5.2570	1.2341
SMEA	7.2198%	2.1517	3.1373	0.7611
CSSX5E	9.6922%	2.2289	3.4018	0.7749
EXS1	4.5064%	2.5865	3.9104	0.6767
SP500	0.0000%	3.0110	4.3923	0.6267

(*) denotes green labelled ETFs

Table 4.5 presents the descriptive statistics of all sample variables and Table 4.6 presents the performance ratios.

Before commenting the results it is important to clarify that the ratios used in the analysis are more reliable if computed on longer time series. Thus, results coming from the reduction of the analysis to a one year time series are less reliable in absolute terms. The first consideration that is necessary to make is that in this second sample that just considers one year of trading day the benchmark significantly improved its performance: all ratios have better results, annualized standard deviation decreased (from 0.25 to 0.20) and annualized returns increased (from 18.41% to 62.71%).

Given this improve of the benchmark it would be more difficult for ETFs in the sample to overperform it. In April 2020 the market was in the middle of the financial crisis due to Covid-19 and prices in financial markets were low. This explains the abnormal return of the S&P500 of 62.71%.

In fact, looking a the Jensen's Alpha results, none ETF in the sample have a negative Jensen's Alpha. The ones with the higher values stay the same as the previous 24 months sample: XZMU among the green ones, CSSPX and SPY4 among the non-green ones.

Moving to the analysis of other indicators compared to benchmark, only the SPY4 (non-green) overperfomed the benchmark.

Let us focus on the BLGBFEA because it has a negative beta, meaning it has an inverse relation to the market. If beta is negative results arising from the Treynor Ratio should not to be considered.

Looking at the overall results and recalling the fact that the benchmark had an extraorinary performance, let us just consider ratios without comparing them with the benchmark. It is true that during the Covid-19 green ETFs in the sample improved their performance indicators, see for example Sharpe Ratio and Sortino Ratio result that do not involve the benchmark into the computation. But it is also true that the improvement also applies to other non-green labelled ETFs in the sample, it results that they improved more than the green ones.

Results from the performance analysis do not demonstrate the higher performance of green over standard ETFs for the sample in the analysis. Limitations arising expecially from the second part of the analysis for the data during the Cobid-19 period have to be considered: the short time series not reliable and the exceptional results of the benchmark.

Conclusions

The considerable importance that climate change has achieved in the last years has spread through the financial markets. The initial commitment of the international organizations has been followed by the growing interest of banks and private investors, due to many factors such as corporate social responsibility, business opportunities, but reputational gains as well.

The aim of this thesis was to touch different aspects about the development of green finance and, in general, social responsible investments. The thesis starts reviewing the main initiatives of the United Nations and the engagements of the parties involved, and then focuses on the engagement of the European Union that developed the first emission market. The EU ETS definitely lay the foundation for the modern green finance. Because of the diffusion of green financial instruments and the increasing market volume, disclosure requirement are strictly necessary and the were introduced by the SFDR that aims to limit the risk of greenwashing by financial markets partecipants, providing more transparency on sustainability factors in a standardised way. It allows member states to compare effectively different financial products with respect to their ESG investment objectives.

Following, the thesis questions about the performance of traditional investments compared to green investments. Using a sample of the first category and compared to a sample of green labelled investments, a performance analysis was performed using the Jensen's Alpha, the Sharpe Ratio, the Sortino Ratio and the Treynor Ratio.

The obtained results put in evidence the fact that during the period there was not one category overperforming the other in absolute terms.

It is necessary to point out that half of the time series analyzed covered the Covid-19 year and thus the trend was affected by multiple factors.

Moreover, it was expected that during the pandemic period green financial products increased their performance: it happened partially because also non-labelled financial products had an exponential increase.

All things considered, the here conducted analysis, with all its limitations, does not seem to deliver strong results that can justify in performance terms the growing interest for green financial instruments.

Moreover, since the SFDR and the taxonomy have been implemeted only patially and they will become fully enforceable in the next years, it may be too early to perceive the benefits of the inclusion of green financial instruments into an investor portfolio.

Over the next years green investments are expected to become fully comparable with traditional investments, thanks to disclosure requirements, but in addition green investments and in general SRI have the advantage of generating positive externalities for both environment and community.

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