How ESG investment funds contribute to the transition to a low-carbon economy?

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Abstract

This paper assesses contribution of ESG investment funds to the transition to a low-carbon economy along three dimensions, i.e., financed activities, portfolio carbon footprint and its evolution over time, and preference for firms with (ambitious) science-based targets. We apply these five metrics to the European investment fund sector to identify potential mismatch between funds' claims and actions. In the absence of a unique definition of an ESG fund, we identify ESG funds using three approaches: funds' declared investment strategies reported by Morningstar (MS), classification of financial products under Article 8 and 9 of the Sustainable Finance Disclosure Regulation (SFDR), and self-marketing based on funds' names. We assess how performance of ESG funds along these metrics differ from the non-ESG funds. Our results indicate lack of coherence between self-marketed ESG funds and funds adopting a sustainable strategy or classified as Article 8/9. Furthermore, ESG funds identified by MS or SFDR perform better in metrics related to financed activities and carbon emissions, while self-marketed funds show less consistent results. Still the MS and SFDR classifications highlight a relatively limited impact that investment funds currently have in financing the transition to a net-zero economy. This work sheds new light on the ESG fund sector and the challenges posed by greenwashing, and inform the policy debate around ESG and E-labels for retail financial instruments.

JEL Codes: C58, G11, G23, Q50, Q51, Q56

Keywords: ESG funds; low-carbon transition; sustainable finance; climate change

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1 Introduction

ESG investment funds have experienced remarkable growth in the recent years, reaching USD 30.3 trillion, or one fourth of the global market (GSIA (2023)). Indeed, increasing demand for sustainable finance products and pressure for the financial sector to take an active part in financing climate transition and sustainability objectives have led to an expanding offer of ESG financial products. At the same time, lack of clarity of what activities are sustainable, small pool of sustainable assets respecting high standards such as the EU Taxonomy, lack of definition of an ESG fund and lack of transparency on funds' strategies as well as absence of sustainability performance assessment of these products have created an important dispersion in types and sustainability ambitions of ESG investment funds offered on the market. Given the concern on greenwashing - mismatch between marketing claims and real impact delivered by ESG financial products - the European Commission has requested the European Supervisory Authorities such as European Securities Market Authority (ESMA) and European Banking Authority (EBA) to analyse greenwashing risks and necessary sustainable finance policies (ESMA (2023a)).

Figure 1 illustrates well the lack of agreement on a definition of an ESG fund as of December 2021. The chart shows that the three main data providers - Bloomberg, Lipper or Morningstar - unanimously agree on a fund being ESG only in around 24% cases out of 1820 investment funds identified as ESG by at least one data provider.

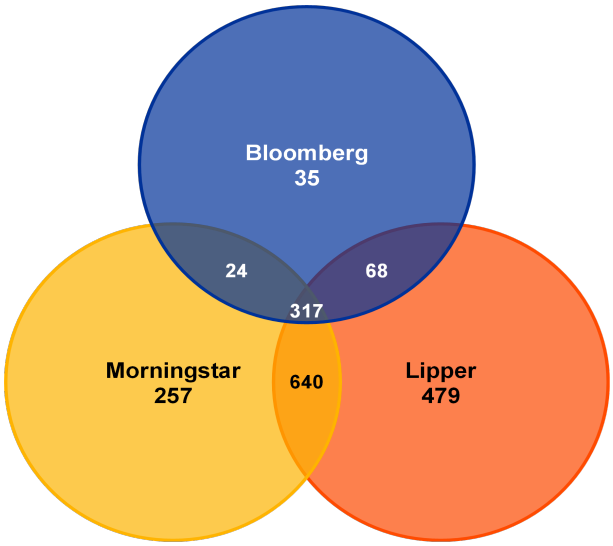


Figure 1: ESG funds as defined by three data providers: Bloomberg, Lipper and Morningstar. The overlapping areas show that more than one data provider consider a fund being ESG. The ESG labels are as of December 2021.

To assess funds' credibility, one first needs to define metrics along which to assess funds' ESG performance. In this paper, we define a list of metrics that shed light on funds' contribution to the low-carbon transition and then compare performance of various ESG funds along these metrics.

To achieve portfolio carbon neutrality, main net-zero initiatives identify several directions (GFANZ (2022), NZAOA (2024), SBTi (2023)): first, financial institutions have to redirect funding to climate solutions and reduce/withdraw funding from fossil fuels. Hence, our first metrics focus on the assets financed by investment funds, how much is invested in renewable energy vs fossil fuels. Second, financial institutions have to set up targets related to the emissions related to their assets and progressively reduce carbon footprint of financial portfolios. Thus, our next set of metrics looks at the level and change in portfolio emissions over time. Furthermore, we look at what factors explain the change in emissions, since reduction in emissions due to divestment has different real-economy and policy implications than reduction in emissions of investee firms.

Third, financial institutions should direct funding to companies that are on the transition path, that is they are aligned with the net-zero trajectory or they have ambitious science-based targets and tangibly act to reach net-zero objective, i.e. by investing in sustainable or taxonomy-aligned activities. Ideally, our third set of metrics should focus on identi-

fying funding share to such companies or activities, however, we are limited by the data availability. These data are unavailable not only to us but potentially to the majority of investors as companies do not have a mandatory obligation to report such information. Currently, financial institutions can use data coming from private initiatives such as SBTi and PACTA (PACTA (2022)) that analyze companies' alignment with net-zero transition path. For this reason, our third type of metrics uses a portfolio share held in companies with science-based targets (SBT) and ambitions of these targets. Given a previous study that finds that companies with more ambitious SBT have lower credit risk (Carbone et al. (2021)), we assume that more environmentally-concerned investors privilege companies that have set up targets and potentially more ambitious targets.

Finally, the current work should be further extended to include indicators of engagement and investor stewardship to assess investors' contribution to the change. Busch et al. (2021) suggest distinguishing investor's contribution from firm's impact. Indeed, investors can only influence companies but cannot reduce emissions (effective outcome) on their behalf, so it is important to assess investors' efforts to drive companies' actions relative to the changes that would have happened even without investors' interventions. A fund that aims at creating impact by steering investee companies to reduce their emissions should undertake significant stewardship engagement with the investees, and these actions need to be assessed (e.g., Boyano et al. (2021)). Unfortunately, to the best of our knowledge, there is no robust and quantitative way to assess companies' engagement practices and their efficiency.

Now, let's turn to a very important question on how we define ESG investment funds. We use three approaches. First, we use Morningstar data to classify funds in five categories: Fossil-Fuel Free (FFF), Green, Impact, general ESG funds and all other funds. FFF focus on low-carbon transition. Green funds are thematic funds; they invest in environment-related assets, renewable energy, water management, etc. Impact funds aim at creating a positive impact via ESG engagement with investee companies. Finally, a general category of ESG funds focus solely on financial materiality of ESG factors and manage ESG-related risks for the sake of financial performance.

In our second approach, we distinguish between Articles 6, 8 and 9 investment funds in

line with the European Sustainable Finance Disclosure Regulation (SFDR). While the regulation categorises funds for pure disclosure purposes, the lack of rigorous regulatory classification of ESG funds lead markets to fill in the void by using Art. 6/8/9 categories to promote and market their sustainability products.

Finally, our third classification is based on text analysis of funds names. We follow the approach of Capotă et al. (2022) to search for key words in funds' names that hint to ESG/green-related investment strategies. Thus, we identify three categories: general ESG funds, Green funds with a specific focus on the environment and low-carbon transition, and all other funds.

To conduct our analysis, we construct a database using three different data sources. We use Refinitiv Lipper to obtain data on funds' characteristics and portfolio holdings, Urgentem - for firm level emissions, and Morningstar - to identify green attributes of funds. The data span six years from 2016 to 2021. The final dataset consists of 1,838 funds that represent 28% of the assets under management in the European Union. Regarding emissions, we focus on two most used metrics, absolute carbon emissions and emission intensity for Scope 1 and 2.[1]

Our analysis provides several interesting findings. First, by comparing different sustainability taxonomies for investment funds, we find the MS sustainability investment strategies quite consistent with the SFDR classification. More specifically, we find that the majority (91%) of GreenTech/LowCarbon funds are either Art. 8 or 9 funds, while most of the Art. 9 funds are either GT/LC funds (60%) or Impact funds (22%). On the other hand, we document that self-marketed Green funds are rather incoherent regarding the two other classification, notably, less than half of these funds are either Art.8/9 and have stringent sustainable investment strategy (GT/LC or Impact), while 28% of these funds are Art.6 and have no sustainable investment strategy at all. The former case refers to green-hushing, limited marketing of sustainability actions to avoid potential accusation of green-washing, while the latter case refers to green-washing, marketing claims not substantiated by real actions.

Second, when comparing financed activities of different ESG investment funds, we observe

[1]We focus on Scope 1 and 2 as currently more reliable data. We run robustness test by including Scope 3 in the analysis.

common and expected patterns for MS and SFDR taxonomies, namely, lower investments in Fossil fuels and larger investments in Renewables for greener categories of investment funds such as GreenTech and Art.9 funds. However, no difference in terms of investments in other sectors such as Financials, HealthCare or Tech relatively to conventional funds with no sustainability objectives. Regarding the self-marketed funds, we observe difference only between Green-marketed funds and other funds and no difference for ESG-marketed funds. Still Green-marketed funds show again the lowest consistency between their names and financed activities as they tend to have larger exposure to the Fossil Fuel sector and at the same time also larger investments in Renewables, while statistically significantly lower financing of Financials, HealthCare and Tech.

Third, analysis of portfolio carbon emissions shows relatively mild differences between funds with sustainable attributes and all other funds. Among funds with MS sustainable strategies, only Impact funds, somewhat surprisingly, show lower level of financed emissions both in 2016 and 2021, and low carbon funds - lower financed emissions and portfolio emission intensity in 2021, with the latter also exhibiting reduction in both variables between 2016 and 2021. Turning to the SFDR classification, Art.8 funds report both lower levels in 2016 and 2021 in financed emissions and portfolio emission intensity, and reduction in these characteristics over the period. Art.9 funds are not statistically different from Art.6 funds. As for the self-marketed funds, overall they show no difference relatively to other funds. ESG funds even have a slightly significantly higher carbon footprint than no-strategy funds.

Finally, when looking at the share of funds' investments into more sustainability-committed firms identified by their Science-based targets, we observe no difference between any sustainability-related and conventional funds.

These findings have important policy implications. They highlight the potential for greenwashing, particularly, in the self-marketed funds and support the position of the ESMA regarding the restriction of the sustainability-related words in fund names (ESMA (2024a)). Furthermore, our work underlines the importance of quantitative criteria for sustainability objectives for ESG investment funds to assure achievement of tangible sustainability results by these funds.

We contribute to two streams of literature. The first one looks at the interaction between transition to a low-carbon economy and funds' investment decisions aimed at reducing risks deriving from a high carbon environment. Boermans and Galema (2019) study if Dutch pension funds actively decarbonize their portfolios from 2009 to 2017. They find that pension funds reduce their carbon footprint by reducing exposure to carbon-intensive industries, and the result is stronger for larger pension funds that also measure and report their carbon footprints. Wang et al. (2023) analyse carbon footprint of Chinese investment firms from 2010 to 2020 and find that after a trough in 2015-2016 financed emissions exceeded the 2010 level by the end of the sample. Exposure towards Electricity, Gas and Water sectors explain more than 50% of financed emissions. Ceccarelli et al. (2024) analyse the trade-off between minimising exposure to climate risks whilst maximising portfolio diversification. Combining Morningstar funds' carbon risk metrics with firms' synthetic carbon risk scores, they find that low carbon funds experienced an increase in flows, especially those with higher-risk-adjusted returns, signalling a search for an optimal balance between climate and conventional risks by investors. Atta-Darkua et al. (2023) focus on global institutional investors and find that portfolio decarbonisation is primarily driven by portfolio reshuffling from more emission-intensive to less emission-intensive firms without statistically-significant reductions in firms' emissions nor increase in financing of green pattents.

The second stream of literature looks at the mismatch between investment funds' claims and their actions and outcomes, that can be identified as greenwashing. Kim and Yoon (2022) investigate if signatories of Principles of Responsible Investing (PRI) improve their fund-level ESG scores and/or integrate ESG principles in their actions following the signing of the principles. The authors consider several proxies for funds' ESG incorporation (e.g., entry/exit, screening, engagement, voting for pro-ESG proposals), but fail to observe evidence of meaningful follow-through, on average. At the same time, PRI signatories attract a large fund inflow without having larger returns. On the other hand, Humphrey and Li (2021) find an opposite result. The authors study if fund families PRI signatories have significantly lower portfolio emissions after signing the initiative than do non-signatory families. Two mechanisms of emission reduction are put forward, access

to the resources offered by the PRI (networks, information, education, etc.) and pro-environmental stakeholders of the families. The authors also that families that reduce their emissions experience significantly increased fund flow.

The rest of the paper is organised as follows. Section 2 defines metrics that are used to assess funds' contribution to low-carbon transition. Section 4 presents our taxonomy to identify ESG investment funds, which constitute the base for our empirical analysis. Section 3 introduces our novel database and outlines the main statistics about data coverage. Section 5 provides some stylised facts and statistics for various funds' categories. Section 6 outlines the main research questions we intend to test and the corresponding econometric framework. Section 7 reports and discusses main findings. Section 8 concludes.

2 Metrics

To assess transition performance (we will use interchangeably terms sustainability, environmental, ESG performance) of investment funds and a potential mismatch between this transition performance and marketing as an ESG fund, we fist need to define such metrics. Financial institutions can contribute to provide funding to the low-carbon transition in several ways (Caldecott et al. (2022)). First, providing or withdrawing capital to/from sustainable or polluting activities, respectively. Second, by reducing or increasing the cost of capital to sustainable or polluting activities, respectively. Third, by encouraging or enabling sustainable practices by companies they invest in.

In this section we introduce three sets of metrics along which we assess low-carbon transition of investment funds following guidelines of main net-zero initiatives (GFANZ (2022), NZAOA (2024), SBTi (2023)). First group of metrics focuses on assets financed by investment funds. We would particularly expect that sustainability-oriented funds redirect funding to climate solutions and reduce/withdraw funding from fossil fuels.

Second set of metrics looks at funds portfolio emissions, both absolute emissions and emission intensity, level and change. The level of emissions may be less clear to interpret as financial institutions may invest in highly carbon-intensive firms and actively engage investees in transition. Thus, emission level should be complemented by the change in

emissions over time with the objective to reach zero portfolio emissions. Funds have different ways to reduce their portfolio emissions, for example, by selling off most carbon-intensive firms. Bolton et al. (2022) suggest how to reach net-zero portfolio with minimum tracking error. Divestment is an important instrument to encourage firms undertake the transition by increasing cost of capital and particularly for firms with activities in fossil fuel sector. However, majority of firms in transition need access to affordable funding to finance the transition (Carradori et al. (2023)). In this case, divestment helps achieve carbon-neutrality of an individual fund but doesn't help solve the problem.

The first two sets of metrics are backward-looking and do not take into account transition plans of firms or funds. Firms' net-zero alignment and/or investments in sustainable activities, like EU Taxonomy-aligned activities, should provide investors with information on firms' engagement in the transition. However, this information is not yet subject to mandatory reporting and thus not regularly available to investors. Currently, funds can have access to data from private sector initiatives like SBTi and PACTA that analyse firms' alignment with net-zero transition plans. Our third group of metrics uses a portfolio share held in companies with science-based targets (SBT) and ambitions of these targets. Given a previous study that finds that companies with more ambitious SBT have lower credit risk (Carbone et al. (2021)), we assume that more environmentally-concerned investors privilege companies that have set up targets and potentially more ambitious targets.

2.1 Financed activities

First, we look at what type of activities are financed by investment funds. Economic sectors are identified by NACE codes (Statistical Classification of Economic Activities in the European Community). It would be relevant to use the European Taxonomy that provides classification of sustainable activities. However, as shown by Alessi and Battiston (2022), the current nomenclature like NACE is a bad fit to assess financing of EU Taxonomy eligible and aligned activities. The authors partially solve the problem by providing a table of weights of the taxonomy eligible/aligned activities within each NACE sector. These weights are estimated by the authors based on the market information and the size of the sector in the market. This approach could be applied to an aggregate

financial sector, like French banking sector or French investment funds (Piquard et al. (2024)), but less justifiable for the use at an entity level.

We group all sectors into five main categories: Renewables and Non-Renewables, Financials, Transformation, Infrastructure and Transportation, and Others. "Renewables" includes traditionally transition-oriented or "green" sectors such as alternative sources of energy and forestry management. "Non-Renewables" refers to "brown" sectors such as extraction of fossil fuels, metals and construction materials. "Financials" consists of investments in financial institutions such as banking and insurance companies. "Transformation, Infrastructure and Transportation" refers to the transformation of resources, construction and management of infrastructures and real estate, utilities and waste, all types of transport, including automotive. "Others" contain all the other sectors such as consumer goods, health care, services, technology and communication.

2.2 Portfolio carbon footprint

Following the EU Sustainable finance disclosure reporting (SFDR), private financial alliances (e.g., NZAOA (2024)) and the ECB climate-related indicators on carbon emissions (ECB (2023)), we use two main metrics: Financed Emissions (FE) and Weighted-Average Carbon Intensity (WACI). Financed emissions are absolute emissions of green house gases measured in tonnes of CO2 equivalent (CO2e). Carbon intensity is defined as firms' absolute emissions divided firms' revenues and measures efficiency of carbon emissions. The two measures are complementary. Absolute emissions depend on the size of a company or a fund and make comparison across entities and sectors less meaningful, on the other hand, absolute emissions allow assessing the progress made to reach net zero objective. Emission intensity makes comparison of the efficiency of activities between companies and funds possible but reduction in emission efficiency does not necessarily lead to reduction in absolute emissions.

2.2.1 Financed emissions

Financed emissions are absolute emissions that measure for how much emissions a fund is responsible by holding a share in a firm. It is defined as follows:

$$AE_{i,t} = \frac{\sum_{j=1}^{H} AE_{j,t} \cdot \omega_{i,j,t}}{\sum_{j=1}^{H} \omega_{i,j,t}}$$

where $i = 1, \ldots, N$ is a given fund, $j = 1, \ldots, H$ a specific firm in the portfolio and $t = 1, \ldots, T$ is a given year. $AE_{j,t}$ is absolute emissions of firm j. $\omega_{i,j,t} = \frac{holding_{i,j,t}}{marketcap_{j,t}}$ represents a ratio of the market value of a fund holding of firm j to the total market capitalization of the firm.

2.2.2 Carbon intensity

Similarly to financed emissions, the weighted-average carbon intensity of a fund's portfolio is defined as:

$$CI_{i,t} = \frac{\sum_{j=1}^{H} CI_{j,t} \cdot \omega_{i,j,t}}{\sum_{j=1}^{H} \omega_{i,j,t}}$$

where $i = 1, \ldots, N$ is a given fund, $j = 1, \ldots, H$ a specific firm in the portfolio and $t = 1, \ldots, T$ is a given year. $CI_{j,t}$ is the carbon of firm j. $\omega_{i,j,t} = \frac{holding_{i,j,t}}{marketcap_{j,t}}$ represents a ratio of the market value of a fund holding of firm j to the total market capitalization of the firm.

2.2.3 Change in portfolio emissions

An important metric is the change in portfolio emissions in time, either change in financed emissions or in carbon intensity. This metric allows assessing portfolio decarbonisation rate. The EU Climate Benchmarks regulation (EC (2019)) sets up at least 7% of annual decarbonisation rate for financial portfolios. This is the rate that will allow reaching carbon neutrality by 2050.

2.2.4 Factor decomposition

Drivers of the change are no less important as reduction in portfolio emissions due to portfolio reshuffling is different from emission reduction in investee firms. To measure the

drivers of the change in financed emissions and carbon intensity of a fund, we decompose these variables into three main components, i.e. changes in firms' absolute emissions (carbon intensity) holding portfolio shares fixed, changes in portfolio shares keeping absolute emissions (carbon intensity) fixed, and cross effects where both are allowed to change at the same time. The decomposition takes the following form:[2]

$$
\begin{aligned}
\Delta AE_{i,t} &= AE_{i,t} - AE_{i,t-1} \\
&= \frac{\sum_j \omega_{i,j,t} AE_{j,t}}{\sum_j \omega_{i,j,t}} - \frac{\sum_j \omega_{i,j,t-1} AE_{j,t-1}}{\sum_j \omega_{i,j,t-1}} \\
&= \left[\frac{\sum_j \omega_{i,j,t} AE_{j,t-1}}{\sum_j \omega_{i,j,t}} - \frac{\sum_j \omega_{i,j,t-1} AE_{j,t-1}}{\sum_j \omega_{i,j,t-1}} \right] \\
&+ \left[\frac{\sum_j \omega_{i,j,t-1} AE_{j,t}}{\sum_j \omega_{i,j,t-1}} - \frac{\sum_j \omega_{i,j,t-1} AE_{j,t-1}}{\sum_j \omega_{i,j,t-1}} \right] \\
&+ \left[\frac{\sum_j \omega_{i,j,t} AE_{j,t}}{\sum_j \omega_{i,j,t}} - \frac{\sum_j \omega_{i,j,t-1} AE_{j,t}}{\sum_j \omega_{i,j,t-1}} - \frac{\sum_j \omega_{i,j,t} AE_{j,t-1}}{\sum_j \omega_{i,j,t}} + \frac{\sum_j \omega_{i,j,t-1} AE_{j,t-1}}{\sum_j \omega_{i,j,t-1}} \right] \\
&= \Delta emiss_{i,t} + \Delta ptf_{i,t} + \Delta cross_{i,t} \quad (1)
\end{aligned}
$$

In Formula 1, the three components are highlighted in square parentheses.

The decomposition of the change in carbon intensity (not reported) follows a similar methodology with the difference that firm-level carbon footprint is defined in emission intensity. Thus, in the decomposition, we distinguish between portfolio rebalancing factor, emission intensity factor and cross-effect. Emission intensity in itself is driven by firm emissions and revenues. For example, firms' carbon intensity can drop by increasing firms' revenue without varying firms' emissions.

2.3 Targets

Our final measures have an objective to introduce a forward-looking perspective. Indeed, financed activities and carbon footprint reflect the past or current state, however, they do not indicate how firms address the transition. We can imagine two firms from the same

[2]Some indexes are omitted for readability.

sector with the same level of emissions, with one firm set up a Paris-aligned objective, established a clear transition plan and investing heavily in new low-carbon technology while another firm continues business as usual and further invests in traditional technology. Previously used measures do not distinguish between these two firms.

Ideally, the best would be to use green capital expenditures, that is tangible investments made in low-carbon technologies. However, this information is currently unavailable for the majority of firms. For this reason, we rely on widely used Science-Based Targets supported by SBT initiative.[3]

We use two metrics. First, portfolio share invested in firms with set Science-based target. We assume that ESG funds should have investment preferences for firms that disclose their intention to reduce emissions. Second, we compute an indicator that reflects firms' target ambitions. We measure ambition with respect to the declared *level* of the reduction of carbon emissions, and to the intended *horizon* of decarbonization. A higher level of emission reductions and/or over a shorter period of time indicate a more ambitious target.

3 Data

Our novel database employs three different data sources. We collect fund level data on sustainable attributes and SFDR Art. 6/8/9 from Morningstar, holdings information on funds' portfolios from Refinitiv Lipper, and firm-level data on emissions from Urgentem. First, we obtain fund-level data from the Morningstar (MS) database, which includes a total of 73,963 open-end funds, active and inactive, domiciled in the EU as of end of 2021. In our analysis we focus on equity funds (20,001 of the total) for two reasons: first, attribution of financed carbon emissions is straightforward since equity holders own a company, have voting rights with the possibility to influence company's decisions and thus directly responsible for company's emissions, second, we focus on active equity funds where asset managers have mandate to choose companies they invest in. From this pool, we extract only funds that are alive in the period between November 2020 and December 2021 (9,775 of the equity funds) and for which TNA and ISIN information is available.

[3]More information available at https://sciencebasedtargets.org/

After Our final MS database is composed of 9,095 active open-end equity funds.

Morningstar started to assign Sustainable Attributes in 2018 with no information being available before that date. Fund categories can change from one year to another mostly because of arrival of new information. For simplicity, we take the attributes as of 2021, assuming that a fund obtaining the label had the same characteristics in the three preceding years.

Second, we construct portfolio holdings using fund-level data from Refinitiv Lipper, which provides both static information (fund name, ISIN code, domicile,...) and time series data (total net assets, ISIN-by-ISIN portfolio holdings, number of shares held, market value of the holdings, percentage of the holdings in the fund's portfolio,...). We collect a total of 8,158 [CHECK THIS NUMBER] distinct open-end equity funds domiciled in the EU with data spanning a total of six years, from 2016 to 2021. We construct a balanced panel so that we can track changes in portfolio composition throughout the entire time span. Furthermore, we keep only funds for which equity holdings represent more than 75% of the portfolio to avoid funds with short positions, positive or negative cash holdings, and other specific cases.

Third, we obtain emission data from Urgentem, which provides firm level data on a variety of carbon-related metrics. For our analysis, we focus on Absolute emissions (measured in tons of carbon dioxide equivalent, or tCO_2e) and Carbon intensity (measured in tons of carbon dioxide equivalent over million dollar revenue, or $tCO_2e/\$m$). In both cases, we have the breakdown of Scope 1, Scope 2 and Scope 3 emissions, where Scope 1 emissions refer to firms' direct emissions, Scope 2 refers to firms' indirect emissions related to energy consumption, and Scope 3 covers all the other upward and downward indirect emissions. The database includes information on the sector, sub-sector and industry of the covered firms, which is crucial for our analysis. We collect a total of 18,627 distinct firms throughout the years 2016 to 2021 Our panel is therefore fully balanced.

We complement the data with information on firm market capitalisation and exchange rates to convert all data into US dollars from Bloomberg.

Lastly, we combine these three sources to obtain our final database. Figure 2 gives a visual summary of its components. We eliminate all funds for which we cannot track

either their respective portfolio holdings with the corresponding firm emissions for the six years considered in the analysis, or the Sustainable attributes provided by Morningstar. In addition, we eliminate outliers in firms' carbon footprint following Bolton and Kacperczyk (2023). For each year, we take the distribution of the year-on-year growth in absolute emissions and we eliminate those firms which exhibited a growth or more than 350%. This number comes from an acceptable reduction of the excess kurtosis of the distribution based on the aforementioned work. On average across the years the kurtosis was decreased to 10, down from values ranging from 4,000 to 20,000.

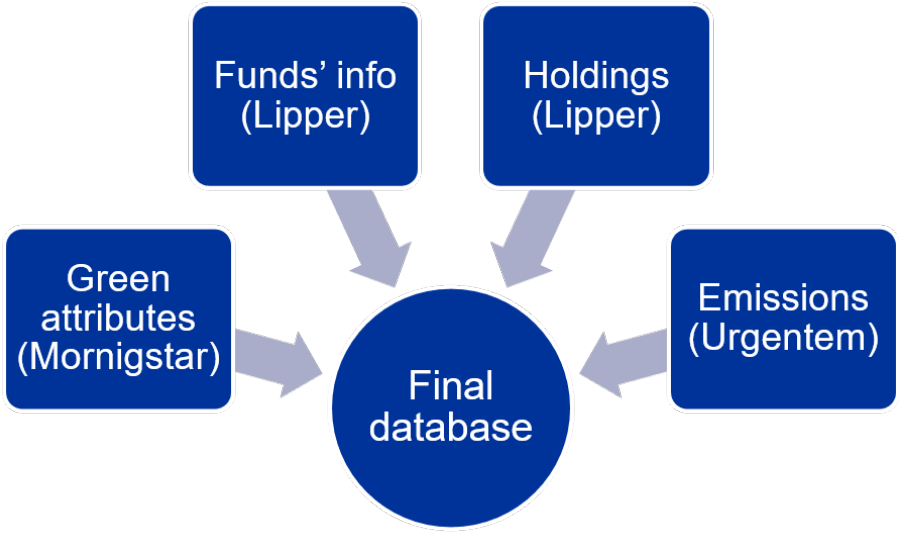


Figure 2: Summary of database sources.

Table 1 provides an overview of the coverage of our database. The benchmark universe of funds is that of Morningstar, which to our knowledge is the most complete picture of open-end equity funds domiciled in the EU.[4] Our sample covers a total of 1,838 funds, 778,480 distinct holdings, and 13,627 unique firms. While the number of funds we cover is approximately 20% of the total, the assets under management (AUM) represent about 28% of the universe.

[4]Figures refer to year 2021, which is the latest available in Morningstar.

Table 1: Database coverage

Data	Number of funds	Total AUM (bn euro)
Morningstar universe	9,095	3,680
Our Database	1,838	1,026
Coverage	20.21%	27.88%

For the econometric analysis, we remove very small and young funds, i.e. funds with a portfolio value less than 10 millions US dollars, and those whose inception date is after 2015. The first exclusion aims at stabilising the sample against fund whose portfolios (and carbon footprint) can change dramatically albeit being negligible to the overall picture, while the second takes into account the fact that very young funds might not have established a clearly defined green strategy yet.

4 Taxonomy

In the absence of regulatory taxonomy for sustainable funds and lack of consensus among taxonomies provided by various data providers, we classify funds in our sample according to their climate-friendly characteristics ourselves. We use three approaches. First, we use Morningstar funds' sustainable attributes that we adapt for our needs. In this classification we focus on the concept of funds' *strategy*, as reported by Morningstar. Second approach uses SFDR Art. 6/8/9 attributes, which capture the concept of *disclosure*, as funds identify themselves as one of the three types and bear the cost of disclosing relevant information. Finally, the last approach is to use funds' *self-marketing* to investors.

4.1 Funds' sustainable strategies (Morningstar)

Literature identifies several strategies regarding sustainability strategies that funds aim to pursue, namely, exclusion or negative screening, positive screening, integration/incorporation, engagement and thematic investments (e.g., Boffo and Patalano (2020)). These strategies are usually stated in funds' prospectuses and defer by the extent to which sustainability factors are integrated. Exclusion strategies are the least demanding as funds only commit

not to invest in certain activities such as fossil fuels or weapons. Integration strategies request a fund to consider sustainability factors in its decision making process, although only to the extent that these factors affect the financial performance of the portfolio. Funds that use engagement strategies commit to engage with firms they invest in and to drive their sustainability performance. This strategy is also commonly referred to as an impact strategy, as funds seek to make an impact with their investments. Finally, fund that pursue thematic investment strategies invest in a specific set of assets, such as climate solutions. Normally, this strategy is not seeking to create impact because investee firms are already sustainable, with the exception when funds are provided to under-capitalised firms. It is important to stress that all these strategies are set by market practice and they are neither standardised nor supervised.

Morningstar collects information on funds' strategies from their prospectus and provides it in the Morningstar Sustainable Attributes package. All characteristics are classified in three levels, as reported in Table 2. Level 1 splits all funds in either Sustainable Investment funds or all other funds. Level 2 further distinguishes between ESG funds, Impact funds and Environmental funds. Finally, Level 3 splits these three categories even further. ESG funds can either incorporate or engage ESG criteria throughout the investment process. Impact funds are categorised by investment themes such as Gender Diversity, Low Carbon/Fossil-Fuel Free, Community Development, Environmental, Other Impact themes. Finally, environmental funds are funds whose strategies are focused on investing in environmentally oriented industries, such as renewable energy and water.

Table 2: Morningstar Sustainable Attributes.

MS Level 1	MS Level 2	MS Level 3	Our classification				
			No	ESG	IMP	GT	LC/FFF
No Sustainable Investment	None	None	*X*				
Sustainable Investment	ESG Fund	ESG Incorporation		*X*			
		ESG Engagement			*X*		
	Impact Fund	Gender Diversity		*X*			
		Low Carbon/Fossil-Fuel Free					*X*
		Community Development		*X*			
		Environmental				*X*	
		Other Impact Themes		*X*			
	Environmental Fund	Renewable Energy				*X*	
		Water-Focused				*X*	
		General Environmental Sector				*X*	

Building on these attributes, we construct our own groups, by aggregating attributes which are specifically "green" or environmental, from the ones that pertain to different ESG areas of focus. Table 2 reports the match between Morningstar and our classification. Our indicator divides funds into five categories. No strategy funds are funds that do not provide any intention to pursue sustainable strategies. ESG funds are funds that follow general "ESG" criteria such as ESG incorporation, or with a focus on topics other than environmental (e.g. social). Our Impact category differs from Morningstar as we focus on funds that explicitly aim to create an impact in companies they invest in via engagement (for example, by using their voting rights). The Green category includes funds that invest in environmental/climate solutions, for instance renewable energy. Finally, we use Morningstar category Low carbon/Fossil-fuel free funds to identify funds with strategies involving investment in low carbon/fossil-fuel free firms.

Our second classification focuses on the regulatory aspect. The European Sustainable Finance Disclosure Regulation (SFDR)[5] requires funds to disclose information depending on their level of integration of sustainability in investments. Article 6 refers to funds who pursue no sustainability objectives and thus bear minimum disclosure requirements. Article 8 concerns funds that aim to promote environmental or social characteristics together

[5]Regulation (EU) 2019/2088 of the European Parliament and the Council (2019)

with other objectives. These funds have to disclose more information. Finally, Article 9 focuses on funds who have sustainable objective as their primary investment objective. These funds bear the highest cost of information disclosure.

In the absence of any regulatory sustainability labels, market participants started using the SFDR regulation with the sole scope of promoting their sustainability engagement. An interesting element is that by self-selecting being Article 8 or 9, funds impose higher reporting costs. This should suggest that Art. 8/9 funds should potentially differ from no strategy funds. SFDR was not intended to be a labelling regime and does not include the type of requirements usually attached to voluntary labels For this reason, from end-2022 until end-2023, ESMA documented a wave of "downgrades" of Art.9 to Art.8 (ESMA (2023b), ESMA (2023c), ESMA (2024b)). According to Morningstar data, the largest wave took place in the fourth quarter of 2022 with some 40% of funds being shifted by asset managers from Art. 9 to Art. 8 (Gard (2023)).

4.2 Name-based self-marketing taxonomy

Our last classification focuses purely on information how funds advertise themselves to investors via their names. Analysis by ESMA (2021) shows that becoming an ESG fund either by setting up a new fund or by conversion of an old non-ESG fund to an ESG fund attracts higher inflows as well as investors who more tolerant to past negative returns (Capotă et al. (2022)). Furthermore, ESG-named funds managed to obtain higher fees, particularly from less financially-literate investors (Black and Kölbel (2024)). Matching self-marketing with ESG strategies and SFDR disclosure could also be a good proxy to reveal possible miss-selling and – potentially – the extent of green-washing. In the spirit of Capotă et al. (2022), we conduct a text-based analysis on the funds' names to search for key words that hint to a green-related marketing strategy. We include multiple definitions of funds' names: the common name, the standard name, the legal name, and the name of the oldest share class to maximise the probability of capturing keywords that hint to a green marketing strategy. As a result, we group the funds into three categories. ESG marketed funds refer to a general ESG focus, not necessarily geared towards environmental issues. It can use such words as "sustainable", "ESG", "Ethical", "Social", "SRI". Green

marketed have names that recall a specific focus on environment-friendly investment using words like "Climate", "Energy transition", "Environment".[6] The last category refers to funds that do not employ neither ESG nor green-related words in their names.

5 Stylised facts

In this section we present some stylised facts that emerge from our database. First, we show the distribution of fund types, then we look at how portfolio composition differs by fund type, and finally we look at heterogeneity in carbon emissions.

5.1 Sustainable strategies

About half of the funds in the sample have a sustainable investment strategy identified by Morningstar, and manage almost two thirds of all assets in the sample (Table 3). The largest group is Impact funds, which make up almost one third of funds in the sample. The next biggest category is low-carbon/fossil-fuel free funds with 10% of funds and 18% of assets under management. Green tech and General ESG funds are the smallest categories contributing 2% and 7% respectively to the whole sample. Interestingly, No strategy funds and General ESG funds have – on average – a smaller portfolio than the others. This may hint to fund class size specific characteristics, as well as to slight selection bias.

Table 3: Sustainable strategies

Strategy	Number of funds	(%)	AUM (bn euro)	(%)
Low carbon/Fossil fuel free	187	10%	188	18%
Green tech	45	2%	45	4%
Impact	525	29%	365	36%
ESG	124	7%	36	4%
No strategy	957	52%	393	38%
Total	1,838	100%	1,026	100%

[6] A complete list of the keywords is available in Table 19 in the Appendix

5.2 SFDR taxonomy

Table 4 shows the sample breakdown in terms of SFDR intentions. Funds that declare compliance to either Article 8 or 9 are about 42% of the sample, while they constitute 53% in terms of AUM. In this case, there is no much discrepancy in average size of the portfolio across fund types.

Table 4: SFDR

SFDR	Number of funds	(%)	AUM (bn euro)	(%)
Art. 9	64	3%	59	6%
Art. 8	714	39%	488	48%
Art. 6	1,060	58%	479	47%
Total	1,838	100%	1,026	100%

5.3 Name-based self-marketing

In Table 5, we report the sample breakdown by type of fund using self-marketing strategy. ESG and Green funds total about 10% of the sample both in number of funds and in terms of assets under management (AUM), so that once again there is no discrepancy in average size of the portfolio across fund types.

Table 5: Name-based self-marketing

Marketing	Number of funds	(%)	AUM (bn €)	(%)
Green-marketed	114	6%	68	7%
ESG-markteted	77	4%	44	4%
Not-marketed	1,647	90%	914	89%
Total	1,838	100%	1,026	100%

5.4 Cross-comparison

In Tables 6, 7 and 8, we compare different categorisations of fund types. Table 6 focuses on Green Tech and Low-Carbon funds and compares these to all other categories of SFDR and self-marketing. We notice that the majority (90%) of Green Tech and Low-Carbon funds are either Art. 8 (72%) or Art.9 (17%) funds. Most of Art. 8 funds do not market themselves as such (59%), while some market themselves as ESG funds (13%). Among Art. 9 funds we see self-marketing strategies quite equally split across all categories.

Table 6: Cross-comparison between MS Green tech/Low carbon strategies and SFDR & ESG self-marketing taxonomies

GT/LC	Green-marketed	ESG-marketed	Not-marketed	Total
Art. 6	1.49%	0.50%	6,44%	8.42%
Art. 8	1.98%	13.37%	58.91%	72.26%
Art. 9	6.44%	5.94%	4.95%	17.33%
Total	9.90%	19.80%	70.30%	100.00%

Table 7: Cross-comparison between SFDR Art. 9 funds and MS & ESG self-marketing taxonomies

Art. 9	No strategy	ESG	Impact	GT/LC	Total
Green-marketed	0.00%	1.72%	1.72%	22.41%	25.86%
ESG-marketed	1.72%	5.17%	13.79%	20.69%	41.38%
Not-Marketed	1.72%	6.90%	6.90%	17.24%	32.76%
Total	3.45%	13.79%	22.41%	60.34%	100.00%

In Table 7, we focus on Article 9 funds and compare them to other categories. We observe that two thirds of these funds are self-marketed with majority being ESG-marketed (41%). Most of Art.9 funds pursue Green Tech - Low-Carbon investment strategies (60%). The two other strategies include Impact (22%) and General ESG (14%).

Finally, in Table 8 we compare Green-marketed funds with the two other classifications. Interestingly, we see that almost half of the green-marketed funds are Art.6 funds (47%) and have no investment strategy (29%). At the same time, around 40% of Green-marketed funds are Art.9 that further pursue Green Tech - Low-Carbon strategy (34%).

As a whole, we see the following picture. The majority of GT/LC funds are Art. 8 and do not market themselves. Most of Art. 9 funds are GT/LC funds and equally choose among the three marketing strategies. Many Art. 9 funds are also Impact funds, and in this case they prefer to market themselves as ESG funds. Finally, less than half of the Green-marketed funds report as Art. 8/9 or have a more focused investment strategy as Impact or GT/LC. Green-marketed funds can somewhat equally be either Art. 6 or Art.

Table 8: Cross-comparison between Green-marketed funds and MS & SFDR taxonomies

Green-marketed	No strategy	ESG	Impact	GT/LC	Total
Art. 6	28.95%	0.00%	10.53%	7.89%	47.37%
Art. 8	0.00%	2.63%	0.00%	10.53%	13.16%
Art. 9	0.00%	2.63%	2.63%	34.21%	39.47%
Total	28.95%	5.26%	13.16%	52.63%	100.00%

9. This observation surprises and raises some questions. Further attention is drawn to the fact that a large share of Green-marketed funds are both Art. 6 and do not have any sustainable investment strategy, which can be interpreted as a warning of potential greenwashing.

5.5 Financed activities by fund type

Looking at the sector level, a clear difference emerges across fund types. In Figures 3 to 5 we show the portfolio composition (weighted by funds' size) of MS strategy, SFDR disclosure and name-based self-marketing funds respectively for 2021. Although our sample spans from 2016 to 2021, a change in sector classification by Urgentem in 2021 forced us to discard previous years.[7] For practical reasons, the original twenty NACE level 1 sectors are grouped into eleven main categories.[8] Financials includes investment in banking and insurance. Infocomm includes information technology and communication. Fossil fuels includes traditionally "brown" sectors such as extraction of fossil fuels, but also other sources of non-renewable energy and materials in general. Energy is a neutral category in that it does not distinguish whether the source is sustainable or not. Water refers to water distribution, management and waste. Services include private and public activities, health as well as education and entertainment. Manufacturing is by far the most problematic sector, since it contains a variety of economic activities whose environmental profile can be very diverse. Future research digging in more granular level data such as NACE 2 and NACE 3 levels may give a more detailed picture, but at the expenses of statistical robustness.

[7] In detail, the classification of the economic sectors developed by the Sustainability Accounting Standards Board (SASB) has been replaced by the standard EU NACE classification. Unfortunately, it is impossible to establish a univocal match between the two methodologies.

[8] The grouping affects mostly various forms of services.

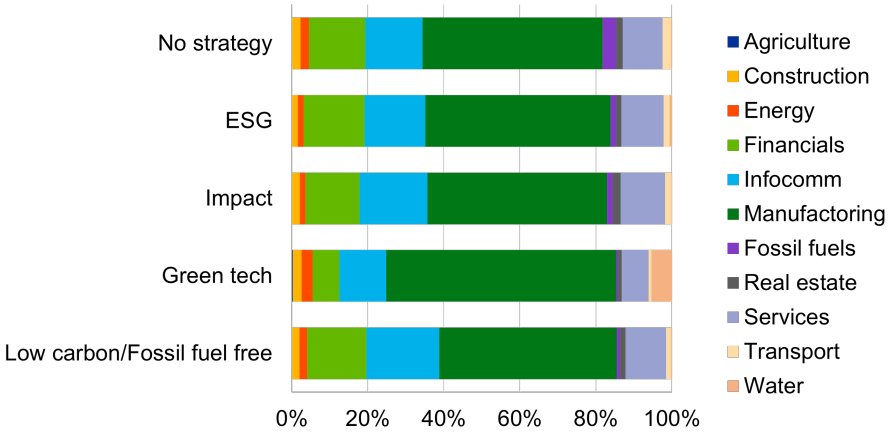


Figure 3: Sectors of investment, MS Sustainable strategies

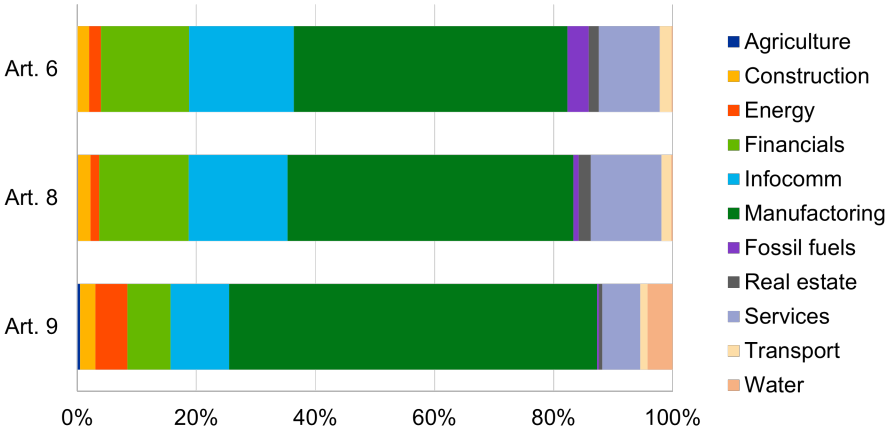


Figure 4: Sectors of investment, SFDR disclosure

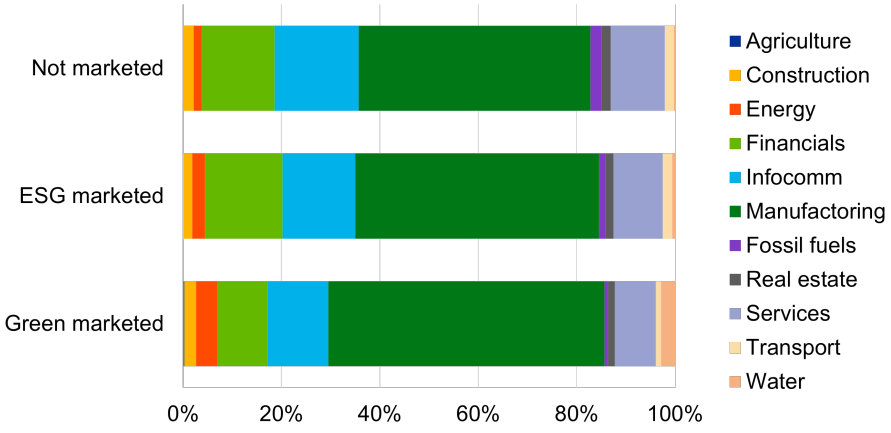


Figure 5: Sectors of investment, Name-based self-marketing

A few patterns are worth analysing. First, Green tech funds are by far the ones that differ the most from traditional "brown" ones (and from the others too). The main source of discrepancy is the relative lower exposure towards financials and information technology,

which is compensated by massive investment in the water sector and – to a lesser extent – energy. The exposure to manufacturing is also significantly higher, but as explained before it does not allow us to draw any conclusions, although we expect of course those extra investment to be geared towards more sustainable production. All other categories of funds are substantially equal to each other, with the notable exception of a lower exposure to fossil fuels (and real estate) of ESG, Impact, and Low carbon funds relative to brown funds.

Second, there is a substantial difference between Art. 9 funds on one side, and Art. 6/8 funds on the other. Indeed, funds with sustainable objectives invest significantly more in energy and water sectors, mainly at the expenses of financials, information technology and services. Once again, the noticeably higher exposure to manufacturing does not allow to draw conclusions. As mentioned, Art. 8 funds do not differ substantially from Art. 6, except for a significantly lower exposure towards fossil fuels. To conclude, by judging from the portfolio composition, it seems that funds with a sustainable strategy tend to be exposed relatively more to green sectors, and relatively less to brown ones.

Lastly, name-based self-marketed funds mimic in part the SFDR taxonomy, in that only one category (Green marketing funds) differs noticeably in portfolio composition, with higher exposure in energy and water.

6 Econometric analysis

In this section, we investigate how sustainable funds defined using three taxonomies perform on five sustainability metrics in an econometric setup. To recall, the taxonomies we employ include: first, Morningstar taxonomy reflecting funds self-declared strategies regarding sustainability, namely, general ESG funds, Impact funds, Green tech and Low-carbon/Fossil-Fuel free funds (Section 4.1); second, SFDR Article 8 and 9 funds (Section 5.2), and third, name self-marketing with ESG and Green funds (Section 4.2). In all regressions we test sustainability-related funds (funds with sustainability strategies defined by Morningstar, funds self-declared as Art. 8/9 or self-marketed ESG/Green funds) against conventional funds (funds that have no strategy according to the Morn-

ingstar, declare themselves as Art. 6 or do not market themselves as sustainable).

The five metrics cover there dimensions: first, financed activities (Section 2.1); second, portfolio carbon footprint in level and change for financed absolute emissions and emission intensity of Scopes 1 and 2 (Section 2.2); and third, firm-level targets (Section 2.3). In addition, we show the drivers of carbon footprint change based on the decomposition introduced in Section 2

We test the following hypothesis.

Financed activities. Investment funds with sustainable attributes are expected to invest more in renewable energy and less in fossil fuel sectors. They should not have significantly higher exposure to sectors such financials and information an communication technologies. The latter sectors have low carbon footprint but also contribute little to the transition, and they have been highlighted as the prevalent destination of ESG funds (e.g., FT (2022)). The econometric setup is as follows:

$$sector_{i;t} = \beta_0 + \beta_1 \delta_i^{fclass} + \sum_{k=1}^{K} \beta_k ctrls_{k;i;t} + \varepsilon_i$$

where $sector_{i;t}$ represents the percent of the portfolio of fund i invested in a given sector, δ_i^{fclass} is the fund's classification under any of the three taxonomies, and $ctrls_{k;i;t}$ are a set of qualitative control variables.[9] t represents the year of measurement, which for this regression setup is 2021 only, since it is as static analysis.

***Level* of portfolio carbon emissions.** Carbon footprint of funds with sustainable attributes may vary by fund type. Funds oriented towards financing green technology and low-carbon activities may be expected to have significantly lower carbon footprint both in financed emissions and emission intensity. On the other hand, impact funds oriented towards financing the transition may have relatively high portfolio emissions conditionally that they engage with the investee companies to drive their emission reductions. For such funds, high level of emissions should be coupled with large emission reduction effect. General ESG funds may have large carbon footprint and no change in the level over time. The econometric setup is as follows:

[9]Throughout the entire econometric setup, the controls are the following: (1) Geographical focus (are of the globe, country-specific, mixed, etc.); (2) Capitalisation focus (small-medium cap, large cap, flexible cap, none); (3) Style focus (growth, value, blend, none).

$$CF_{i;t} = \beta_0 + \beta_1 \delta_i^{fclass} + \sum_{k=1}^{K} \beta_k ctrls_{k,i,t} + \varepsilon_i$$

where $CF_{i;t}$ is the level of carbon footprint (either absolute emissions or carbon intensity) of fund i in year t (where t is either 2016 or 2021), and all the other terms are the same as above.

***Change* in portfolio carbon emissions.** As discussed in the previous item, funds investing in green technologies may have already low carbon footprint and in this case may reduce their emissions by relatively little or not at all. Impact funds are expected to reduce carbon emissions significantly over time. General ESG funds may not have any specific mandate regarding carbon emissions and for this reason may not do it.

$$\Delta CF_{i,t,t-h} = \beta_0 + \beta_1 \delta_i^{fclass} + \sum_{k=1}^{K} \beta_k ctrls_k + \varepsilon_i$$

where $\Delta CF_{i,t}$ is the change of carbon footprint (either absolute emissions or carbon intensity) of fund i in year t (where t is either 2016 or 2021), and all the other terms are the same as above.

Share of firms with science-based targets in fund portfolio. We expect funds with sustainable attributes to invest more in firms with science-based targets as setting up an SBT signalling firm's commitment and forward-looking orientation to reduce emissions.

$$target_{i;t} = \beta_0 + \beta_1 \delta_i^{fclass} + \sum_{k=1}^{K} \beta_k ctrls_k + \varepsilon_i$$

where $target_{i;t}$ is the percentage of firms that have science-based targets in the portfolio of fund i in year t (where t is either 2016 or 2021), and all the other terms are the same as above.

Additionally, we control for a wide range fund-specific characteristics, such as the total net assets under management, the change in total net assets over the time-span of analysis, and a set of investment focus specifics. The latter include investment geographical focus,

preference for certain market capitalisation (small, mid, large), and the investment style (growth, value, blend). Some funds have a combination of these investment characteristics, while some have none.

Tables 20 to 31 in the Appendix present a statistical summary of the variables used in the econometric analysis for both 2016 and 2021, divided by fund type across the three taxonomies[10]

7 Results

This section is dedicated to the results obtained by running four econometric specifications outlined in Section 6 and by decomposing change in portfolio carbon footprint by factor described in Section 2.

7.1 Financed activities

In this Subsection we discuss results of the econometric analysis on financed activities by various types of sustainable investment funds. We compare how investment allocations by sector in funds with MS sustainable strategies, SFDR Art.8/9 or ESG/Green self-marketing differ from conventional funds with no sustainability attributes in 2016 and 2021.

Table 9 presents results of economic activities financed by investment funds with MS sustainability strategies in comparison to conventional funds in 2021.

Results partly confirm our predictions. Sustainable funds invest less in relative to No strategy funds: the relation is strongly significant for Green tech and Low carbon funds, while ESG and Impact funds also display negative coefficients, albeit not significant Transport, which is another sector associated with higher emissions, is also relatively less present in (all) sustainable funds' portfolios. When it comes to greener sectors, ESG and Green tech funds clearly indicate a preference for investing in water management. Interestingly, all but Green tech funds exhibit negative coefficient of relative investment in the energy sector. Unfortunately, because of the lack of information on the source of energy (whether

[10]Qualitative control variables are excluded.

or not renewable), the variable is likely to combine both, therefore blurring the results. No other major patterns appear, apart from the composition of Green tech portfolios, who finance significantly less financial and information technology sectors. This result is consistent with the definition of the investment strategy, which focuses solely on sectors whose economic activity intrinsically entails the use of green technology, which is not applicable to many other. Green tech also finance manufacturing activities significantly more, but the usual caveat in terms of heterogeneity of the sector applies.

Table 9: Financed activities - Morningstar investment strategy (2021)

	(1) Agriculture b/p	(2) Construction b/p	(3) Energy b/p	(4) Financials b/p	(5) Infocomm b/p	(6) Manufacturing b/p	(7) Fossils b/p	(8) Real estate b/p	(9) Services b/p	(10) Transport b/p	(11) Water b/p
No strategy	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
ESG	0.060	-0.747	-0.641	-0.048	0.423	2.547	-1.646	-0.957	1.567*	-0.861*	0.303*
	(0.477)	(0.164)	(0.211)	(0.968)	(0.668)	(0.115)	(0.051)	(0.334)	(0.038)	(0.016)	(0.027)
Impact	0.010	0.330	-0.477	-0.512	-0.900	0.535	-0.164	1.280*	0.459	-0.553**	-0.009
	(0.836)	(0.279)	(0.102)	(0.447)	(0.108)	(0.560)	(0.731)	(0.023)	(0.284)	(0.006)	(0.908)
Green tech	0.158	0.393	1.218	-7.452***	-3.719*	12.636***	-3.774**	-0.328	-0.527	-1.276*	2.670***
	(0.231)	(0.638)	(0.128)	(0.000)	(0.015)	(0.000)	(0.004)	(0.832)	(0.654)	(0.021)	(0.000)
Low carbon	0.137	0.575	-0.563	-1.013	-1.406	3.134*	-2.384***	1.885*	0.168	-0.671*	0.137
	(0.053)	(0.198)	(0.187)	(0.305)	(0.086)	(0.020)	(0.001)	(0.022)	(0.789)	(0.024)	(0.230)
Constant	0.251*	2.113**	5.583***	14.020***	11.257***	39.488***	11.979***	1.397	10.029***	3.017***	0.865***
	(0.019)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.263)	(0.000)	(0.000)	(0.000)
Geo	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cap	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Style	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.021	0.196	0.069	0.111	0.259	0.157	0.098	0.183	0.118	0.023	0.132
Adj. R-squared	0.011	0.187	0.059	0.101	0.251	0.148	0.088	0.174	0.108	0.012	0.123
F(2, N)	2.01	22.37	6.85	11.41	32.06	17.12	9.99	20.49	12.27	2.12	13.99
N	1670	1670	1670	1670	1670	1670	1670	1670	1670	1670	1670

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10 reports regressions results that compare portfolio allocation of Art. 8 and Art. 9 funds with Art.6 funds for 2021.

The results largely mirror the findings for the funds with the MS sustainable investment strategies, and suggest an alignment of the two taxonomies. Both Art. 8 and 9 invest significantly less in fossils, but there is more heterogeneity in the other sectors, with Art. 8 financing less transport, and Art. 9 financing more water management. Out of the two, Art. 9 funds have a more concentrated portfolio, with significantly less investment in financial and infocomm, but a disproportionately higher financing in agriculture, hinting to the fact having climate impact as an investment objective results in the choice of particular sectors at the expenses of more polluting ones. In other words, transition is achieved mainly via portfolio allocation. Once again we abstain from any interpretation on manufacturing.

Table 10: Financed activities - SFDR disclosure (2021)

	(1) Agriculture b/p	(2) Construction b/p	(3) Energy b/p	(4) Financials b/p	(5) Infocomm b/p	(6) Manufacturing b/p	(7) Fossils b/p	(8) Real estate b/p	(9) Services b/p	(10) Transport b/p	(11) Water b/p
Art. 6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Art. 8	0.008	-0.346	-0.684**	-0.614	-0.701	3.246***	-1.945***	0.253	1.082**	-0.399*	0.100
	(0.853)	(0.206)	(0.009)	(0.311)	(0.161)	(0.000)	(0.000)	(0.618)	(0.005)	(0.028)	(0.161)
Art. 9	0.442***	0.262	0.708	-4.733**	-5.880***	14.425***	-5.026***	-0.124	-0.935	-0.677	1.537***
	(0.000)	(0.716)	(0.304)	(0.003)	(0.000)	(0.000)	(0.000)	(0.926)	(0.355)	(0.158)	(0.000)
Constant	0.232*	1.940**	5.513***	13.644***	11.466***	40.175***	11.623***	1.134	10.386***	2.830***	1.057***
	(0.028)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.360)	(0.000)	(0.000)	(0.000)
Geo	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cap	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Style	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.027	0.194	0.070	0.106	0.264	0.169	0.106	0.177	0.120	0.016	0.083
Adj. R-squared	0.018	0.187	0.061	0.098	0.257	0.161	0.097	0.169	0.112	0.007	0.075
F(2, N)	2.90	24.94	7.80	12.31	37.00	20.99	12.21	22.27	14.15	1.72	9.40
N	1670	1670	1670	1670	1670	1670	1670	1670	1670	1670	1670

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Finally, Table 11 shows results for ESG and Green self-marketed funds. The main conclusion that we can draw is the relatively better performance of latter, which invest less in fossils, financials, infocomm and transport while focusing on water. On the contrary, ESG marketed funds show no significant difference with the benchmarks, except for financing more the water management sector. All in all, by judging solely on the financed activities, there is evidence of miss-selling among ESG marketed funds only.

Table 11: Financed activities - Self-marketing (2021)

	(1) Agriculture b/p	(2) Construction b/p	(3) Energy b/p	(4) Financials b/p	(5) Infocomm b/p	(6) Manufacturing b/p	(7) Fossils b/p	(8) Real estate b/p	(9) Services b/p	(10) Transport b/p	(11) Water b/p
Not marketed	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)	(.)
ESG marketed	-0.093	0.829	-0.164	0.444	-1.826	2.603	-1.075	0.196	-1.088	-0.813	0.987***
	(0.351)	(0.189)	(0.786)	(0.750)	(0.114)	(0.171)	(0.278)	(0.866)	(0.219)	(0.052)	(0.000)
Green marketed	0.135	0.601	0.077	-2.876*	-2.001*	6.861***	-2.587**	0.710	-0.824	-0.721*	0.624***
	(0.111)	(0.261)	(0.881)	(0.015)	(0.041)	(0.000)	(0.002)	(0.473)	(0.273)	(0.042)	(0.000)
Constant	0.252*	1.871**	5.665***	13.774***	11.457***	39.738***	11.928***	0.958	10.344***	2.984***	1.030***
	(0.018)	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.442)	(0.000)	(0.000)	(0.000)
Geo	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cap	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Style	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.020	0.195	0.065	0.105	0.257	0.152	0.092	0.177	0.117	0.017	0.075
Adj. R-squared	0.011	0.187	0.056	0.096	0.250	0.144	0.083	0.169	0.108	0.008	0.066
F(2, N)	2.16	25.00	7.20	12.11	35.81	18.49	10.49	22.29	13.63	1.80	8.43
N	1670	1670	1670	1670	1670	1670	1670	1670	1670	1670	1670

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7.2 Carbon footprint level and change

In this section, we look the level and change in carbon footprint measured in Scope 1&2 absolute emissions and carbon intensity of investments funds with sustainability attributes and how different these funds are from conventional funds along these metrics.

Table 12 shows results for the full sample. We observe the following: there is no significant relation between funds' size and portfolio carbon footprint (*level*), but funds with bigger portfolios and bigger carbon footprint (higher levels of absolute emissions and carbon intensity) in 2016 reduced their emissions by more. The first result comes from the construction of the metric - carbon footprint per unit of investment - that allows isolating mere changes in funds' size.[11]

Table 13 reports results regarding carbon footprint of funds with MS sustainable strategies. We notice that Impact funds and to a some extent ESG funds (lower statistical significance) have lower level of absolute emissions at the start of our sample (relative to No strategy funds). At the end of the sample, all but ESG funds have lower levels of absolute emissions. As for carbon intensity, none of the fund categories, except Low carbon / Fossil Fuel Free funds, show difference in levels relative to the conventional funds either in 2016 or in 2021.

In terms of change, only Low carbon / Fossil Fuel Free funds show a significant reduction in carbon footprint for both measures between 2016 and 2021, however, significant only at 10%. It is important to note that the statistical significance of the coefficient is compatible with the possibility of LC/FFF increasing their emissions by less than conventional funds, and not necessarily reducing their emissions. All other funds with sustainable attributes defined by Morningstar demonstrate no statistical difference relative to no strategy funds. The results inform that sustainable strategy funds (except LC/FFF) have indeed an overall lower absolute emissions, but they did not necessarily reduce their emissions over the period.

Table 14 presents results comparing level and dynamics of emissions between Art.8 and 9 funds and all the other funds. Art.8 funds exhibit lower financed emissions in 2016

[11] If we look at carbon footprint in absolute terms, i.e. in tonnes of CO2e or tonnes of CO2e over millions dollar revenues, the correlation (not shown here) is positive and strongly significant.

and 2021 relatively to Art.6 funds and a lower carbon intensity in 2021. They also show stronger statistically significantly negative change, that can be interpreted as a larger reduction or smaller increase in emissions. On the other hand, Art. 9 funds have no statistically significant difference compared to Art. 6. The conclusion is that funds that commit to a sustainable strategy as one of their primary objective do not seem to deliver the expected results, at least within the timespan considered. One reason behind this result is that EU SFDR regulation entered into force in March 2021[12], and it was conceived as a reporting not labelling regulation. SFDR was further criticised for lack of clarity between different categories. Finally, a relatively low number of Art.9 funds in our sample may be not sufficient to exhibit statistical power.

Finally, Table 15 shows results how self-marketed funds differ from non-marketed funds regards their carbon footprint. We see no statistically significant difference between ESG-marketed funds and non-marketed funds, apart from a slightly higher initial carbon footprint for ESG-marketed funds. All in all, self-marketing seems to be a very poor predictor of actual delivery of results in terms of sustainable performance, thereby hinting to possible greenwashing concerns.

Table 12: Portfolio carbon footprint: Overall sample

	(1) CI 2016 b/se	(2) AE 2016 b/se	(3) CI 2021 b/se	(4) AE 2021 b/se	(5) CI change b/se	(6) AE change b/se
TNA (2016)	-0.256	-1.97e+04			-0.024	-0.189**
	(3.953)	(41049.137)			(0.024)	(0.061)
TNA change (16-21)	-0.010	-198.313*	-0.011	-203.326	0.000	0.000
	(0.008)	(82.670)	(0.008)	(104.835)	(0.000)	(0.000)
TNA (2021)			0.152	-1.37e+04		
			(3.516)	(47369.906)		
CI level (2016)					-0.001***	
					(0.000)	
AE level (2016)						-0.000***
						(0.000)
Constant	254.026***	1.51e+06***	158.417***	1.73e+06***	0.152	1.690***
	(26.125)	(2.71e+05)	(25.699)	(3.46e+05)	(0.162)	(0.410)
Geo	Yes	Yes	Yes	Yes	Yes	Yes
Cap	Yes	Yes	Yes	Yes	Yes	Yes
Style	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.055	0.219	0.080	0.093	0.079	0.046
Adj. R-squared	0.046	0.212	0.072	0.084	0.069	0.036
F(2, N)	6.24	30.04	9.33	10.93	8.55	4.78
N	1619	1619	1619	1619	1619	1619

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[12]However, the regulation was adopted on 27 November 2019, by the European Parliament and Council giving investment funds sufficient time to align with the regulation criteria

Table 13: Portfolio carbon footprint: funds with MS sustainability strategy

	(1) CI 2016 b/t	(2) AE 2016 b/t	(3) CI 2021 b/t	(4) AE 2021 b/t	(5) CI change b/t	(6) AE change b/t
No strategy	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
ESG	-35.925	-6.35e+05*	-13.701	-5.29e+04	-0.101	-0.431
	(-1.225)	(-2.169)	(-0.473)	(-0.163)	(-0.555)	(-0.921)
Impact	-4.808	-5.15e+05***	-5.309	-4.46e+05**	-0.005	-0.165
	(-0.376)	(-4.031)	(-0.422)	(-3.155)	(-0.066)	(-0.804)
Green tech	-28.378	-8.89e+05	-63.419	-1.10e+06*	-0.417	-0.451
	(-0.601)	(-1.886)	(-1.361)	(-2.093)	(-1.417)	(-0.597)
Low carbon	-2.474	-2.50e+05	-57.475**	-8.75e+05***	-0.328*	-0.824*
	(-0.119)	(-1.207)	(-2.807)	(-3.798)	(-2.539)	(-2.488)
CI level (2016)					-0.001***	
					(-7.903)	
AE level (2016)						-0.000***
						(-5.231)
Constant	243.491***	1.60e+06***	163.916***	1.92e+06***	0.116	1.811***
	(8.434)	(5.547)	(5.736)	(5.960)	(0.629)	(3.891)
Geo	Yes	Yes	Yes	Yes	Yes	Yes
Cap	Yes	Yes	Yes	Yes	Yes	Yes
Style	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.059	0.245	0.091	0.151	0.084	0.051
Adj. R-squared	0.047	0.235	0.079	0.140	0.071	0.037
F(2, N)	4.75	24.45	7.58	13.39	6.53	3.83
N	1452	1452	1452	1452	1452	1452

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 14: Portfolio carbon footprint: SFDR disclosure classification

	(1) CI 2016 b/t	(2) AE 2016 b/t	(3) CI 2021 b/t	(4) AE 2021 b/t	(5) CI change b/t	(6) AE change b/t
Art. 6	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Art. 8	-15.527	-3.04e+05**	-60.959***	-8.28e+05***	-0.241***	-0.477*
	(-1.340)	(-2.613)	(-5.309)	(-6.414)	(-3.340)	(-2.572)
Art. 9	64.381	-6.99e+04	-49.523	-1.02e+06	-0.415	-0.746
	(1.217)	(-0.132)	(-0.956)	(-1.752)	(-1.261)	(-0.883)
CI level (2016)					-0.001***	
					(-7.963)	
AE level (2016)						-0.000***
						(-5.290)
Constant	237.723***	1.55e+06***	158.280***	1.88e+06***	0.124	1.833***
	(8.279)	(5.393)	(5.596)	(5.899)	(0.677)	(3.959)
Geo	Yes	Yes	Yes	Yes	Yes	Yes
Cap	Yes	Yes	Yes	Yes	Yes	Yes
Style	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.060	0.237	0.103	0.162	0.086	0.051
Adj. R-squared	0.049	0.228	0.093	0.152	0.074	0.039
F(2, N)	5.43	26.27	9.70	16.34	7.47	4.26
N	1452	1452	1452	1452	1452	1452

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 15: Portfolio carbon footprint: ESG self-marketed funds

	(1) CI 2016 b/t	(2) AE 2016 b/t	(3) CI 2021 b/t	(4) AE 2021 b/t	(5) CI change b/t	(6) AE change b/t
Not-marketed	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
ESG-marketed	54.487*	5.98e+05*	-32.119	-2.70e+05	-0.252	-0.256
	(2.141)	(2.262)	(-1.314)	(-0.819)	(-1.647)	(-0.646)
PA/green marketed	-0.766	-2.44e+04	-14.849	31935.371	-0.141	-0.146
	(-0.034)	(-0.104)	(-0.683)	(0.109)	(-1.036)	(-0.415)
TNA (2021)			0.019	-1.32e+04		
			(0.005)	(-0.277)		
CI level (2016)					-0.001***	
					(-8.515)	
AE level (2016)						-0.000***
						(-5.413)
Constant	250.933***	1.48e+06***	162.038***	1.74e+06***	0.184	1.724***
	(9.522)	(5.396)	(6.245)	(4.968)	(1.128)	(4.170)
Geo	Yes	Yes	Yes	Yes	Yes	Yes
Cap	Yes	Yes	Yes	Yes	Yes	Yes
Style	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.058	0.222	0.081	0.093	0.081	0.046
Adj. R-squared	0.048	0.214	0.072	0.084	0.070	0.035
F(2, N)	5.78	26.87	8.35	9.68	7.80	4.28
N	1619	1619	1619	1619	1619	1619

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7.3 Drivers of carbon footprint

Decomposition of portfolio financed emissions

After investigating if funds with sustainable attributes have reduced their carbon footprint between 2016 and 2021, we analyse drivers behind these changes. More specifically, we decompose change in portfolio carbon footprint, as outlined in Formula 1, in two main factors - reduction in emissions of firms in portfolio and portfolio rebalancing. Each factor is expressed in percent change of carbon footprint of an average fund within each category. As such, the numbers are directly comparable with the regressions results outlined above in terms of unit of measure.[13] Figures 6 to 8 report the decomposition of the percent change in absolute emissions of an average fund for each category. For the Morningstar categories (Fig. 6), all strategies performed better than funds with no strategy (even though emissions increased across all categories). These results are comparable with those of Column 6 of Table 13. Low-carbon funds reduced their overall emissions between 2016 and 2021, and this is in line with the regressions results showing that solely reduction in emissions of Low carbon funds was statistically significantly lower relatively to the no-

[13]Clearly, whereas the first analysis comes from a regression of sustainability-related funds relatively to no-strategy funds as a benchmark, here we do an algebraic decomposition for each category separately.

strategy funds. Interestingly, all other categories of funds increased their emissions, and primarily via rebalancing their portfolios towards highly emitting firms, while changes in firms' emissions played little or no role. Still, some of the reduction in emissions of ESG and Green Tech funds was driven by firms these funds invested in. Cross effects capture the case when both portfolios weights and firms' emissions change at the same time. They are difficult to interpret, but they unambiguously pushed towards a reduction of emissions for all fund categories.

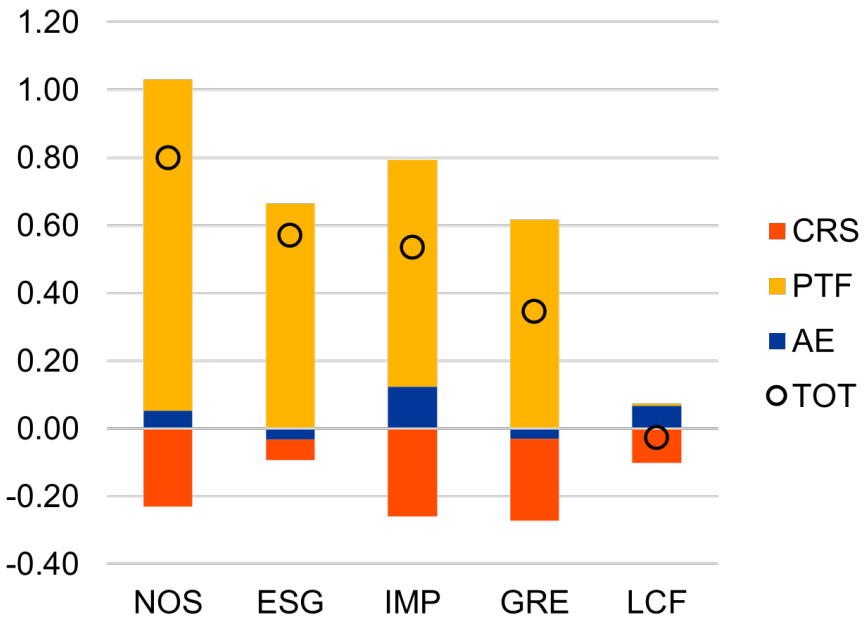


Figure 6: Decomposition of the average percent change in funds' absolute emissions (Scope 1&2) between 2016 and 2021, by Morningstar strategy. AE refers to change in portfolio emissions driven by the change in investee firms' absolute emissions; PTF refers to change in portfolio emissions driven by portfolio rebalancing; CRS refers to the cross-effect when portfolio weights and firms' emissions change at the same time; TOT refers to the overall change in portfolio emissions. The numbers are expressed in percentage change of portfolio emissions.

Figure 7 reports factors behind the change in portfolio emissions along the SFDR categories. All the fund categories increased their emissions from 2016 to 2021, however, increase of Art. 8 and 9 funds was twice smaller than that of Art 6. funds. This confirms the consistency with the regression results (Table 14) since the overall change (increase) in emissions of Art.8/9 funds has been relatively lower than the benchmark Art. 6 funds. The increase was primarily driven by portfolio reallocation. Art.9 funds additionally saw their carbon footprint reduced via reduction in emissions of the investee firms, however,

to a relatively tiny fraction.

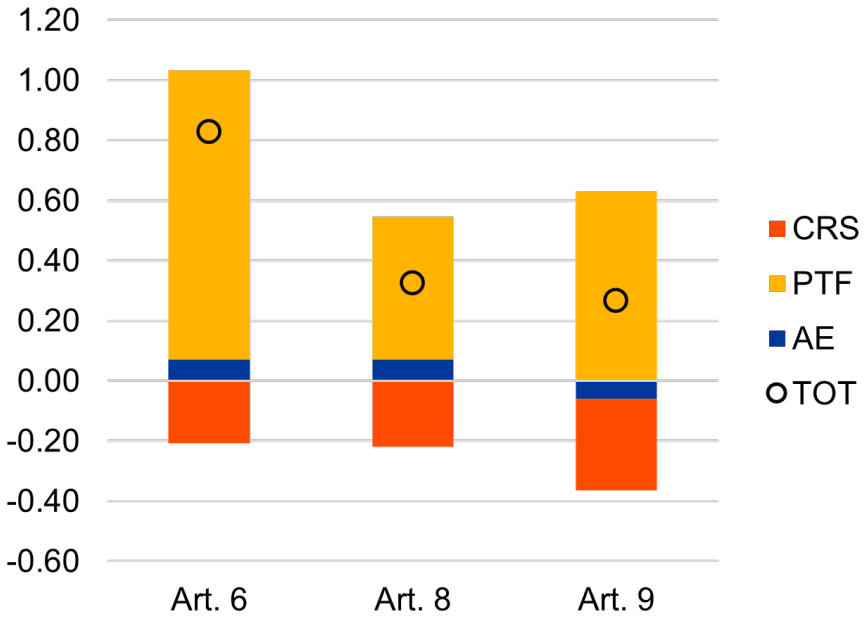


Figure 7: Decomposition of the average percent change in funds' absolute emissions (Scope 1&2) between 2016 and 2021, by SFDR category. AE refers to change in portfolio emissions driven by the change in investee firms' absolute emissions; PTF refers to change in portfolio emissions driven by portfolio rebalancing; CRS refers to the cross-effect when portfolio weights and firms' emissions change at the same time; TOT refers to the overall change in portfolio emissions. The numbers are expressed in percentage change of portfolio emissions.

Finally, Figure 8 confirms the overall regression results of Column 6 in Table 15: both ESG-marketed and Green-marketed funds increased their emissions less than conventional funds. Once again, all variation is primarily driven by portfolio rebalancing. Additionally, ESG-marketed funds saw their carbon footprint reduced thanks to the investee firms decarbonisation efforts.

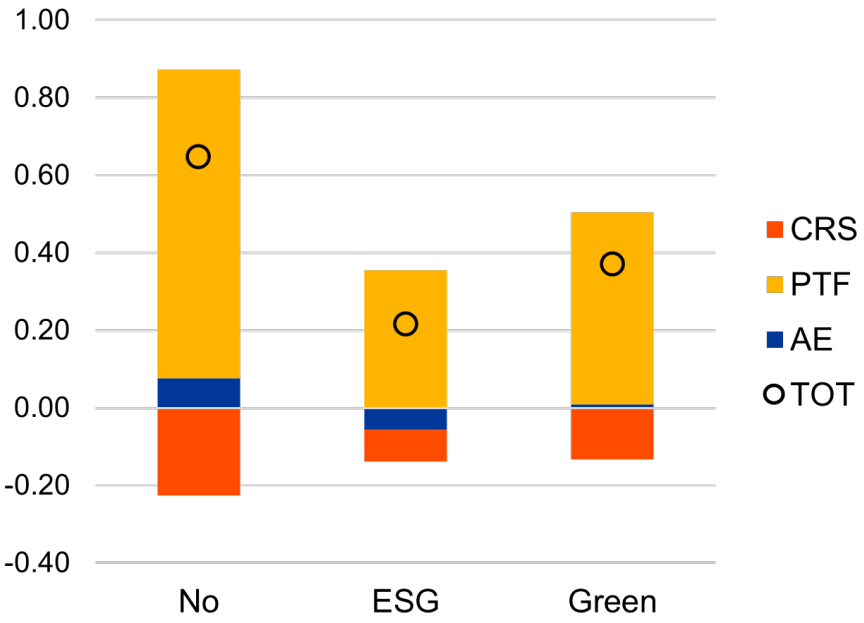


Figure 8: Decomposition of the average percent change in funds' absolute emissions (Scope 1&2) between 2016 and 2021, by name-based self-marketing. AE refers to change in portfolio emissions driven by the change in investee firms' absolute emissions; PTF refers to change in portfolio emissions driven by portfolio rebalancing; CRS refers to the cross-effect when portfolio weights and firms' emissions change at the same time; TOT refers to the overall change in portfolio emissions. The numbers are expressed in percentage change of portfolio emissions.

Overall, our results show that

Decomposition of portfolio carbon intensity

Figures 9 to 11 report the decomposition of the percent change in carbon intensity of an average fund for each category. Overall, results are harder to interpret compared to absolute emissions. The main difficulty in drawing conclusions is the strong negative cross effect which is common to all categories for all the three taxonomies. An hypothesis that might explain this behaviour could be some hidden correlation with changes in firms' revenues, which are implicitly captured in the definition of carbon intensity. Figure 9 reports the decomposition of each Morningstar category. Out of all categories, ESG, Green Tech and Low carbon/Fossil fuel free funds have (mildly) reduced intensity, mainly thanks to a combination of rebalancing towards relatively less polluting firms, and to a reduction of emissions of the firms in their portfolios

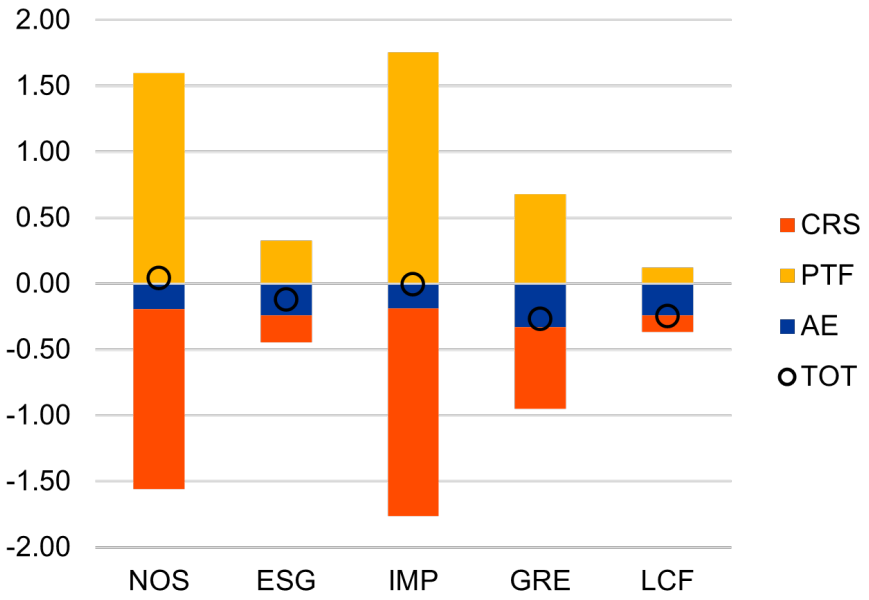


Figure 9: Decomposition of the average percent change in funds' carbon intensity, by Morningstar strategy

Results of SFDR taxonomy outlined in Figure 10 show an overall better performance of Art. 8/9 funds, but the predominance of cross effects makes it impossible to draw firm conclusions.

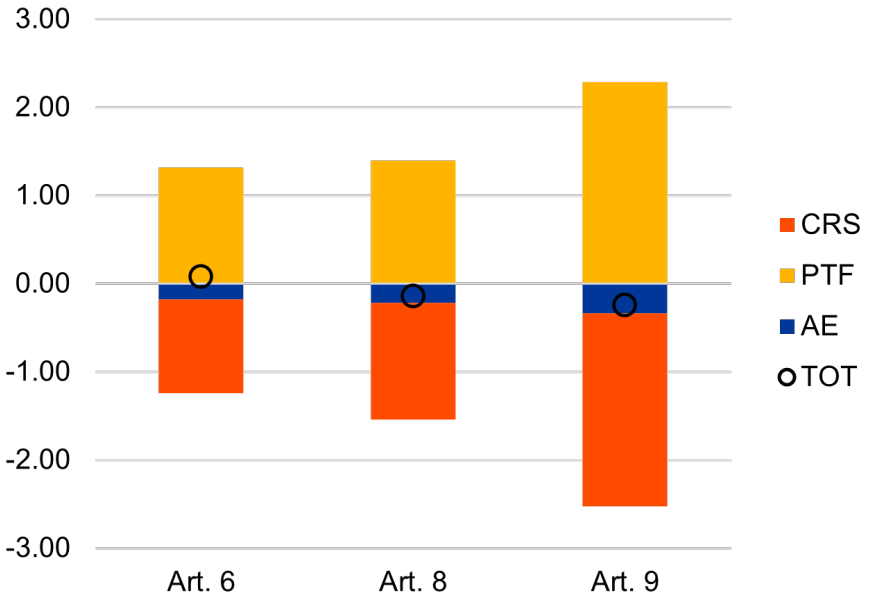


Figure 10: Decomposition of the average percent change in funds' carbon intensity, by SFDR disclosure

Finally, Figure 11, while confirming the overall regression results of Column 5 in Table 15, remains heavily affected by the same cross effect bias.

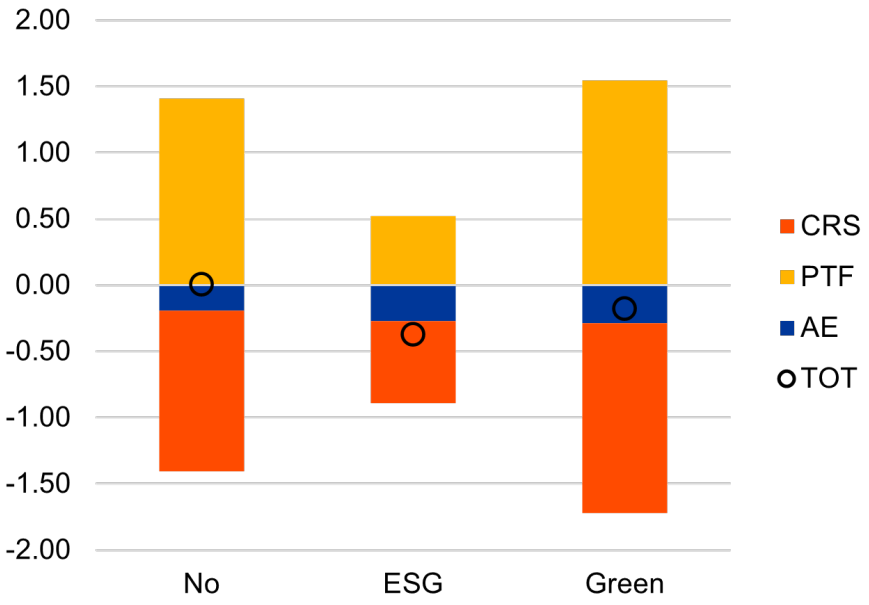


Figure 11: Decomposition of the average percent change in funds' carbon intensity, by text-based self-marketing

7.4 Targets

In this section, we look whether funds with sustainability attributes hold a larger share of firms with Science-based targets. Information on the targets is also provided by Urgentem, and includes different dimensions, such as primary metrics of the target (e.g. reduction in scopes 1 and 2 absolute emissions, ceiling for carbon intensity etc.) and declared horizon for the their achievement. For simplicity, given the high degree of heterogeneity in the definition of targets, we construct a variables that indicates solely the share of firms with a target in a fund's portfolio, regardless of what it may be.[14] Tables 16 to 18 present the regression results for each taxonomy, which show that funds, regardless of the sustainability classifications, behave in a similar manner as conventional funds when considering their financing of firms with science-based targets. If any, signs hint to the fact that self-marketed funds are somewhat correlated with an higher share of firms with targets, but this correlation is by no means significant. These results hint to the fact that the presence of a clearly defined carbon footprint target does not constitute a preferential

[14]The sample of firms with targets provided by Urgentem is smaller than that of emissions, and we have no way to determine whether firms are not reported because they do not have targets, or because of data availability. As an approximation, we consider all firms in our emissions database that are not in the target database as having no target.

investment choice for green funds.

Table 16: Firms with science-based targets in funds, by MS sustainability strategy

	(1)	(2)
	% target (2016)	% target (2021)
	b/se	b/se
No strategy	0.000	0.000
	(.)	(.)
ESG	-0.031	-0.044
	(0.038)	(0.036)
Impact	-0.042*	-0.038
	(0.021)	(0.021)
Green tech	0.065	0.082
	(0.058)	(0.056)
Low carbon	-0.019	-0.020
	(0.031)	(0.030)
Constant	0.444***	0.492***
	(0.044)	(0.046)
Geo	Yes	Yes
Cap	Yes	Yes
Style	Yes	Yes
R-squared	0.222	0.229
Adj. R-squared	0.214	0.220
F(2, N)	25.42	27.18
N	1619	1670

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 17: Firms with science-based targets in funds, by SFDR disclosure classification

	(1)	(2)
	% target (2016)	% target (2021)
	b/se	b/se
Art. 6	0.000	0.000
	(.)	(.)
Art. 8	-0.003	0.006
	(0.019)	(0.018)
Art. 9	-0.017	-0.005
	(0.053)	(0.049)
Constant	0.451***	0.499***
	(0.044)	(0.045)
Geo	Yes	Yes
Cap	Yes	Yes
Style	Yes	Yes
R-squared	0.219	0.225
Adj. R-squared	0.212	0.218
F(2, N)	28.15	30.04
N	1619	1670

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 18: Firms with science-based targets in funds, by self-marketing

	(1) % target (2016) b/se	(2) % target (2021) b/se
Not marketed	0.000	0.000
	(.)	(.)
ESG marketed	0.035	0.036
	(0.044)	(0.043)
Green marketed	0.060	0.040
	(0.039)	(0.036)
Constant	0.435***	0.489***
	(0.044)	(0.045)
Geo	Yes	Yes
Cap	Yes	Yes
Style	Yes	Yes
R-squared	0.221	0.226
Adj. R-squared	0.213	0.219
F(2, N)	28.37	30.17
N	1619	1670

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

8 Conclusions

ESG investment funds have experienced remarkable growth in the recent years. Indeed, increasing demand for sustainable finance products and pressure for the financial sector to take an active part in financing climate transition and sustainability objectives have led to an expanding offer of ESG financial products. At the same time, lack of clarity of what activities are sustainable, small pool of sustainable assets respecting high standards such as the EU Taxonomy, lack of definition of an ESG fund and lack of transparency on funds' strategies have created an important dispersion in types of ESG investment funds offered on the market. Given the concern on greenwashing, mismatch between marketing claims and real impact delivered by ESG financial products, the European Commission has requested the European Supervisory Authorities such as European Securities Market Authority (ESMA) to analyse greenwashing risks and necessary sustainable finance policies (ESMA (2023a)).

In this paper, we define ESG investment funds using three approaches. First, we use Morningstar data to classify funds in five categories: Low carbon/Fossil fuel free, Green tech, Impact, general ESG funds and all other funds. FFF focus on low-carbon transition. In our second approach, we distinguish between Art. 6, 8 and 9 investment funds in line with the European Sustainable Finance Disclosure Regulation (SFDR). While the

regulation categorises funds for pure disclosure purposes, the lack of rigorous regulatory classification of ESG funds lead markets to fill in the void by using Art. 6/8/9 categories to promote and market their sustainability products. Finally, our third classification is based on text analysis of funds names. We follow the approach of Capotă et al. (2022) to search for key words in funds' names that hint to green-related investment strategies. Thus, we identify three categories: general ESG funds, Green funds with a specific focus on the environment and low-carbon transition and all other funds.

We compare ESG investment funds to conventional funds along five metrics. First, financial institutions have to redirect funding to climate solutions and reduce/withdraw funding from fossil fuels. Hence, our first metrics focus on the assets financed by investment funds, how much is invested in renewable energy vs fossil fuels. Second, financial institutions have to set up targets related to the emissions related to their assets and progressively reduce carbon footprint of financial portfolios. Thus, our next set of metrics looks at the level and change in portfolio emissions over time. Furthermore, we look at what factors explain the change in emissions, since reduction in emissions due to disinvestment has different real-economy and policy implications than reduction in emissions of investee firms. Third, financial institutions should direct funding to companies that are on the transition path, that is they are aligned with the net-zero trajectory or they have ambitious science-based targets and tangibly act to reach net-zero objective. And we employ information regarding share of investments into firms with (more ambitious) science-based targets as our third set of metrics.

Our analysis provides several interesting findings. First, by comparing different sustainability taxonomies for investment funds, we find the MS sustainability investment strategies quite consistent with the SFDR classification. More specifically, we find that the majority (91%) of GreenTech/LowCarbon funds are either Art. 8 or 9 funds, while most of the Art. 9 funds are either GT/LC funds (60%) or Impact funds (22%). On the other hand, we document that self-marketed Green funds are rather incoherent regarding the two other classification, notably, less than half of these funds are either Art.8/9 and have stringent sustainable investment strategy (GT/LC or Impact), while 28% of these funds are Art.6 and have no sustainable investment strategy at all.

Second, when comparing financed activities of different ESG investment funds, we observe common and expected patterns for MS , namely, lower investments in sectors considered highly polluting, such as Fossil fuels and Transport, and in some cases (GreenTech) larger investments in traditionally more sustainable sectors like Water management. However, no indication of sustainable investment in funds pursuant othe strategies relatively to conventional funds with no sustainability objectives. Conversely, Art. 9 funds show a highly significant bias towards greener sectors (and less towards polluting ones) with respect to the other articles. Regarding the self-marketed funds, we observe difference mainly between Green-marketed funds and other funds and no difference for ESG-marketed funds. Still Green-marketed funds show again the lowest consistency between their names and financed activities. Financing manufacturing seems to more popular than the benchmark in all specifications, but without a further breakdown, the result has little or no interpretation.

Third, analysis of portfolio carbon emissions shows relatively mild differences between funds with sustainable attributes and all other funds. For funds with sustainability strategies, only Low carbon/Fossil fuel free funds exhibit reduction in financed emissions between 2016 and 2021. Art.8 funds report both lower levels in 2016 and 2021 and reduced financed emissions over the period. Art.9 are instead nowhere different from funds without disclosure. On the other hand, self-marketed funds show no difference relatively to other funds.

Fourth, decomposition of the change in carbon footprint shows that almost everywhere the main drive has been portfolio reallocation rather than reduction in absolute emissions/carbon intensity, although there are some difference among funds with different strategies/taxonomy/marketing, the stricter in terms of green objectives exhibiting a more visible reduction of carbon footprint per unit of investment.

Finally, when looking at the share of funds' investments into more sustainability-committed firms identified by their Science-based targets, we observe no difference between funds according to either of the sustainability taxonomies and conventional funds.

These findings have important policy implications. They highlight the potential for greenwashing, particularly, in the self-marketed funds and support the position of the ESMA re-

garding the restriction of the sustainability-related words in fund names (ESMA (2024a)). Furthermore, our works underlines the importance of quantitative criteria for sustainability objectives for ESG investment funds to assure achievement of tangible sustainability results by these funds.

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Appendix

Text-based analysis

Table 19 reports the keywords used to search for sustainability-related labels in funds' names. To capture as many characteristics as possible, the allows for abbreviations, since funds are often identified with their short names in the markets. Most keywords are in English, but there are few cases of other languages.

Table 19: Keywords of the text-based analysis

PA/Green funds	ESG funds
alternative energy	esg
carb	eth
clim	etisk
clm	free
ecol	imp
energy trans	resp
env	rsp
green benefit	social
green tigers	sri
natu	sus
renew	trans
solar	-
transition energy	-

Summary statistics

Tables 20 to 31 report the summary statistics for all the variables employed in the econometric analysis (with the exception of the controls, which are qualitative). The figures read as follows: sectors are in percentage over total portfolio, TNA is in million euro, change in TNA is in percentage, absolute emissions is in tonnes of CO2 equivalent, change in absolute emissions is in percentage, carbon intensity is in tonnes of CO2 equivalent over million dollar revenues, change in carbon intensity is in percentage, targets are in percentage over total portfolio.

Table 20: Total sample

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.18	1.11	0.00	0.00	0.00	0.00	0.00	0.80	32.31
Construction	3.30	6.01	0.00	0.00	0.00	1.39	3.84	12.31	46.06
Energy	2.63	5.39	0.00	0.00	0.00	0.34	3.30	10.51	64.00
Financials	15.28	12.45	0.00	0.00	7.40	14.63	20.09	32.12	100.00
Infocomm	12.91	10.96	0.00	0.00	5.61	10.42	18.15	33.36	87.79
Manufacturing	45.60	17.32	0.00	6.76	37.75	47.25	56.08	71.74	91.97
Fossil fuels	2.85	9.43	0.00	0.00	0.00	0.00	2.51	10.30	100.00
Real estate	2.96	10.80	0.00	0.00	0.00	0.00	1.84	8.03	87.20
Services	11.80	7.82	0.00	0.00	7.00	10.81	15.67	25.80	84.54
Transport	2.11	3.57	0.00	0.00	0.00	1.20	2.96	7.27	47.97
Water	0.37	1.44	0.00	0.00	0.00	0.00	0.00	2.31	19.41
TNA (2016)	297.99	549.18	0.09	5.08	31.50	104.03	305.45	1,329.27	6,492.12
TNA (2021)	558.36	1,242.62	0.95	9.23	49.69	178.76	522.61	2,312.55	24,091.96
ΔTNA	616.73	5,028.45	-98.98	-68.65	-17.70	46.28	197.00	1,457.41	138392.05
AE (2016)	7.31e+06	9.67e+06	2,420.53	155766.63	1.10e+06	3.69e+06	1.02e+07	2.49e+07	1.13e+08
AE (2021)	1.35e+07	1.74e+07	22,420.24	340326.28	2.35e+06	7.56e+06	1.84e+07	4.45e+07	2.08e+08
ΔAE	216.79	479.87	-98.36	-50.19	15.02	91.88	230.33	816.30	6,547.68
CI (2016)	610.55	478.53	4.98	124.41	313.49	536.89	774.38	1,382.86	5,635.19
CI (2021)	933.30	716.77	33.10	202.91	503.20	785.21	1,143.08	2,189.47	7,848.86
ΔCI	101.55	214.53	-86.87	-43.77	3.22	45.58	130.04	414.45	4,465.74
Targets (2016)	53.17	40.80	0.00	0.00	0.00	71.90	90.32	97.67	100.00
Targets (2021)	51.91	40.10	0.00	0.00	0.00	68.74	87.92	97.59	100.00

Table 21: MS No strategy

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.18	1.31	0.00	0.00	0.00	0.00	0.00	0.68	32.31
Construction	3.34	6.30	0.00	0.00	0.00	1.34	3.68	13.36	46.06
Energy	2.96	5.77	0.00	0.00	0.00	0.85	3.83	13.06	60.09
Financials	15.91	13.78	0.00	0.00	7.60	14.72	20.47	35.17	100.00
Infocomm	12.76	11.40	0.00	0.00	5.43	10.13	17.69	33.82	87.79
Manufacturing	44.31	18.02	0.00	2.50	36.23	46.59	55.37	70.78	89.41
Fossil fuels	3.58	11.53	0.00	0.00	0.00	0.21	2.83	13.81	100.00
Real estate	2.74	10.79	0.00	0.00	0.00	0.00	1.41	7.22	84.08
Services	11.52	7.72	0.00	0.00	6.97	10.53	15.02	25.23	84.54
Transport	2.42	4.12	0.00	0.00	0.00	1.59	3.13	8.09	47.97
Water	0.28	1.02	0.00	0.00	0.00	0.00	0.00	2.04	12.70
TNA (2016)	259.90	545.44	0.09	4.39	25.43	84.58	251.13	1,142.93	6,492.12
TNA (2021)	410.35	1,009.98	1.26	7.25	36.40	127.62	373.82	1,509.31	11,208.53
ΔTNA	285.11	1,783.12	-95.68	-69.85	-21.11	33.63	150.21	899.00	47,200.65
AE (2016)	8.48e+06	1.11e+07	2,420.53	123522.28	1.16e+06	4.45e+06	1.21e+07	3.06e+07	1.13e+08
AE (2021)	1.58e+07	2.05e+07	22,420.24	303287.09	2.40e+06	9.24e+06	2.20e+07	5.22e+07	2.08e+08
ΔAE	214.60	472.77	-96.21	-48.82	16.76	88.41	214.58	808.77	5,894.57
CI (2016)	620.08	491.35	4.98	108.05	322.78	556.94	786.06	1,377.02	5,635.19
CI (2021)	958.07	705.17	33.10	192.37	524.94	834.50	1,177.93	2,172.49	7,848.86
ΔCI	108.75	249.33	-86.87	-41.96	6.59	48.81	128.47	420.31	4,465.74
Targets (2016)	55.36	40.63	0.00	0.00	0.00	73.90	91.63	98.47	100.00
Targets (2021)	54.03	39.88	0.00	0.00	0.00	72.17	89.01	98.04	100.00

Table 22: MS ESG

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.19	0.84	0.00	0.00	0.00	0.00	0.00	0.93	6.12
Construction	2.66	3.24	0.00	0.00	0.00	1.73	3.69	8.90	17.89
Energy	2.37	2.96	0.00	0.00	0.00	1.56	4.13	7.80	16.00
Financials	15.25	11.20	0.00	0.00	9.17	15.09	19.28	32.03	98.92
Infocomm	13.06	8.88	0.00	0.00	7.18	11.12	18.65	27.42	55.36
Manufacturing	48.34	13.85	0.00	25.61	40.38	47.81	54.47	75.54	88.91
Fossil fuels	1.32	2.61	0.00	0.00	0.00	0.00	1.62	5.49	16.63
Real estate	1.27	1.98	0.00	0.00	0.00	0.00	2.14	5.16	8.49
Services	13.26	7.60	0.00	3.28	7.77	12.14	17.60	26.29	42.52
Transport	1.60	2.05	0.00	0.00	0.00	1.03	2.56	5.65	12.33
Water	0.68	1.59	0.00	0.00	0.00	0.00	0.50	4.00	8.70
TNA (2016)	182.06	396.79	0.75	3.23	21.17	56.23	148.99	955.67	2,398.71
TNA (2021)	289.62	682.00	0.95	6.71	27.78	86.35	249.92	1,329.77	4,909.69
ΔTNA	809.65	4,602.61	-94.33	-72.24	-21.33	34.53	110.75	3,261.75	48,358.62
AE (2016)	7.46e+06	8.58e+06	22,991.50	151207.16	1.36e+06	3.52e+06	1.21e+07	2.68e+07	3.90e+07
AE (2021)	1.38e+07	1.41e+07	97,377.73	332363.84	3.59e+06	8.05e+06	2.07e+07	3.95e+07	7.34e+07
ΔAE	255.22	549.26	-84.53	-43.56	19.85	123.36	252.40	960.75	5,362.11
CI (2016)	565.97	319.54	48.05	124.07	317.03	524.37	799.81	1,124.71	1,719.55
CI (2021)	926.26	565.88	104.52	312.32	527.55	843.14	1,144.76	2,042.30	3,763.03
ΔCI	110.98	187.08	-67.36	-37.26	11.18	48.87	143.59	435.04	1,151.20
Targets (2016)	52.59	43.51	0.00	0.00	0.00	77.73	93.54	99.81	100.00
Targets (2021)	51.32	42.32	0.00	0.00	0.00	69.32	92.17	98.30	100.00

Table 23: MS Impact

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.14	0.67	0.00	0.00	0.00	0.00	0.00	0.77	5.80
Construction	3.50	6.45	0.00	0.00	0.00	1.25	4.15	12.29	45.87
Energy	2.01	4.74	0.00	0.00	0.00	0.00	2.67	7.88	64.00
Financials	15.24	10.72	0.00	0.00	8.04	15.02	20.55	31.23	84.40
Infocomm	13.08	11.09	0.00	0.00	5.72	10.64	18.21	35.07	69.71
Manufacturing	45.57	16.74	0.00	9.97	37.99	47.27	56.18	70.83	83.37
Fossil fuels	2.59	7.70	0.00	0.00	0.00	0.00	2.51	9.85	100.00
Real estate	3.78	11.90	0.00	0.00	0.00	0.00	2.67	11.44	79.72
Services	12.10	8.00	0.00	0.00	6.88	11.23	16.49	27.09	46.58
Transport	1.79	2.79	0.00	0.00	0.00	0.44	2.85	6.73	28.41
Water	0.20	0.85	0.00	0.00	0.00	0.00	0.00	1.32	10.89
TNA (2016)	368.33	584.38	0.54	9.22	60.07	146.91	404.51	1,489.04	4,814.20
TNA (2021)	694.53	1,197.70	1.78	20.09	95.68	286.41	749.23	2,816.37	11,164.37
ΔTNA	951.53	7,991.93	-98.98	-68.37	-22.49	44.33	265.76	1,871.91	138392.05
AE (2016)	5.43e+06	6.62e+06	35,627.80	178405.48	834197.63	3.01e+06	7.65e+06	2.06e+07	4.67e+07
AE (2021)	1.09e+07	1.32e+07	56,483.80	370966.19	1.83e+06	6.06e+06	1.40e+07	3.97e+07	8.93e+07
ΔAE	206.66	387.99	-98.36	-46.44	21.70	104.56	234.23	803.55	4,576.52
CI (2016)	585.19	454.54	36.42	152.70	299.52	477.19	729.97	1,383.55	4,825.75
CI (2021)	898.97	764.01	50.79	203.35	479.30	710.75	1,052.29	2,189.51	6,196.80
ΔCI	93.04	165.33	-83.57	-49.21	1.46	46.70	134.45	375.58	1,489.38
Targets (2016)	48.32	40.68	0.00	0.00	0.00	63.79	87.50	96.90	100.00
Targets (2021)	46.92	40.13	0.00	0.00	0.00	61.41	85.88	96.63	100.00

Table 24: MS Green tech

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.34	1.09	0.00	0.00	0.00	0.00	0.00	3.15	5.28
Construction	2.64	2.48	0.00	0.00	0.00	2.15	4.06	7.78	8.38
Energy	4.53	7.64	0.00	0.00	0.00	1.70	5.39	19.55	35.89
Financials	6.36	6.77	0.00	0.00	0.00	3.44	11.69	18.83	23.93
Infocomm	10.93	10.00	0.00	0.00	2.33	10.66	15.80	31.96	39.39
Manufacturing	58.48	13.52	33.67	38.16	47.81	57.37	65.26	81.60	91.97
Fossil fuels	1.79	6.06	0.00	0.00	0.00	0.00	0.95	7.41	39.30
Real estate	0.81	1.72	0.00	0.00	0.00	0.00	0.72	4.95	7.10
Services	9.98	6.69	0.00	1.96	4.41	9.07	14.47	19.11	29.60
Transport	1.14	1.95	0.00	0.00	0.00	0.00	1.71	5.47	7.87
Water	3.01	5.55	0.00	0.00	0.00	0.00	3.62	18.99	19.41
TNA (2016)	267.63	552.36	4.64	10.00	22.99	50.31	311.08	1,503.92	2,722.16
TNA (2021)	1,002.09	1,701.38	4.30	15.55	71.50	282.29	732.48	4,002.75	8,369.38
ΔTNA	597.94	1,130.65	-74.03	-14.38	69.58	183.00	891.55	1,840.43	7,058.64
AE (2016)	7.16e+06	1.42e+07	135665.45	273387.03	1.08e+06	2.72e+06	7.66e+06	2.08e+07	8.90e+07
AE (2021)	1.14e+07	1.23e+07	147924.39	1.00e+06	3.35e+06	6.60e+06	1.61e+07	4.24e+07	5.18e+07
ΔAE	305.38	617.68	-92.59	-70.04	47.18	146.87	338.55	811.79	3,898.05
CI (2016)	806.55	855.01	111.05	126.80	390.46	603.40	773.54	2,615.46	4,885.87
CI (2021)	1,317.93	1,045.38	126.53	202.32	692.00	1,058.76	1,390.26	4,284.37	4,695.87
ΔCI	138.44	212.51	-81.18	-63.69	23.74	89.17	158.67	593.77	901.73
Targets (2016)	61.78	37.80	0.00	0.00	45.15	81.55	92.14	96.63	97.01
Targets (2021)	61.49	37.56	0.00	0.00	41.67	77.32	89.16	98.14	100.00

Table 25: MS Low carbon/Fossil fuel free

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.24	1.14	0.00	0.00	0.00	0.00	0.00	1.66	12.19
Construction	3.13	5.15	0.00	0.00	0.00	1.53	3.43	12.80	32.45
Energy	2.36	5.48	0.00	0.00	0.00	0.00	2.64	9.89	44.77
Financials	14.36	10.70	0.00	0.00	6.80	14.42	19.29	27.70	86.97
Infocomm	13.60	9.72	0.00	0.00	6.18	11.78	19.80	31.30	48.65
Manufacturing	47.38	16.65	0.00	12.15	40.38	48.67	56.87	72.19	83.62
Fossil fuels	1.17	2.75	0.00	0.00	0.00	0.00	1.46	5.03	26.26
Real estate	3.44	12.06	0.00	0.00	0.00	0.12	2.82	6.98	87.20
Services	11.90	8.12	0.00	0.00	7.62	10.62	15.33	25.90	50.95
Transport	2.00	3.41	0.00	0.00	0.00	1.16	2.77	6.35	31.83
Water	0.44	1.51	0.00	0.00	0.00	0.00	0.00	2.66	16.97
TNA (2016)	379.57	523.36	0.69	5.10	42.08	189.57	516.27	1,505.89	3,300.50
TNA (2021)	1,004.90	2,124.25	3.80	18.08	92.38	401.88	1,250.86	3,150.61	24,091.96
ΔTNA	1,250.51	6,150.14	-96.26	-67.98	15.09	106.19	309.69	2,955.68	61,273.84
AE (2016)	6.51e+06	7.04e+06	11,767.90	229618.11	1.61e+06	3.72e+06	9.84e+06	1.97e+07	3.72e+07
AE (2021)	9.56e+06	9.14e+06	28,987.14	373324.84	2.75e+06	6.54e+06	1.42e+07	2.70e+07	5.40e+07
ΔAE	209.64	639.04	-95.57	-54.87	-4.40	46.79	210.74	715.49	6,547.68
CI (2016)	615.39	430.48	47.02	147.31	321.78	548.16	790.71	1,355.62	3,452.99
CI (2021)	815.10	589.15	105.22	205.08	452.63	672.96	983.05	1,790.28	3,853.72
ΔCI	73.56	150.44	-83.68	-46.16	-13.65	23.09	108.10	370.26	1,010.40
Targets (2016)	53.84	39.95	0.00	0.00	0.00	74.43	89.18	96.85	100.00
Targets (2021)	53.12	39.24	0.00	0.00	0.00	69.16	86.88	97.13	100.00

Table 26: SFDR Art. 6

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.18	1.26	0.00	0.00	0.00	0.00	0.00	0.75	32.31
Construction	3.40	6.41	0.00	0.00	0.00	1.35	3.67	13.66	46.06
Energy	2.93	5.61	0.00	0.00	0.00	0.87	3.79	12.66	60.09
Financials	15.95	13.55	0.00	0.00	7.67	14.80	20.46	34.97	100.00
Infocomm	13.20	11.61	0.00	0.00	5.72	10.40	18.35	35.00	87.79
Manufacturing	43.50	17.84	0.00	2.04	35.32	46.10	54.51	68.44	89.41
Fossil fuels	3.97	12.02	0.00	0.00	0.00	0.27	3.19	15.73	100.00
Real estate	2.89	11.05	0.00	0.00	0.00	0.00	1.49	7.98	80.32
Services	11.40	7.83	0.00	0.00	6.72	10.26	15.03	25.33	84.54
Transport	2.28	3.85	0.00	0.00	0.00	1.44	3.12	7.72	47.97
Water	0.29	1.18	0.00	0.00	0.00	0.00	0.00	1.97	19.34
TNA (2016)	287.13	606.26	0.09	4.37	25.04	81.71	258.38	1,333.14	6,492.12
TNA (2021)	451.89	1,160.64	1.26	7.17	36.16	117.83	356.46	1,873.75	11,208.53
ΔTNA	415.62	4,590.08	-98.98	-71.10	-27.26	26.82	151.70	948.97	138392.05
AE (2016)	8.10e+06	1.05e+07	2,420.53	160676.19	1.28e+06	4.36e+06	1.12e+07	2.68e+07	1.13e+08
AE (2021)	1.54e+07	1.99e+07	54,133.98	305620.91	2.57e+06	8.96e+06	2.14e+07	5.14e+07	2.08e+08
ΔAE	208.35	450.64	-98.36	-50.94	17.37	89.30	225.18	804.29	5,894.57
CI (2016)	631.73	511.55	4.98	120.15	315.05	554.28	792.60	1,444.85	5,635.19
CI (2021)	979.80	770.92	33.10	195.69	529.89	834.82	1,178.25	2,190.97	7,848.86
ΔCI	104.25	192.25	-86.87	-44.04	5.38	50.59	129.90	423.10	1,702.68
Targets (2016)	53.92	40.78	0.00	0.00	0.00	72.02	90.92	98.02	100.00
Targets (2021)	52.27	39.87	0.00	0.00	0.00	68.20	87.73	97.38	100.00

Table 27: SFDR Art. 8

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.19	0.84	0.00	0.00	0.00	0.00	0.00	0.93	6.12
Construction	2.66	3.24	0.00	0.00	0.00	1.73	3.69	8.90	17.89
Energy	2.37	2.96	0.00	0.00	0.00	1.56	4.13	7.80	16.00
Financials	15.25	11.20	0.00	0.00	9.17	15.09	19.28	32.03	98.92
Infocomm	13.06	8.88	0.00	0.00	7.18	11.12	18.65	27.42	55.36
Manufacturing	48.34	13.85	0.00	25.61	40.38	47.81	54.47	75.54	88.91
Fossil fuels	1.32	2.61	0.00	0.00	0.00	0.00	1.62	5.49	16.63
Real estate	1.27	1.98	0.00	0.00	0.00	0.00	2.14	5.16	8.49
Services	13.26	7.60	0.00	3.28	7.77	12.14	17.60	26.29	42.52
Transport	1.60	2.05	0.00	0.00	0.00	1.03	2.56	5.65	12.33
Water	0.68	1.59	0.00	0.00	0.00	0.00	0.50	4.00	8.70
TNA (2016)	182.06	396.79	0.75	3.23	21.17	56.23	148.99	955.67	2,398.71
TNA (2021)	289.62	682.00	0.95	6.71	27.78	86.35	249.92	1,329.77	4,909.69
ΔTNA	809.65	4,602.61	-94.33	-72.24	-21.33	34.53	110.75	3,261.75	48,358.62
AE (2016)	7.46e+06	8.58e+06	22,991.50	151207.16	1.36e+06	3.52e+06	1.21e+07	2.68e+07	3.90e+07
AE (2021)	1.38e+07	1.41e+07	97,377.73	332363.84	3.59e+06	8.05e+06	2.07e+07	3.95e+07	7.34e+07
ΔAE	255.22	549.26	-84.53	-43.56	19.85	123.36	252.40	960.75	5,362.11
CI (2016)	565.97	319.54	48.05	124.07	317.03	524.37	799.81	1,124.71	1,719.55
CI (2021)	926.26	565.88	104.52	312.32	527.55	843.14	1,144.76	2,042.30	3,763.03
ΔCI	110.98	187.08	-67.36	-37.26	11.18	48.87	143.59	435.04	1,151.20
Targets (2016)	52.59	43.51	0.00	0.00	0.00	77.73	93.54	99.81	100.00
Targets (2021)	51.32	42.32	0.00	0.00	0.00	69.32	92.17	98.30	100.00

Table 28: SFDR Art. 9

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.14	0.67	0.00	0.00	0.00	0.00	0.00	0.77	5.80
Construction	3.50	6.45	0.00	0.00	0.00	1.25	4.15	12.29	45.87
Energy	2.01	4.74	0.00	0.00	0.00	0.00	2.67	7.88	64.00
Financials	15.24	10.72	0.00	0.00	8.04	15.02	20.55	31.23	84.40
Infocomm	13.08	11.09	0.00	0.00	5.72	10.64	18.21	35.07	69.71
Manufacturing	45.57	16.74	0.00	9.97	37.99	47.27	56.18	70.83	83.37
Fossil fuels	2.59	7.70	0.00	0.00	0.00	0.00	2.51	9.85	100.00
Real estate	3.78	11.90	0.00	0.00	0.00	0.00	2.67	11.44	79.72
Services	12.10	8.00	0.00	0.00	6.88	11.23	16.49	27.09	46.58
Transport	1.79	2.79	0.00	0.00	0.00	0.44	2.85	6.73	28.41
Water	0.20	0.85	0.00	0.00	0.00	0.00	0.00	1.32	10.89
TNA (2016)	368.33	584.38	0.54	9.22	60.07	146.91	404.51	1,489.04	4,814.20
TNA (2021)	694.53	1,197.70	1.78	20.09	95.68	286.41	749.23	2,816.37	11,164.37
ΔTNA	951.53	7,991.93	-98.98	-68.37	-22.49	44.33	265.76	1,871.91	138392.05
AE (2016)	5.43e+06	6.62e+06	35,627.80	178405.48	834197.63	3.01e+06	7.65e+06	2.06e+07	4.67e+07
AE (2021)	1.09e+07	1.32e+07	56,483.80	370966.19	1.83e+06	6.06e+06	1.40e+07	3.97e+07	8.93e+07
ΔAE	206.66	387.99	-98.36	-46.44	21.70	104.56	234.23	803.55	4,576.52
CI (2016)	585.19	454.54	36.42	152.70	299.52	477.19	729.97	1,383.55	4,825.75
CI (2021)	898.97	764.01	50.79	203.35	479.30	710.75	1,052.29	2,189.51	6,196.80
ΔCI	93.04	165.33	-83.57	-49.21	1.46	46.70	134.45	375.58	1,489.38
Targets (2016)	48.32	40.68	0.00	0.00	0.00	63.79	87.50	96.90	100.00
Targets (2021)	46.92	40.13	0.00	0.00	0.00	61.41	85.88	96.63	100.00

Table 29: Text-based Non marketed

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.18	1.12	0.00	0.00	0.00	0.00	0.00	0.79	32.31
Construction	3.29	5.98	0.00	0.00	0.00	1.35	3.83	12.66	46.06
Energy	2.61	5.50	0.00	0.00	0.00	0.06	3.26	10.57	64.00
Financials	15.48	12.61	0.00	0.00	7.69	14.63	20.09	32.72	100.00
Infocomm	13.02	11.19	0.00	0.00	5.68	10.35	18.08	34.25	87.79
Manufacturing	45.03	17.37	0.00	5.86	36.99	46.86	55.79	70.92	91.97
Fossil fuels	3.02	9.66	0.00	0.00	0.00	0.00	2.66	11.42	100.00
Real estate	2.94	10.71	0.00	0.00	0.00	0.00	1.85	8.10	87.20
Services	11.95	7.95	0.00	0.00	7.09	10.91	15.90	26.00	84.54
Transport	2.20	3.71	0.00	0.00	0.00	1.29	3.06	7.69	47.97
Water	0.27	1.07	0.00	0.00	0.00	0.00	0.00	1.88	18.99
TNA (2016)	308.23	564.60	0.09	5.29	32.83	110.25	310.81	1,352.98	6,492.12
TNA (2021)	555.21	1,253.23	1.26	9.04	47.59	177.63	527.81	2,264.34	24,091.96
ΔTNA	514.87	4,876.59	-98.98	-69.09	-20.03	41.53	181.59	1,141.76	138392.05
AE (2016)	7.11e+06	9.49e+06	2,420.53	150575.23	1.03e+06	3.55e+06	9.89e+06	2.44e+07	1.13e+08
AE (2021)	1.34e+07	1.77e+07	22,420.24	333383.69	2.12e+06	7.15e+06	1.81e+07	4.43e+07	2.08e+08
ΔAE	213.07	465.31	-98.36	-50.30	15.16	91.77	229.42	803.97	6,547.68
CI (2016)	598.66	464.75	4.98	120.79	307.71	522.87	760.42	1,361.43	5,635.19
CI (2021)	906.76	693.89	33.10	198.85	494.02	769.83	1,122.08	2,030.07	7,848.86
ΔCI	99.08	215.58	-86.87	-44.04	3.69	45.62	128.45	374.75	4,465.74
Targets (2016)	51.97	40.85	0.00	0.00	0.00	69.16	89.81	97.67	100.00
Targets (2021)	50.68	40.11	0.00	0.00	0.00	66.71	87.20	97.33	100.00

Table 30: Text-based ESG marketed

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.03	0.18	0.00	0.00	0.00	0.00	0.00	0.12	1.52
Construction	3.40	7.02	0.00	0.00	0.33	1.71	2.82	9.63	45.21
Energy	2.61	3.34	0.00	0.00	0.00	1.71	4.18	6.61	19.55
Financials	15.98	12.77	0.00	0.00	9.74	16.07	20.14	32.03	98.92
Infocomm	11.61	8.31	0.00	0.00	4.91	10.73	18.20	25.78	35.75
Manufacturing	49.05	14.47	0.00	11.50	45.13	49.58	55.85	70.31	81.60
Fossil fuels	1.91	9.91	0.00	0.00	0.00	0.00	1.34	3.59	87.01
Real estate	2.43	9.18	0.00	0.00	0.00	0.00	1.40	5.47	59.52
Services	10.30	5.61	0.00	0.27	7.16	9.99	12.85	20.50	26.16
Transport	1.31	1.52	0.00	0.00	0.00	0.84	2.22	4.24	6.29
Water	1.38	3.61	0.00	0.00	0.00	0.00	0.57	8.64	19.41
TNA (2016)	274.64	480.18	0.75	4.98	30.99	96.41	218.76	1,453.24	2,398.71
TNA (2021)	575.59	1,188.74	0.95	12.02	71.50	237.33	443.79	3,443.38	7,747.49
ΔTNA	882.00	5,516.98	-76.09	-63.33	-2.91	62.88	281.02	1,336.10	48,358.62
AE (2016)	1.12e+07	1.36e+07	95,114.75	384379.72	2.47e+06	7.34e+06	1.43e+07	3.65e+07	8.90e+07
AE (2021)	1.77e+07	1.51e+07	124862.81	991425.25	5.57e+06	1.38e+07	2.43e+07	5.18e+07	6.27e+07
ΔAE	222.79	636.08	-92.59	-37.58	27.78	101.42	200.83	960.75	5,362.11
CI (2016)	796.88	710.60	48.05	100.41	439.74	717.85	859.68	2,007.71	4,885.87
CI (2021)	1,147.14	833.36	202.91	314.34	636.27	969.99	1,309.70	2,822.38	4,695.87
ΔCI	103.60	198.74	-63.69	-33.64	7.60	28.59	95.76	481.05	1,151.20
Targets (2016)	66.00	38.50	0.00	0.00	45.94	87.64	93.52	97.35	100.00
Targets (2021)	64.46	38.43	0.00	0.00	46.50	83.95	94.46	100.00	100.00

Table 31: Text-based Green marketed

Variable	Mean	SD	Min	p5	p25	p50	p75	p95	Max
Agriculture	0.27	1.25	0.00	0.00	0.00	0.00	0.00	1.40	12.19
Construction	3.37	5.80	0.00	0.00	0.00	1.51	4.54	11.02	34.81
Energy	2.81	4.89	0.00	0.00	0.00	1.19	3.54	11.39	30.52
Financials	12.00	9.02	0.00	0.00	2.97	13.09	19.55	24.81	32.94
Infocomm	12.22	8.97	0.00	0.00	5.38	11.68	19.05	28.72	39.39
Manufacturing	51.49	17.14	0.00	25.39	42.03	51.19	61.72	80.38	88.91
Fossil fuels	1.16	3.94	0.00	0.00	0.00	0.00	1.40	5.17	39.30
Real estate	3.53	12.92	0.00	0.00	0.00	0.00	2.53	7.01	81.49
Services	10.75	7.02	0.00	0.00	6.19	10.52	14.50	23.06	35.90
Transport	1.37	1.91	0.00	0.00	0.00	0.00	2.28	5.62	7.90
Water	1.02	2.64	0.00	0.00	0.00	0.00	0.00	8.18	16.97
TNA (2016)	165.82	291.59	1.03	3.05	22.26	66.55	156.28	622.61	2,142.45
TNA (2021)	592.16	1,127.99	6.24	15.55	61.80	167.18	531.64	3,134.89	8,369.38
ΔTNA	1,909.15	6,503.33	-86.20	-57.78	11.47	122.16	654.62	10,334.47	61,273.84
AE (2016)	7.46e+06	8.56e+06	24,508.64	240851.89	1.63e+06	4.43e+06	9.85e+06	2.81e+07	4.56e+07
AE (2021)	1.33e+07	1.35e+07	34,244.73	377201.22	4.29e+06	9.05e+06	1.72e+07	4.27e+07	7.98e+07
ΔAE	266.53	561.06	-91.66	-53.25	12.88	86.04	260.89	1,081.27	4,288.50
CI (2016)	656.43	457.19	60.90	175.56	348.54	562.61	809.27	1,496.92	2,734.51
CI (2021)	1,172.01	878.78	104.52	205.08	534.91	937.45	1,422.28	3,069.46	4,366.52
ΔCI	135.95	208.27	-83.57	-43.77	-0.58	67.38	178.02	593.77	1,010.40
Targets (2016)	61.78	39.41	0.00	0.00	0.00	83.22	92.95	98.49	100.00
Targets (2021)	61.20	38.74	0.00	0.00	0.00	82.53	90.24	98.09	100.00