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SSE Riga Student Research Papers
2022 : 2 (244)

BIG THREE IN NET-ZERO TRANSITION: GREEN BRANDING OR ACTUAL FOOTPRINT REDUCTION?

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ISSN 1691-4643
ISBN 978-9984-822-68-6

May 2022
Riga

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Abstract

We investigate the carbon footprint of green branded funds by Blackrock, Vanguard, and State Street (the Big Three issuers). Our findings suggest that the Big Three have lower footprint, measured as CO2 emissions per dollar AUM, compared to the market proxy. Yet, the market is reducing its footprint at a faster rate than the Big Three. We also find that green branded funds have been charging 10-30 basis points in extra fees compared to the cap-based non-green-labelled funds with identical return profile. We conclude that green branding amplifies the investor demand sensitivity to fund performance, increasing funds flows by additional 0.51 percentage points when returns increase. Finally, we find evidence that when it comes to fund flows, green branding matters more than emissions the investor owns per $1 invested in the fund, as actual greenness of the fund does not have additional significant effect of flow-performance sensitivity.

We would like to acknowledge the guidance and honest feedback of our supervisor Marta Khomyn, PhD at the University of Technology Sydney and Lecturer at the University of Adelaide. We appreciate her industry knowledge and academic rigour that helped us to ensure relevance, novelty, and thorough technical execution of the thesis.

1. Introduction

Intergovernmental Panel on Climate Change (IPCC) highlights how 1.5°C and 2°C of increase in temperatures is going to have far-reaching implications for the global economy, leading to the escalation of various economic issues. In 2015, the Paris Agreement was signed to keep temperature rise below 1.5°C, which would imply decreasing the emissions to net-zero by 2050 (United Nations, 2015).

The transition toward a net-zero economy necessitates the global economy to re-allocate capital from carbon-intensive companies to ensure the long-term financial resilience in the carbon-neutral economy (Blackrock, 2021). Given the transmission mechanisms of the financial markets, the capital markets play an important role in re-directing capital to cleaner alternatives, divesting from the companies with high carbon footprint and raising their cost of capital.

Krueger *et al.* (2020) finds evidence that the investment world cares about minimizing carbon intensity of their portfolios as the risks associated with raising temperatures are beginning to materialize. Lower demand for the carbon-intensive stocks is already reflected in the green premium documented by Bolton and Kacperczyk (2021). Investors have a wide range of motivations to align their portfolios with net-zero goal: Levine (2021) mentions that some investors are driven by higher long-term returns, while Lucia, Ossola, and Panzica (2021) states that investors are ready to sacrifice returns to reduce their carbon exposure.

BlackRock, Vanguard, and State Street are often referred to as the "Big Three" passive index fund as they are dominating the passive investment industry (Fisch, Hamdani, and Solomon, 2019). Big Three are collectively managing over $15 trillion, controlling circa 73-80% of the passive index market (Segal, 2022a) and they are the largest shareholders in 88% of S&P 500 firms (Hirst & Bebchuk, 2019), making them capable of steering investors' money away from carbon-intensive companies.

The recent climate finance literature finds new evidence that carbon emissions have a substantial social cost for the society as the effects of the uncertainty around transmission channels and the effect on welfare are multiplicative (Barnett , Brock, and Hansen, 2020). With the Big Three joining the Net Zero Asset Managers Initiative in 2021, the asset managers made a commitment to take a set of actions to achieve net-zero greenhouse gas emissions by 2050 or sooner (Bloomberg, 2021). One key action is focused on the Investment Management: The Big Three is committed to offering temperature-aligned and climate-oriented investment instruments (BlackRock, 2021). More than 93 sustainable investment products were established by BlackRock in 2020 only – the offering has been growing since 2015. As the concept of a sustainable fund is rather vague (*e.g.,* it can be focused on social issues), we derive our definition of a *"green"* fund that will be used throughout the paper in a similar way as proposed by Briere and Ramelli (2021). In our research, the fund is considered to be a *green* fund if the marketing prospectus states that fund objective states minimizing carbon footprint or reduce exposure to carbon intensive companies.

Further, Shive and Forster (2019) find that public companies in the US have higher greenhouse emissions than equivalent private companies, while Hong and Karolyi (2020) propose that topic of divestment, as it is likely to influence the cost of capital of the target companies.

Therefore, given the combination of (1) the magnitude of the social cost of carbon, (2) the capital allocation role of the public markets, (3) the power of Big Three to direct the capital flows and (4) the growing number of *green* funds offered, it is important to study the carbon footprint of the Big Three funds. We focus on investigating whether actual carbon footprint reduction has been achieved by Big Three and whether the investor demand for a fund is affected by the actual footprint reduction and/or green branding of the fund. We separate our analysis in the supply and demand side. Supply side part addresses the questions of the carbon footprint of Big Three funds, while demand side part explores the relationship between the investor demand and carbon footprint or green classification of the portfolio.

From the supply side perspective, Choi *et al.* (2020) find that institutional (13F) investors gradually reduce their carbon exposure relative to the US value-weighted market portfolio. The research finds that institutional investors moved from overweighting to underweighting carbon-intensive firms. Azar *et al.* (2021) emphasize that it is reasonable to expect that the effect for the Big Three asset managers could be different from the wider investment space. Matos (2020) and Lucia, Ossola, and Panzica (2021) mention that it is not clear to which extent asset managers implement green strategies, while Kaustia and Yu (2021) state that there is a risk of a purposeful rebranding of funds to capture higher flows. Overall, the net effect on carbon per $1 AUM of Big Three funds is not clear since (1) some stocks that are excluded from green funds are often included in other funds and (2) flows that go to green and non-green funds may grow at different rates. Therefore, we arrive at our supply side research question:

Research question 1. Do Big Three asset managers decrease their carbon footprint (per 1$ of AUM) relative to market proxied by S&P 500 and Russell 1000?

Sub-question: Is the trend different for carbon emissions per $1 of revenue (compared to S&P 500 and Russell 1000)?

From the demand side perspective, there is a growing recognition among investors that portfolios need to be decarbonized (Bansal *et al*., 2017; Krueger *et al.*, 2020, Bolton and Kacperczyk, 2021). There is a well-documented way how academic literature studies the investor demand for mutual funds and ETFs. Sirri and Tufano (1998) and Del Guercio *et al.* (2002) explain that investor demand (proxied with mutual fund flows) is positively related to fund performance. By studying classic flow-performance relationship we can explore the additional effect of green branding on investor demand for a fund and whether this affect is different changes in flows driven by actual carbon footprint of the fund. For instance, Rau and Wang (2021) finds evidence that investor demand is affected by a gender effect (a fund being female-managed). Therefore, we arrive at our demand side research question:

Research question 2. Is investor demand for a fund more affected by "green" branding or by actual carbon exposure of the Big Three fund?

To give a brief overview of the results, we find that Big Three, represented by a portfolio of all Big Three funds, is reducing its footprint level in absolute terms over time. However, the Big Three aggregate portfolio is not reducing its footprint relative to the market over time. The footprint of the market proxy is falling at a faster rate. Though it is also important to understand that, as a starting point, $1 invested in the portfolio of all Big Three fund is less exposed to CO2 emissions, yet the wedge is becoming less significant over time.

Furthermore, when we controlled for fund size, age, type and investment style, we find that green-branded funds charge 11 basis points higher fees. As the regression analysis does not account for return similarities, we use another approach to quantify how much extra the investors are paying for green branded funds that have almost identical portfolio composition and subsequently highly correlated return profiles. By constructing a correlation matrix and conducting a pairwise analysis, we find that green funds were charging 10-30 basis points more for highly comparable fund yet differently branded. Interestingly, with the launch of a larger number of green funds over time, the average extra fee charged decreased by 20 basis points.

Besides, we find that green branding amplifies the investor demand sensitivity to fund performance, resulting in 0.5082 percentage point higher flows when return increases by 1 percentage point if compared to non-green funds. We also find evidence that green branding matters more than emissions the investor owns per $1 invested in the fund, as we do not find additional significant effect on flows when the footprint is lower and the performance change.

While we find that green branding is associated with less sensitive demand to changes in fees, we cannot conclude whether the sensitivity for green branded funds is higher than that of the fund with lower footprint. Due to the stickiness of the expense ratio over quarters, the overall conclusion for fee-flows relationship is rather inconclusive.

The thesis is structured in the following way: in section 2, we present the literature that helps to understand the existing research done on carbon footprint and Big Three asset managers. We also develop academic grounds for our hypotheses in the literature review rection. In section 3, we present methodology used for each of the hypothesis developed in the previous section. In section 4, we discuss our data collection methods and present the overview of the data used in the research. Section 5 presents a discussion of the results for the supply and demand parts of our thesis. In section 6, we put forward several limitations our thesis possesses and in section 7, we draw final conclusions and summarize the key findings.

2. Literature review

Our research takes the angle of the carbon footprint, focusing specifically on three biggest passive asset managers and their differently marketed funds. The literature review section presents a flow of academic and industry-specific literature that leads to the research questions. Firstly, we discuss the social cost of carbon and topics that require further research with Climate Finance. Then, we discuss the role of Big Three in net-zero transition, the actions taken by the big asset managers, and related academic literature. This allows us to derive the definition of green funds.

2.1. Carbon as a social cost

A growing number of climate finance papers focuses on the assessment of the long-term uncertainties related to the greenhouse emissions and the magnitude of the economic repercussions.

Bansal, Kiku and Ochoa (2016) conclude that increasing temperatures imply a significant social cost of carbon emissions and have a significant negative effect on wealth. Hong and Karolyi (2020) illustrate that if efforts to transition to net-zero economy are not made, it would result into a substantial damage on the economy, capital markets and firm profits. Overall, the literature suggests that social cost associated with carbon emissions is large.

Considering the public and private markets, Shive and Forster (2019) find that public companies in the US have higher greenhouse emissions than equivalent private companies due to the ownership structure, corporate governance, and legislation. Hong and Karolyi (2020) summarise that one of the areas where research push should be made is the topic of divestment, as it is likely to influence the cost of capital of the target companies.

2.2. Role of the Big Three

Considering that the passive investing industry is dominated by three asset managers BlackRock, Vanguard, and State Street, they are capable in steering investors' money away from carbon-intensive companies. Big Three are collectively managing over $15 trillion and controlling circa 73-80% of the passive index market (Segal, 2022b).

Academic literature extensively explores the aspects of power of Big Three and their major economic impact in both stewardship and directing capital flows. Azar *et al.* (2021) highlight that Big Three characteristics such as size and ownership stakes are the reasons for a growing interest in Big Three research, and these characteristics differentiate them from the institutional investors. Major part of the research covers market concentration and ownership of Big Three. Hirst & Bebchuk (2019) and Coates (2018) discuss that Big Three have an average stake of 20% in S&P 500 companies and suggest that in the upcoming years they are likely to obtain a majority vote. Market demand has also re-oriented towards Big Three funds with more than 80% of fund flows going to the three asset managers (Hirst & Bebchuk, 2019). Overall, Big Three play a substantial role in directing capital flows of long-term investments made via public markets.

2.3. Big Three and net-zero transition

Having joined the Net Zero Asset Managers Initiative in 2021, Big Three made a commitment to take a set of actions to achieve net-zero greenhouse gas emissions by 2050 or sooner (Bloomberg, 2021).

Though the area of Big Three and carbon footprint is rather novel in the academic circles, one recent paper investigates the impact of Big Three investment stewardship on carbon footprint of the fund constituents. Firstly, Azar *et al.* (2021) show that Big Three funds tend to engage more with companies that have higher carbon footprint. Essentially, if the company is characterized by high carbon emissions, there is a higher probability that the Big Three funds will engage with them. Secondly, the study shows that that higher Big Three ownership is associated with subsequent lower carbon emissions when carbon footprint of individual firms is considered. Azar *et al.* (2021) research illustrates that Big Three commitment to practice investment stewardship has tangible impact on carbon emissions of the public companies.

Big Three, BlackRock in particular, states that it is committed to offering temperature-aligned (options aligned with Paris Agreement goal of 1.5 degrees temperature increase) and climate-oriented investment options to enable investor to achieve net-zero goals with their portfolios. Only in 2020, BlackRock issued 93 new sustainable funds and enabled investors to allocate $93 billion to sustainable strategies (BlackRock, n.d.).

Considering the way climate-oriented funds are marketed to investors, we derive a definition of a *"green"* fund that will be used throughout the paper. The fund is considered to be a green fund if the marketing prospectus states that fund objective is minimizing carbon footprint or reducing the exposure to carbon intensive companies. Given portfolio composition strategy, it reasonable to expect that carbon footprint of green portfolio will be lower than of the non-green portfolio.

Considering the salience of social cost of carbon, the power of Big Three in steering investor capital and the number of green funds offered by the issuers, we focus on investigating whether actual carbon footprint reduction has been achieved by Big Three and whether the investor demand is directed towards green investment strategies. Essentially, we separate our analysis in the supply and demand side questions and hypotheses. Supply side part addresses the questions of the carbon footprint of Big Three funds, while demand side part explores the relationship between the investor demand and carbon footprint of the portfolio.

2.4. Supply side

Schneller (2021) and OECD (2021) explain that there is no universal approach to sustainable investing, which is why sustainability-branded strategies can result in varied investment outcomes. The outcomes could be potentially misaligned with the sustainability goals of the investors, namely the reduction of the portfolio carbon footprint.

To provide more clarity into the topic, we use the *definition* of a green fund from the marketing prospectus of Big Three funds derived above. Lastly, we focus on carbon footprint reduction of *Big Three* asset managers, as the capital flows and incentives of the previously researched institutional investors are different (Azar *et al.*, 2021).

Big Three manage both green and non-green funds. Though Big Three started offering an increasing number of funds that aim to reduce the carbon footprint of the portfolio, Matos (2020) mentions that it is not clear to which extent asset managers implement green strategies.

Lucia, Ossola, and Panzica (2021) explain that publicly traded funds with a ‘green’ or ‘sustainable’ label are likely to be less environmentally friendly than it would be expected by investors. Lucia, Ossola, and Panzica (2021) present the reasons but do not quantify the reduction of carbon footprint achieved by the funds.

Overall, the net effect on carbon footprint of the Big Three funds is not clear. More specifically, we infer it is not clear whether a bigger number of green funds makes a difference in terms of carbon per $1 AUM of Big Three funds. Firstly, the stocks that are excluded from green funds are often included in other funds. And secondly, the flows that go to green and non-green funds may grow at different rates. Mathematically, if Big Three in aggregate hold $X AUM in green funds and $Y AUM in other portfolios, depending on relative flows into X vs Y fund, Big Three can obtain a higher or lower carbon per $ AUM. Therefore, we arrive at our first hypothesis:

Hypothesis 1 (a). CO2 emission per $1 invested in the portfolio of all Big Three funds is decreasing over time.

Hypothesis 1 (b). CO2 emission per $Sales of the Big Three portfolio is decreasing over time.

Furthermore, we investigate whether Big Three funds in aggregate follow the same pattern as institutional investors. Institutional investors have been reducing their exposure to carbon intensive companies relative to the market (Choi *et al*., 2020). Thus, we get our second hypothesis:

Hypothesis 2 (a). Big Three reduce CO2 emission per 1$AUM at a faster rate compared to the market proxied by S&P 500 and Russell 1000.

Hypothesis 2 (b). Big Three reduce CO2 emission per 1$Sales at a faster rate compared to the market proxied by S&P 500 and Russell 1000.

Depending on the relative flows to the differently marketed funds and overall market dynamics in the carbon footprint reduction, Big Three in aggregate might be able or not to support the goal of net-zero greenhouse gas emissions.

2.5. Demand side

Bansal *et al.* (2017), Krueger *et al.*, (2020), Bolton and Kacperczyk (2021) present diverse evidence of the fact that carbon risks have begun to materialize and investors care about reducing carbon footprint of their portfolios. Krueger *et al.* (2020) survey shows that institutional investors recognize that carbon emissions represent a material risk and aim to shift their strategies to low-carbon ones. Though it is believed that considerable price and real effects can be expected only in the distant future, Bolton and Kacperczyk (2021) show investors demand higher compensation for stocks with high carbon emissions level (also, referred to carbon premium). A statistically significant carbon premium reflects a decreasing demand for carbon-intense companies (Bolton and Kacperczyk, 2021).

Given the recent academic works, we conclude that there is a growing recognition among investors that portfolios need to be decarbonized, though the investor motivations for carbon footprint reduction vary.

Levine (2021) presents several motives of why investors are holding green portfolios. The first motive involves avoiding companies that have high carbon footprint. By avoiding carbon-intense companies, the investors increase the companies' cost of capital, which is seen to incentivize the companies to decrease its footprint.

Second motive also involves divesting from carbon-intense companies to reap higher long-term returns. To illustrate, Brandon, Krueger, and Mitali (2021) propose a novel way of measuring the equity portfolio-level "sustainability footprint" of a 13F institutions and show positive relationship between portfolio sustainability and risk-adjusted portfolio performance. Additionally, Lucia, Ossola, and Panzica (2021) find that investors are ready to accept lower stock returns to reduce their carbon exposure.

Big Three asset managers provide passive investment vehicles to achieve carbon footprint reduction aligned with net-zero transition. The most recent literature suggests that there is increasing demand for green portfolios due to a variety of motivations. Therefore, we pose the following research question:

Research Question 2. Is investor demand for a fund more affected by "green" branding or by actual carbon exposure of the Big Three fund?

With this question, we aim to provide an insight into what is driving capital flows and whether these flows are steered away from carbon-intense companies. We approach this question by testing several hypotheses.

Firstly, green funds tend to fall into different categories – both broad-based and specialized. Ben-David *et al.* (2021) find that specialized ETFs have higher fees then the broad-based ones. Literature suggests that some ESG portfolios tend to be marginally different from the market portfolios, which would imply that they lean more towards broad-based ones.

Literature also suggests the existence of green risk premium (Lucia *et al.*, 2019). The conclusion for green funds is not clear, thus, we hypothesize:

Hypothesis 3. "Green" branded funds charge higher fees than funds with comparable performance not branded as "green".

Investors pay more attention to price or performance depending on various fund-level characteristics. To illustrate, Ben-David *et al.* (2021) finds that investors are more sensitive to fees when funds are specialized and not broad-based. Though for the late sample (2010-2019) with more specialized funds included, Ben-David et al. (2021) conclude fee-flow relationship is insignificant. According to the Bordalo *et al.* (2016) framework, insignificant sensitivity to fees implies a quality-salient equilibrium (investors do not care about price but rather regard quality as a more important characteristic). As previously discussed, Lucia, Ossola, and Panzica (2021) find that investors are ready to sacrifice short-term financial returns and pay higher fees to align their portfolios net-zero targets with an expectation to obtain higher returns in the future. Based on that, we build our next hypothesis:

Hypothesis 4. "Green" branded funds have lower *fee-flow* sensitivity than comparable funds not branded as "green".

While it is a well-documented fact that investor demand is positively related to fund performance (Sirri & Tufano, 1998; Del Guercio *et al.*, 2002), recent research suggests that some of the effects have not been studied. For instance, Rau and Wang (2021) finds evidence that investor demand is affected by a gender effect (a fund being female-managed). Briere and Ramelli (2021) study the relationship between ETF-flows-based Green Sentiment Index, stock performance, and corporate action. While the research does not find a significant relationship, it developed a useful measure for the direction of investor demand for green assets. Given the literature above, we investigate the following hypothesis:

Hypothesis 5. "Green" branded funds have lower *flow-return* sensitivity than comparable funds not branded as "green".

Finally, recent years have seen a large number of academic papers written on the topic of greenwashing. Kaustia and Yu (2021) find that mutual funds are likely to engage in greenwashing – intentional repurposing of the fund – to attract larger fund flows, while Clements (2022) states that reputational costs make it unlikely that ETFs would engage in greenwashing. The question of whether Big Three funds are actually green on the aggregate level is addressed in the supply part of the thesis. With the demand side part, we study whether investors react differently to green labelling and actual carbon footprint – a research angle that has not been addressed in the literature yet. We investigate the following hypotheses:

Hypothesis 6. The fee-flow sensitivity is higher for funds branded as "green" than for comparable funds that have lower CO_2 footprint but are not branded as "green".
Hypothesis 7. The flow-return sensitivity is higher for funds branded as "green" than for comparable funds that have lower CO_2 footprint but are not branded as "green".

3. Methodology

3.1 Portfolio carbon footprint

To address the research questions posed, we construct the measures for the carbon footprint of Big Three funds. Following Palazzolo *et al.* (2021), we use two approaches to measure portfolio carbon footprint. The first metric measures the amount of CO_2 emissions the investor *"owns"* by holding a fund, expressed as kilograms of CO_2-equivalent emissions per \$ invested – we will further refer to it as *CO2 emission per \$AUM*. The second one – *CO2 emission per \$Sales* – measures fund exposure to carbon-intensive firms and is expressed in kilograms of CO_2-equivalent emissions per \$1 of revenue.

We use two measures for several reasons. Firstly, to correct for cases where companies have large market capitalization but are not generating much revenue. With large market capitalization, the company will appear to be very "green" in figures with CO_2 emission per \$AUM; but if it has small sales, its "greenness" will be less prominent in figures with CO_2 emission per \$Sales. Secondly, CO_2 emissions per \$Sales is seen to reflect better carbon intensity of the operations of the company.

To arrive at the fund-level carbon footprint, we follow these steps:

(1) We obtain annually updated firm-level data on scope 1 and 2 carbon emissions (*CO2 Emission*). Scope 3 emissions are not included because of the low quality of the available data.
(2) We obtain Big Three fund constituents (component identifiers and their weights) for every quarter for the same time frame (Dec 2015 – Dec 2020).
(3) We calculate fund carbon exposure using two approaches and data on scope 1 and 2 emissions. Exposures are calculated for each Big Three fund in each quarter.

Fund-level CO2 emission per \$AUM is calculated using the following formula:

$$CO2\ emission\ per\ \$AUM_{j,t} = \Sigma \frac{w_{i,j,t} * CO2\ Emission_{i,t}}{Market\ Cap_{i,t}} \quad (1)$$

where w_{ijt} is the weight of stock i in fund j at time t, CO2 Emission is the estimated level of CO2 emissions for stock i in the year that corresponds to time t, Market Cap is market capitalization of stock i at time t. Derivation for this equation is provided in Appendix 1.

Fund-level CO2 emission per $Sales is the weighted average of the constituents' CO2 emissions level normalized by sales.

$$CO2\ emission\ per\ \$Sales_{j,t} = \Sigma\, w_{i,j,t} * \frac{CO2\ Emission_{i,j,t}}{Sales_{i,j,t}} \quad (2)$$

where w_{ijt} is the weight of stock i in fund j at time t, CO2 Emission is the estimated level of CO2 emissions for stock i in the year that corresponds to time t, Market Cap is market capitalization of stock i at time t, Sales is the revenue of stock i in fund j at time t.

The measure represents a fund exposure to carbon-intensive companies and indicates whether a fund invests more into carbon intensive stocks relative to other portfolios or the market.

In some cases, not all fund holdings contain emissions data, either because the holdings data is not complete or because emissions data is not available for some stocks. Consequently, the calculated above measures would not represent the real CO2 emission per $AUM or per $Sales of the entire portfolio. If such cases occur, we extrapolate the data by dividing the calculated measures of the portfolio by the sum of weights of stocks that contain CO2 Emission and Market Cap or Sales data. As the end result, we obtain fund-level footprint represented by two measures for each Big Three fund.

3.2 Hypotheses tests

In this section, we present the tests chosen for the hypotheses discussed in the literature review section. Supply side hypotheses addresses the research question of whether Big Three is more efficient in reducing its carbon footprint compare to the market.to its promise to achieve carbon neutrality with their portfolios. Demand side hypotheses address the research question of whether investors demand for a fund is sensitive to fees or returns and whether it is affected by green branding or actual carbon footprint of the fund.

3.2.1 Supply side

Hypothesis 1 (a). CO_2 emission per \$1 invested in the portfolio of all Big Three funds is decreasing over time.

Hypothesis 1 (b). CO_2 emission per \$Sales of the Big Three portfolio is decreasing over time.

We test these hypotheses by analysing the Big Three funds using the measures introduced in the previous section – CO_2 emissions per \$AUM and CO_2 emissions per \$Sales – which is why we separate two sub hypotheses above.

As we aim to see how CO_2 emissions per \$AUM (\$Sales) levels are changing on the Big Three aggregate level, we calculate the weighted average CO_2 emissions per \$AUM (\$Sales) of Big Three as a time series value. Similarly to Choi *et al.* (2020), to make time series comparison, we calculate average Big Three CO_2 emission per \$AUM (\$Sales) using the formulas below:

$$\overline{CO2\ emission\ per\ \$AUM_t^{Big\ Three}} = \Sigma\, fund\ weight_{j,t} * CO2\ emission\ per\ \$AUM_{jt} \quad (3)$$

where *fund weight* is the weight of fund *j* in quarter *t* calculated as TNA of the fund *i* divided by the total TNA of all the funds in quarter *t*. All the values are calculated on the quarterly basis for the period of Dec 2015 – Dec 2020.

In the analysis part, we plot Big Three CO_2 emission per \$AUM and per \$Sales time series to illustrate the trend graphically. To quantify the trend and provide interpretation, we also formally test the trend with regression model where time is an independent variable.

Hypothesis 2 (a). Big Three reduce CO_2 emission per 1\$AUM at a faster rate compared to the market proxied by S&P 500 and Russell 1000.

Hypothesis 2 (b). Big Three reduce CO_2 emission per 1\$Sales at a faster rate compared to the market proxied by S&P 500 and Russell 1000.

To test the hypotheses above, we calculate Big Three CO_2 emission per \$AUM and per \$Sales relative to the market proxies. A similar approach was used by Choi *et al.* (2020) for the calculation of market-adjusted carbon exposure of the institutional investors. We calculate adjusted Big Three measures relative to the equivalent measures of the funds tracking S&P 500 and Russell 1000 indices. Russell *2000* is not taken as a proxy for market, as in Choi *et al.* (2020), because of low carbon emissions data availability for the long-tail fund constituents. We select iShares Trust: iShares Core S&P 500 ETF and iShares Russell 1000 ETF as our benchmarks. The benchmarks allow to capture a large universe of stocks making it more representative of the market, while preserving carbon data availability at the level above 70% of portfolio weight.

Thus, we calculate relative CO2 emission per \$AUM and per \$Sales on the individual fund level as the difference between these measures for the fund and for the benchmark in each quarter. Then, we calculate the weighted average CO2 emission per \$AUM and per \$Sales to obtain times series of the portfolio consisting of all Big Three funds:

$$\overline{relative\ CO2\ emission\ per\ \$AUM\ _{t}^{Big\ Three}} = \Sigma\ fund\ weight_{j,t} * relative\ CO2\ emission\ per\ \$AUM_{jt} \quad (4)$$

where *relative CO2 emission per \$AUM* is the difference between footprint of fund *j* and the market proxy in quarter *t*; *fund weight* is the weight of fund *j* in quarter *t* calculated as TNA of the fund *j* divided by the total TNA of all the funds in quarter *t*.

The formulas represent relative CO2 emission per \$AUM and per \$Sales of Big Three portfolios as an aggregate value. We plot the time series to visualize the trend. If relative measures are zero, it implies that total CO2 emission per \$AUM (\$Sales) of Big Three is equivalent to that of the market, namely Big Three altogether do not achieve more rapid reduction in fund carbon emissions.

3.2.2 Demand side

Demand side section is designed to understand whether investors care about (a) whether the fund is branded as green and/or (b) the actual carbon emissions of the fund. Additionally, we investigate how much extra fees green investors pay for the same performance, if any.

Variable construction. Considering that we analyse the demand for a fund, we need to construct several common variables. Fund flows are generally used as a proxy for investor demand. We follow the formulas used by Chevalier and Ellison (1997) and Miguel and Su (2019) for fund flow calculations:

$$Fund\ flow_{i,t} = \frac{TNA_{i,t} - TNA_{i,t-1} * (1 + R_{i,t})}{TNA_{i,t-1}} \quad (5)$$

where $TNA_{i,t}$ is the total net assets of fund *i* at the end of quarter *t*, and $R_{i,t}$ is fund i’s raw return in quarter *t*.

Raw return is calculated based on NAV (net asset value) of each fund *i* in quarter *t*:

$$R_{i,t} = \frac{NAV_{i,t} - NAV_{i,t-1}}{NAV_{i,t-1}} \quad (6)$$

Hypotheses testing.

Hypothesis 3. "Green" branded funds charge higher fees than funds with comparable performance not branded as "green".

To understand whether green-branded funds have higher fees, we regress fees on category of the fund (dummy *Green*) and a vector of fund-level control variables, accounting for fund type (retail or institutional), fund investment style (cap-based, style, sector, regional), fund size, date and launch year fixed effects. Fees in the regression is the annualized expense ratio of a fund in each quarter (updated annually). The general form of the regression is below:

$$Fee_{jt} \sim Green_{jt} + controls_{jt} + \epsilon_i \quad (7)$$

A similar approach was used in the study by Ben-David *et al.* (2021), where the authors investigated ETF space, including the differences in fees for ETF categories (e.g., specialized versus broad-based).

This will allow us to see whether there is a significant difference in fees of green and non-green funds, given the control variables. Yet, to prove the hypothesis, we should see whether the fees differ for the funds that are comparable in terms of their performance.

To do that, we create the correlation matrix between the returns of green-branded funds and non-green cap-based funds (separating the institutional and retail funds into two batches). Then, for each green fund we select the non-green funds that have return correlation of more than 0.98 with the given green fund. We compute the average annual expense ratio for this selection of funds and compare it to the annual expense ratio of the green fund. If the difference in fees is above zero, investors whose main objective is high returns overpay by investing in green-labelled funds. We create a time-series graph by finding the TNA-weighted average of the fee differences for each year examined – this will give an insight into whether investors overpay in fees for the same return, as well as will show the fee difference dynamics over time.

Hypothesis 4. "Green" branded funds have lower fee-flow sensitivity than comparable funds not branded as "green".

Hypothesis 5. "Green" branded funds have lower flow-return sensitivity than comparable funds not branded as "green".

We will address the hypotheses with the OLS regression. Ben-David *et al.* (2021) looked at the ETFs fund flow sensitivity to fees and past performance for specialized and nonspecialized ETFs. The authors regressed the next-period fund flows on fees, return rank, specialized ETF dummy and its interaction terms with the previous two variables. They also added control variables to control for fund size and for fund age; time-fixed effects. We use the modification of this regression:

$$Fund\ flow_{j,t+1} \sim Fee_{j,t} + Green_{j,t} + R_{j,t} + Fee_{j,t} * Green_{j,t} + R_{j,t} * Green_{j,t} + Fund\ investment\ style_{j,t} + Institutional_j + Retail_j + log(TNA_{j,t}) + log\ (Age_{j,t}) + quarterFE \quad (8)$$

where

- $Fund\ flow_{j,t+1}$ is fund flow in quarter t+1
- $Fee_{j,t}$ is the annualized expense ratio of the fund from quarter *t-1* to quarter *t*
- $R_{j,t}$ is a quarterly return of the fund j
- $Green_{j,t}$ indicates if a fund is labeled as green.
- $Fund\ investment\ style_{j,t}$ is a classification of the fund according to CRSP database (e.g., cap-based, sector-based, etc.). We add this measure given that (Ben-David *et al.*, 2021) proved a significant difference in fees for specialised ETFs (e.g., sector-based) compared to broad-based ETFs.
- $Institutional_j$ indicates whether the fund is for institutional investors
- $Retail_j$ indicates whether the fund is for retail investors
- $TNA_{j,t}$ is a fund i's total net assets in time t
- $Age_{j,t}$ is a fund i's age in days in time t, calculated as the difference between date t and the Fund Launch Date.

Hypothesis 6. The fee-flow sensitivity is higher for funds branded as “green” than for comparable funds that have lower CO2 footprint but are not branded as “green”.

Hypothesis 7. The flow-return sensitivity is higher for funds branded as “green” than for comparable funds that have lower CO2 footprint but are not branded as “green”.

We test hypothesis 6 and 7 with similar regressions as used for hypotheses 4 and 5. Rau and Wang (2021) used a similar regression modification and a set of control variables to investigate the relationship between mutual fund flows, performance, and gender of the fund manager. We run two additional regressions to study the relationship between fund flows, performance, fees, actual carbon emissions of the fund and green branding.

Instead of *Green* dummy, we use funds' CO2 emission per $AUM for the first regression specification and funds' CO2 emission per $Sales for the second regression. We expect the significance levels next to CO2 emission measures (and their interaction terms) to be lower compared to the significance level of *Green* variable (and Green interaction terms).

4. Data collection and descriptive statistics

The period for all datasets is from December 2015 to December 2020 (5 years, 21 period). We choose this period due to the decreasing quality of the emissions data over time. To eliminate survivorship bias, we include data both on current and dead funds and stocks.

Data utilized in the paper is extracted from Refinitiv database, WRDS database for mutual funds (CRSP), and Big Three's websites. We use Refinitiv to extract stock-level annual data on CO2 Emissions (scope 1 & scope 2), Revenue for each year, and a number of identification variables. The data is extracted for the entire universe of stocks (both US and non-US). We further use the WRDS mutual funds database (CRSP) to obtain fund-level quarterly data for Big Three equity funds. The variables obtained are the following: identification variables, Date, Net Asset Value (NAV), Total Net Assets (TNA), Fund Launch Date, Expense Ratio (updated annually), and CRSP objective codes (Fund type, Country, Sector), which show whether the fund is domestic or international, the style of investment, and the sector/region of investment.

We manually add the column *Green* to indicate whether the fund is marketed as green or non-green based on the information form marketing prospectus of the Big Three funds. Briere and Ramelli (2021) perform a similar manual check and classification while constructing an ETF-flow-based Green Sentiment Index. We also calculate such variables as Age, as well as Return (R) and Fund Flow calculations, described in section 3.2.2.

For the funds of Big Three from the dataset described above, we obtain their quarterly holdings from the WRDS Mutual Funds database (CRSP) and create a separate dataset – holdings-level quarterly dataset containing fund identification variables, as well as Date, Weight of Stock in Portfolio, Market Value, Revenue. To this dataset, we add data on CO2 Emissions and Revenue from the stock-level dataset described at the beginning of this section. Based on the data from this holdings-level dataset, we calculate CO2 emission per $AUM and CO2 emission per $Sales for each fund and add these variables to our funds-level dataset.

We analyze our final fund-level dataset which already contains calculated variables such as Age, Fund flow, Return, fund-level CO2 emission per $AUM and per $Sales. At first, we filter out unreasonably high Return and Fund flow values. After filtering out the outliers, we end up with 24,091 unique fund-level observations. Out of them, 1,386 observations have missing values for return variable and 1,478 observations do not have fund flows data. This is largely because it is impossible to calculate the return and, subsequently, fund flows for the first date (December 2015 or any further date if the fund was only offered in a later date for the first time).

Per year, our dataset contains from 1,105 to 1,183 unique funds with no particular time trend (Appendix 2). When it comes to the funds labeled as green, there is a total of 90 distinct funds. The number grows from 11 funds in December 2015 to 88 funds in December 2020 with a very pronounced upwards trend, especially in the last quarters (Appendix 3).

It is important to assess the availability and quality of emissions data (CO2 emission per $AUM and per $Sales measures). For that, we compute two additional variables. Namely, we calculate the percent of the weight of portfolio that has data on CO2 emission per $AUM or per $Sales. Ideally, the values should be close to 100%. The lower is the number, the smaller is the percent of portfolio's TNA that has CO2 emission per $AUM and per $Sales data. The mean of these additional variables is lower in earlier periods (see Appendix 4): from December 2020 to December 2015, it decreases from 73% to 52% for CO2 emission per $AUM data and from 67% to 45% for CO2 emission per $Sales data. This signals that emissions data has a poorer quality in early periods.

In calculations that require data on carbon footprint measures, we exclude all funds that have emissions data for less than 50% of their portfolio weight. For all other funds, we adjust the CO2 emissions variables to represent the 100% of the portfolio weight, as described in the methodology section.

Table 1 below presents summary statistics for our main variables. The most important point to highlight is a low availability of emissions data. After the exclusion of fund emissions data for funds that have it for less than 50% of the weight of their portfolio, approximately 50% of the CO2 emission per $AUM or per $Sales is not available due to low quality of CO2 emissions dataset.

Given the skewness of CO2 emission variables, especially in the case of CO2 emission per $AUM (see Table 1), we make a decision to modify our return-flow regressions to include the logarithm of CO2 emission per $AUM or per $Sales, instead of the absolute values.

Table 1. Summary statistics for key research variables.

The table shows summary statistics for our key variables at the fund level, for the period from December 2015 to December 2020. CO2 emission per $Sales and per $AUM represent the calculated footprint for each individual fund. The values are already adjusted to represent the 100% of composition for each fund. Fund flows are computed as $(TNAt+1 - TNAt \times R+1)/TNAt$ and represent a % change in TNA of the fund in the next period. R is the raw return of the fund in the respective quarter. All numbers below one hundred are reported with two significant figures, everything above 100 is reported as integer. Calculated by the authors.

	CO2 emission per $AUM	CO2 emission per $Sales	Fund flow	TNA	R	NAV	Annuallized expense ratio	Age (in days)
Number of obs.	11762	10672	22570	23968	22705	24091	20851	24091
% of missing obs.	51%	56%	6.3%	0.51%	5.8%	0.0%	13%	0.0%
Standard deviation	3821	36	0.23	17954	0.11	64	0.0052	3377
Min	0.019	0.34	-1.1	0.10	-0.82	2.4	-0.00050	1.0
Q2	3.4	10	-0.038	22	-0.0078	13	0.0012	1766
Median	21	20	0.0026	241	0.028	26	0.0035	3745
Mean	789	27	0.032	4774	0.021	49	0.0051	4333
Q4	156	32	0.062	1991	0.066	58	0.0065	6276
Max	88442	467	2.0	359553	1.8	1370	0.030	33421

5. Empirical analysis

5.1. Supply side

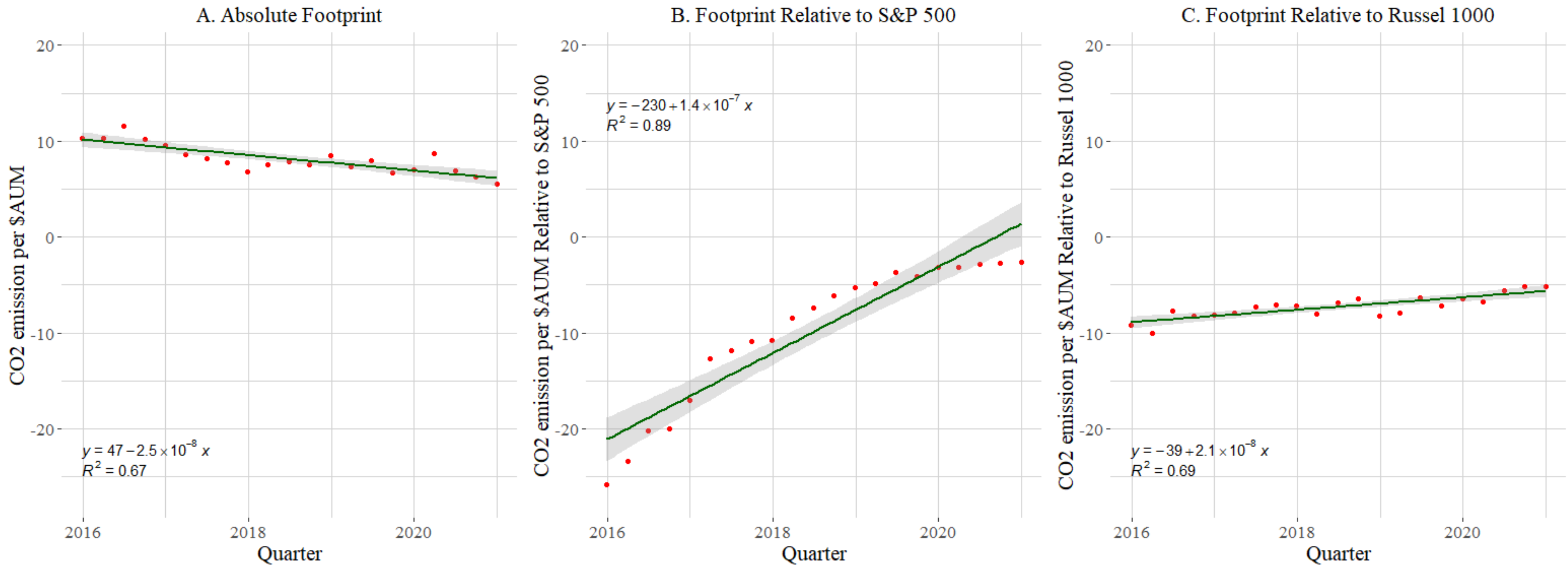
The Big Three asset managers have the power to direct capital flows to less carbon intensive companies. Having joined Net Zero Asset Managers Initiative, the Big Three also promise to facilitate transition to carbon neutrality on the asset manager level and offer numerous climate and temperature aligned funds to enable investors to align their portfolios with carbon neutrality goals. Therefore, we focus on quantifying the carbon emissions associated with Big Three portfolios and investigating Big Three performance on moving towards net zero targets over 2015-2020 period.

We measure the carbon footprint of a fund as CO2 emission per $AUM. CO2 emission per $AUM illustrates how money invested in Big Three aggregate portfolio is exposed to CO2 emissions.

Considering the results presented in the Figure 1, we propose the following interpretation. Figure 1 Panel A shows that the footprint (CO2 emission per $AUM) of Big Three has decreased from December 2015 to December 2020. Simply put, if investors allocated $1 in all Big Three funds in this period, their investment would become less exposed to CO2 emissions by December 2020. The result confirms our first hypothesis that CO2 emission per $1 invested in Big Three decrease over time.

Figure 1. The Time Series of Big Three CO2 Emission per $AUM

The figure represents the number of kilograms of CO2 emissions associated with $1 of Big Three AUM over the period December 2015-2020. The Big Three footprint is a weighted average of the CO2 emission per $AUM values for individual funds. Fund weight in the Big Three aggregate portfolio is calculated as total net assets (TNA) in quarter *t* divided by total Big Three AUM in quarter *t*. Panel A reports footprint for the portfolio of all Big Three funds. Panel B reports footprint of the Big Three portfolio relative to S&P 500, which is the weighted average of the relative footprint for each Big Three fund (fund *i*'s footprint in quarter *t minus* market footprint in quarter *t*). Panel C reports footprint of the Big Three portfolio relative to Russell 1000. The fitted line in the figures represents the regression Footprint *t* ~ Beta0 + Beta1*Quarter *t*. Equations for the fitted lines and the R-squared are indicated in each panel. On the panel A, we see a decreasing trend for the CO emission per $AUM over time, while on panel B and C relative CO2 emission per $AUM is increasing over time yet staying below zero.



Yet, Figure 1 Panel B shows that the difference between carbon footprint of Big Three (represented by CO2 emission per $AUM) and carbon footprint of S&P 500 (used as a proxy for the market) is quickly approaching zero in the given period. The difference of zero would imply that no meaningful reduction of Big Three footprint is achieved relative to the market. In our case, the graph demonstrates that the footprint (CO2 emission per $AUM) for S&P 500 decreased at a much faster rate than for the Big Three. The finding refutes our hypothesis 2 (a), which stated that Big Three would be decreasing footprint at a faster rate than the market, given the net-zero commitments Big Three are making.

The difference in pace of reduction of footprint for Big Three and the market proxies is well observed in the Figure 2, where the fitted line slope for S&P 500 footprint is much steeper. The footprint of the market is decreasing at a faster rate mainly due to a sharp increase in concentration of the index and skyrocketing market capitalization of top five stocks (technology stocks) of the index in the period examined (Debru, 2020). As the market capitalization of top ten stocks and their total weight grows from c.15% of the index to c.30% from 2015 to 2020, CO2 emission per $AUM for S&P 500 drops 4.5 times in the period.

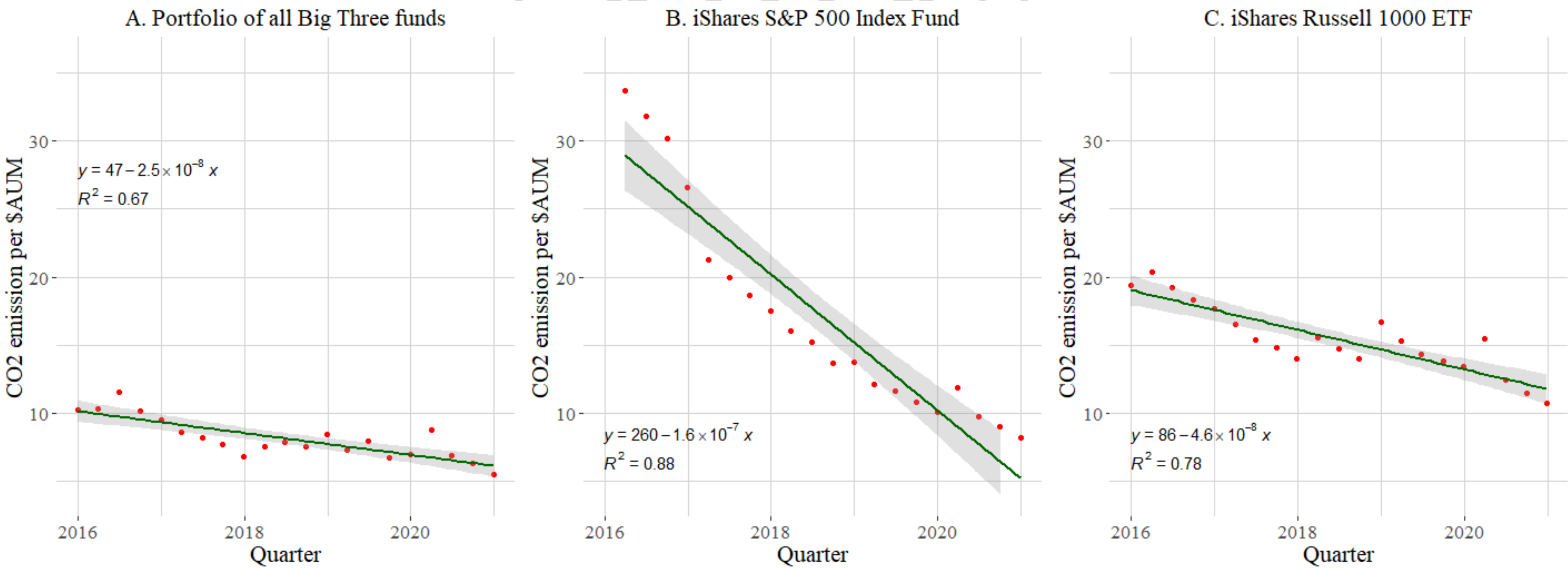
To reduce the effect of the skyrocketing valuations of the technology stocks (Figure 2 Panel B), we also take Russell 1000 as a market proxy to increase coverage of the mid-cap stocks and sectors that are not technology related (Figure 2 Panel B). In terms of Big Three footprint relative to the market, Figure 1 Panel C still shows that the wedge between Big Three and the market is decreasing, however, at a slower rate.

Overall, we can conclude that Big Three do not snow an improving "greenness" over time when compared to the market. Importantly, though we do not observe relative improvement in Big Three footprint over time, Big Three CO2 emission per $AUM remains lower than that of the market in absolute terms. Interestingly, our findings for Big Three differ from the results obtained by Choi *et al.* (2020) for the institutional investors where it was found that institutional investors reduce their exposure to CO2 emissions relative to the market over time. The difference in results was expected due to the fund characteristics Big Three possess as discussed in Azar *et al.* (2021). Also, Choi *et al.* (2020) find that institutional investors moved from overweighting to underweighting carbon-intensive firms.

Besides, the discussion shows that the choice of the market proxy matters as results differ depending on the benchmark fund selected. If market is measured by S&P 500, which has a heavier exposure to tech stocks, then Big Three perform poorly in terms of CO2 emission per $AUM over time, relative to market; but if a broader proxy like Russell 1000 is used, the Big Three manages to maintain some reduction in footprint relative to the market.

Figure 2. The Time Series of Big Three and S&P 500 CO2 Emission per Dollar AUM

The figure represents the number of kilograms of CO2 emissions associated with $1 of Big Three AUM and $1 of S&P 500 AUM over the period December 2015-2020. The Big Three footprint is a weighted average of the CO2 emission per $AUM values for individual funds. Panel A reports footprint for the portfolio of all Big Three funds, while Panel B reports footprint of the iShares S&P 500 Index fund taken as a proxy for the market. Panel C reports footprint of the iShares Russell 1000 ETF taken as an alternative proxy for the market. The fitted line in the figures represents the regression Footprint t ~ Beta0 + Beta1*Quarter t. Equations for the fitted lines and the R-squared are indicated in each panel. We see Big Three portfolio shows the lowest reduction in footprint (Panel A), while S&P 500 exhibits a very sharp decrease.

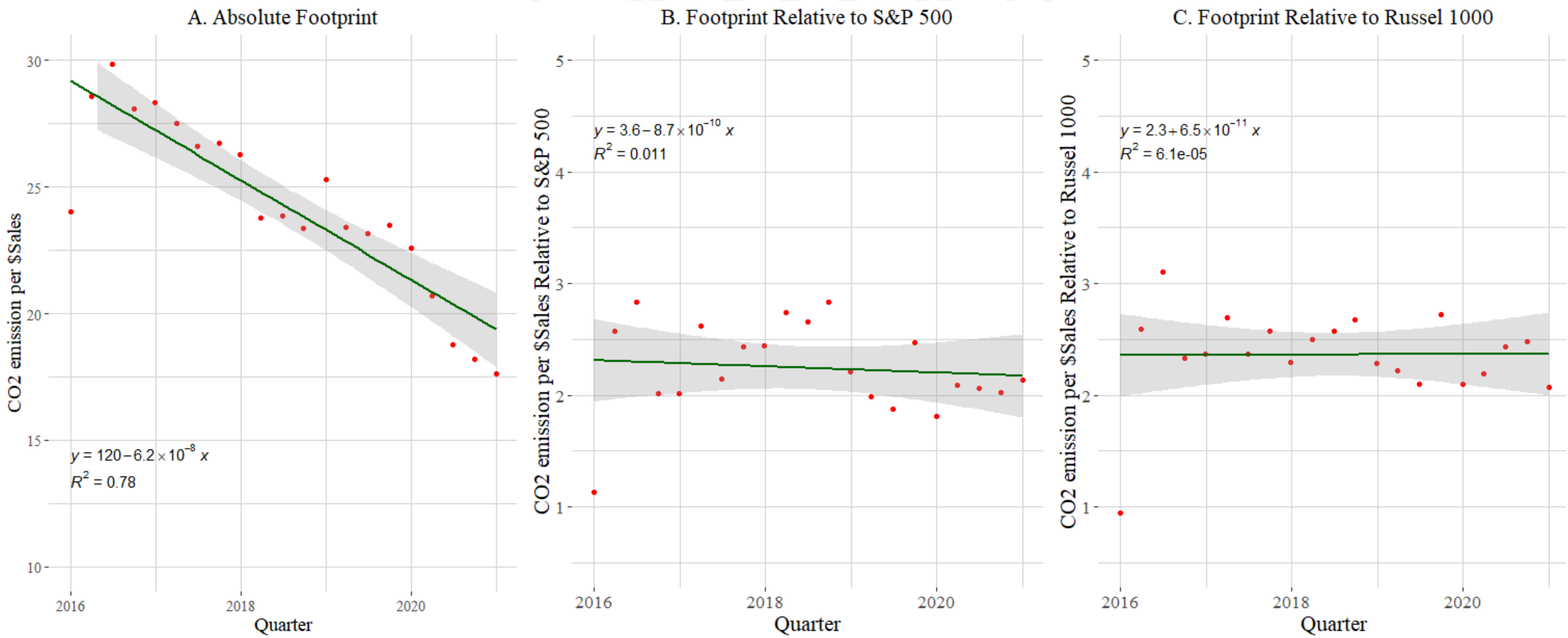


To correct for cases where companies have large market capitalization but are not generating much revenue, we use the measure of CO2 emissions per $Sales. It is designed to better reflect company core operations as opposed to potentially inflated valuation. CO2 emission per $Sales is often used to quantify how carbon intense company operations are.

Figure 3 shows that scaling CO2 emissions by Sales supports the previous findings when scaling was done by AUM. Similarly, we conclude that Big Three reduce their carbon footprint over time, confirming the hypothesis 1 (b). However, when related to the market proxy, Big Three hold more CO2 emission per $Sales than the market – proxied by both S&P 500 (Figure 3 Panel B) and Russel 1000 (Figure 3 Panel C) – and no significant improvement in "greenness" relative to the market is observed over time. In economic terms, it implies that both the market and the Big Three are decreasing their CO2 emission per $Sales level at the same rate (not at faster rate as we hypothesized in hypothesis 2 (b). Within this hypothesis, it is also important to look at the starting point: Big Three has a higher CO2 emission per $Sales relative to the market. From the literature perspective, Choi *et al.* (2020) find that institutional investors moved from overweighting to underweighting carbon-intensive firms. In the case of the Big Three, as asset managers, they generally overweight carbon intensive companies.

Figure 3. The Time Series of Big Three CO2 Footprint per Dollar Sales

The figure represents the number of kilograms of CO2 emissions associated with $1 of Sales over the period December 2015-2020. To arrive at the Big Three level of CO2 emission per $Sales, we make the following calculations: 1) company level: we divide kg of CO2 emissions of company *i* by Sales of company *i* in quarter *t*; 2) fund-level: multiply company *i* weight in fund *j* by the company level footprint and calculate fund level weighted average footprint (CO2 emission per $Sales); 3) Big Three level: multiply fund *j* weight in Big Three TNA in quarter *t* by the fund-level footprint. Fund weight in the Big Three aggregate portfolio is calculated as total net assets (TNA) in quarter *t* divided by total Big Three TNA in quarter *t*. Panel (a) reports CO2 emission per $Sales for the portfolio of all Big Three funds. Panel (b) reports CO2 emission per $Sales of the Big Three portfolio relative to S&P 500, which is the weighted average of the relative footprint for each Big Three fund (fund *i*'s CO2 emission per $Sales in quarter *t minus* market CO2 emission per $Sales in quarter *t*). Panel (c) reports CO2 emission per $Sales of the Big Three portfolio relative to Russell 1000. The fitted line in the figures represents the regression Footprint *t* ~ Beta0 + Beta1*Quarter *t*. Equations for the fitted lines and the R-squared are indicated in each panel.



5.2.Demand side

As we made our conclusions about the carbon footprint of the Big Three funds, we further discuss how investors' demand for a fund is affected by green branding and actual "greenness" of the portfolio – the level of CO2 emission per $AUM and per $Sales. Besides, we quantify the amount the investors pay extra for the "green" branded fund.

As we discussed in the literature review, it is not clear whether "green" branded funds charge higher fees, as "green" branded funds tend to fall into both categories – broad-based and specialized. Considering the result in Table 2, green branded funds charge 11 basis points more in annualized expense ratio, all else being equal. Interestingly, the result is similar to findings of Ben-David *et al.* (2021), where specialized ETFs were found to have 13 basis points higher fees than broad-based ETFs. Though in our case, we control the style of the fund (*e.g.,* specialized, cap-based), meaning that the difference is associated with green branding of the fund.

Table 2. Difference in Fees for Green Funds

The table reports the difference in fees of green and non-green funds from December 2015 to December 2020. The dependent variable Fee is the annualized expense ratio of a fund in each quarter reported in bps. Green is a dummy variable that equals 1 if a fund is a green fund. The regression is controlled for size and age of the fund by adding logarithm of Total Net Assets (TNA) and of Age of the fund. The regression accounts for quarter, fund style and fund type fixed effects. t-statistics are reported in parentheses. *** indicates significance at the 0.01% CI.

	Dependent variable: Fee (annualized expense ratio, bps)
Green (dummy)	11.08*** (2.27e-07)
log(TNA)	-9.312*** (< 2.00e-16)
log(Age)	18.37*** (< 2.00e-16)
Constant	-89.94*** (< 2.00e-16)
Date FE	Yes
Institutional vs Retail FE	Yes
Investment style FE	Yes
Observations	20,832
R squared	0.4276

Note: .p<0.1; *p<0.05; **p<0.01, ***p<0.001

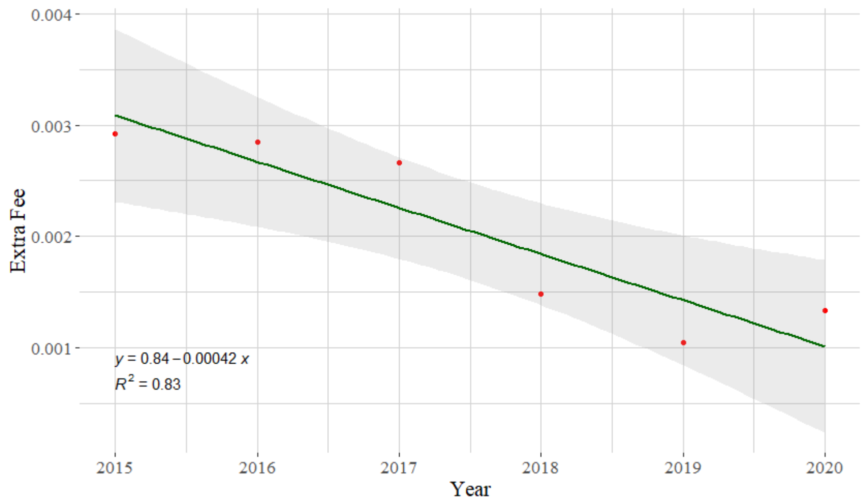
We see that the fees are statistically higher for green-branded funds, when we control for fund size, age, type and investment style. At the same time, it is not possible to conclude from this regression whether green funds charge higher fees for the same performance due to certain funds being labelled as green.

To understand this aspect, we construct Figure 4 which presents the weighted average fee difference between green funds and their non-green cap-based "twins" – funds with the same performance over time, measured by raw return. We observe that green funds charge 10-30 basis points more in fees than their non-green competitors with an identical return profile. Investors of green funds seem to overpay for the same performance. The extra fee is decreasing over time, dropping by approximately 20 basis points over five years examined – this can be explained by the increased competition among green funds, given that the number of them is growing rapidly, as presented in Appendix 3.

It is important to note that out of all green funds examined only 2 funds had return profiles that did not correlate with at least one cap-based non-green fund at a level above 0.98. Correlation matrix included a sample of 24 funds since other funds did not have enough observations to compute return correlations.

Figure 4. Weighted average fee difference between green and non-green funds with identical return profiles

The figure represents the weighted average fee difference between green and non-green broad-based funds that have a raw return correlation above 0.98. Time series is reported on an annual basis (2015-2020). Constructed by the authors.



Further, we explore changes in investor demand for a fund in response to changes in fees and performance. We use fund flows as a proxy for the investor demand for a fund; performance is measured as raw fund return and fee (or price) is the annualized expense ratio.

Table 3 shows three regression modifications, where Green variable is modified. The first column uses a dummy variable to indicate whether a fund is branded as green, while the second and third columns use a continuous variable that represents actual footprint (CO_2 emission per $AUM or per $Sales) of the fund. The modification allows to observe the differences in fund flows trends depending on green branding and actual "greenness" of the fund. Firstly, we discuss the basic economics relationships that should be observed in the regressions, and then we focus on cases where our key variables of interest are the interaction terms. Table 4 summarizes the key results of the regressions are presented in Table 3.

Table 3. Fund Flow Sensitivity to Fees and Performance.

The table presents the flow sensitivity of Big Three fund to the fund's change in fees and its past performance. The dependent variable is fund flows in quarter $t + 1$, computed as $(TNA_{t+1} - TNA \times R_{t+1})/TNA_t$. In each quarter t, we calculate raw return of the fund. Green is a dummy variable that equals 1 if a fund is a green fund. Expense ratio is the annualized expense ratio of the fund in quarter t. The regression accounts for quarter, fund style and fund type fixed effects and controls for size and age. t-statistics are reported in parentheses. . , *, **, and *** indicate significance at the 10%, 5%, 1%, and 0.01% confidence intervals.

Dependent variable: Fund Flow in the next period (pp)			
Green variable:	Green (dummy)	log(CO2 emission per $AUM)	log(CO2 emission per $Sales)
Expense Ratio(bps)	-0.04197*** (< 2.00e-16)	-0.01357 (0.1337)	-0.01078 (0.4255)
R(pp)	0.1926*** (6.39e-14)	0.2135*** (2.86e-08)	0.2691*** (1.05e-05)
Green	7.853*** (5.01e-05)	0.9302*** (1.62e-10)	-0.04973 (0.8781)
(Expense Ratio(bps))*Green	0.08723* (0.01400)	-0.01448*** (7.62e-09)	-0.01797*** (8.19e-05)
R(pp)*Green	0.5082*** (5.36e-06)	-0.008090 (0.2621)	-0.04242* (0.021276)
log(TNA)	-0.1265. (0.06438)	0.08041 (0.5212)	-0.2721* (0.01216)
log(Age)	-4.461*** (< 2.00e-16)	-3.970*** (< 2.00e-16)	-4.2732*** (< 2.00e-16)
Constant	43.40*** (< 2.00e-16)	38.61*** (1.31e-12)	45.88*** (< 2.00e-16)
Quarter FE	Yes	Yes	Yes
Institutional vs Retail FE	Yes	Yes	Yes
Investment style FE	Yes	Yes	Yes
Observations	19124	9713	8815
R squared	0.07683	0.08965	0.08907

Note: .p<0.1; *p<0.05; **p<0.01, ***p<0.001

Table 4. Summary of Results in the Key Regressions.

The table presents the summary of the key effects found in the regressions form Table 3. First column describes the relationship observed in the regressions, columns 2-4 describe the response in fund flows. Column 2 matches the green dummy regression, column 3 corresponds to log(CO2 emission per $AUM) and column 4 corresponds to log(CO2 emission per $Sales) regression. Dependent variable is the fund flow of fund *i* in quarter *t+1*. The table also indicates the confidence interval.

Effect studied	Green dummy	log(CO2 emission per $AUM)	log(CO2 emission per $Sales)
Fees increase by 1 bps	Flows decrease by 0.042 pp in the next quarter. 0.1% CI.	Negative effect but not significant	Negative effect but not significant
Fees increase by 1 bps (for a green fund or for a fund that has 1% lower footprint)	The flows will change less or in the opposite direction. The additional effect moves in the opposite direction. 5% CI.	The flows will change less. The additional effect moves in the opposite direction. 0.1% CI.	The flows will change less. The additional effect moves in the opposite direction. 0.1% CI.
Return increases by 1 pp	Flows increase by 0.193 pp. 0.1% CI.	Flows increase by 0.214 pp. 0.1% CI.	Flows increase by 0.269 pp. 0.1% CI.
Return increases by 1 pp (for a fund that is green or has 1% lower footprint)	The flows will change more. Additional positive effect from green branding. 0.1% CI.	Not significant.	The flows change more if the fund is having lower CO2 emission per $Sales. 5% CI.
Green branded fund	The flows are 7.853 pp higher for green branded funds. 0.1% CI.		

Fund fee-flow relationship. Firstly, according to the economic theory and academic literature on fund flows, if fund fees increase, the fund flows in the next period are expected to decrease – the fee-flow relationship should be negative. In the regression with green dummy (Table 3 Column 1), we find that the expected negative relationship. If the expense ratio of a fund increases by 1 bps, the fund flows are expected to decrease by 0.04197 pp in the next period. For the regressions with CO2 emission per $AUM and $Sales, the sign of the coefficient is also negative yet not significant. This could be because fees are rather sticky and are updated only annually, meaning that they change at most on an annual basis. Thus, there could be not enough data to observe a significant effect. Indeed, we have less observations for the two regressions due to the availability of emissions data. To address the issue, a longer period should be taken; however, extending the period would deteriorate the quality of the emissions data.

Fund flow-performance relationship. Secondly, we investigate the flow-performance relationship. It is well-documented that investor demand is positively related to fund performance (Sirri & Tufano, 1998). The relationship holds in all regression modifications presented in Table 3 at the 0.1% confidence interval. We cannot compare the coefficients across the regressions due to different independent variables used and a different number of observations.

As the basic economic relationships are mostly confirmed to hold in our regressions, we proceed to the discussion of our key variables of interest – interaction terms between return (and fees) and variable Green.

Fund fee-flow relationship and Green variable. In the Table 3 Column 1, we find that green-branding has an additional effect on the investors fee-flow sensitivity. This additional effect can be observed when we look at the interaction term between the expense ratio and dummy Green. The coefficient is significant at 5% confidence interval. If we consider only the direction of the additional effect for a green-branded fund, an opposite sign from the base effect means that if the fees increase, the consequent decrease in flows in the next period would be less pronounced if the fund is branded as green. This finding supports our hypothesis 4, which stated that green branded funds have lower fee-flow sensitivity than comparable funds not branded as green. Economically, the result suggests that investor demand for a green fund would deviate more towards a quality-salient equilibrium discussed in the Bordalo *et al.* (2016) framework. This would mean that investors consider quality – in this case, claim of being "green" – as a more important characteristic than price.

Yet, if we evaluate both the direction of the effect and its absolute value, the result becomes more unusual: if the fund is labeled as green, the increase in fees will increase the fund flows in the next period. There can be two explanations to this result: 1) the coefficient next to the interaction term is not precise, given its lower significance; 2) the increase in fees for green funds is accompanied by the change in their strategy to one that is more favored by investors (*e.g.*, switching from positive screening to exclusionary strategy, which is considered to be more effective when it comes to footprint reduction). Taking all into account, the results for hypothesis 4 are inconclusive.

Now, we consider the interaction term between two continuous variables – fund expense ratio and CO2 emissions per $AUM (and per $Sales). We find that the lower the CO2 emission per $AUM of the fund, the less pronounced decrease in fund flows will be observed when the fees increase. If expense ratio increases by 1 bps, all else being equal, the fund with 1% higher level of CO2 emission per $AUM will have an additional 0.01448 pp decrease of fund flows in the next quarter (Table 3 Column 2). This means that higher level of CO2 emission per $AUM of the fund implies higher sensitivity to fees and vice versa. The same relationship is observed for CO2 emission per $Sales regression. Importantly, we cannot conclude about the strength of the effect of 1% change in portfolio footprint since the base relationship was insignificant.

Overall, it appears that the findings could support our hypothesis 6 that green branded funds have higher sensitivity to fees than the funds with lower footprint, as we observe the effects that move in the same direction and the base coefficient for footprint regressions is insignificant. However, it general the results are inconclusive since we cannot properly judge which effect is stronger. The reason could be the stickiness of the fund expense ratio over time.

Fund flow-performance relationship and Green variable. What has not been documented in the previous literature is the effect of fund characteristics like green branding and footprint on the flow-performance relationship. For a non-green fund, if return increases by 1 percentage point, the fund flows would increase by 0.198 percentage points in the next period. However, if the fund is branded as green, the same 1 percentage point increase in return would increase quarterly inflows by 0.692 percentage points (additional increase of 0.494 pp). This is an interesting finding that illustrates that green branding of the fund matters when it comes to fund performance. All else being equal, green funds experience higher change in fund flows when returns change than comparable non-green funds.

Interestingly, we cannot confirm our hypothesis 5 that the flow-return sensitivity is lower for funds branded as "green", as we expected that investors in green funds would be ready to sacrifice performance to align portfolios with net-zero goals, as discussed in the literature. Potentially, investor demand for a fund could be more sensitive to charges in returns when returns are positive – green funds experience even higher inflows. In that case, the demand could remain unchanged when returns turn negative – green funds do not experience amplified outflows.

For CO2 emission per $Sales measure, when return of the fund changes, 1% lower footprint is associated 0.0424 pp additional increase in return-flow sensitivity. The effect is significant at 5% confidence interval and shows the trend that is moving in the same direction as in the regression with Green dummy. In simple terms, the lower is the footprint of the fund portfolio, the higher is the change in flows in response to the change in returns. The insignificance of results for the CO2 emission per $AUM could be explained by the fact that CO2 emission per $Sales is easier to observe on the company level and investors can analyze carbon intensity of constituents' operations, which is why some significance is achieved. CO_2 emission per $AUM is a fund-level measure that is not easily observed.

Overall, considering the findings for flow-performance relationship, we can conclude that green branding of the fund amplifies the investor demand sensitivity to fund performance, supporting hypothesis 5. If a green branded fund is exhibiting better performance, it can expect higher inflows in the next quarter than a non-green fund – the result is significant at 0.001 confidence interval. The results also partially support the hypothesis 7 that green branded funds have higher sensitivity to performance than comparable funds that have lower footprint measured as CO_2 emission per $AUM. As carbon intensity of portfolio constituents is more obvious to investors, CO_2 emission per $Sales regression suggests that lower exposure to carbon intensive companies is also associated with higher sensitivity to returns – the result is significant at 5% confidence interval.

6. Dataset-specific limitations

In this section, we summarise the main dataset-specific limitations that can affect our results. First of all, the expense ratio variable used in all demand-side hypotheses is updated only on an annual basis. While this is enough to confirm hypothesis 3, an annual update may not be enough to see a meaningful coefficient in our fee/performance-flow regressions. If the fees change in the middle of the year, we observe the changes only at the end of the year, which does not allow us to capture the next-quarter fund flow change attributed to the expense ratio change. The more general problem of stickiness of the fees may also lead to insignificant results next to the fees coefficient and can be addressed only with examining a longer time period.

Another issue arises due to lack of emissions data – this means filtering out around 50% of our dataset for all hypotheses that require us using the CO_2 per $AUM or per $Sales measure. Such a poor quality of emissions dataset can make our results biased in various directions, depending on the assumptions. For hypotheses that did not require carbon footprint measures, we used the entire dataset available, thus having more observations.

Another issue which might affect the significance of our regressions in Table 3 is the availability of only quarterly data. If investors react faster to changes in fees and performance, their reaction might not be captured entirely if the quarterly data is used. Finally, the number of green funds surged only closer to the end of our period examined, meaning that the number of observations for green funds is very low for the early quarters in our dataset.

7. Conclusion

BlackRock, Vanguard, and State Street, referred to as the “Big Three”, represent a dominant part of the passive index fund industry, which makes them capable of steering investors’ money away from carbon-intensive companies. While international organizations emphasize the importance and document the goal of decreasing the emissions to net-zero by 2050, the Big Three pledges to take a set of actions to facilitate by 2050 or sooner. Combined with the salience of the social cost of carbon, our thesis relies on the premise that it is important to study how Big Three performs in terms of footprint and how green-branding ubiquitous among Big Three fund affects investor demand for a fund.

We find that the Big Three, represented by a portfolio of all Big Three funds, is reducing its footprint level in absolute terms over time, which is in line with our first hypothesis. However, the important trend is observed when Big Three footprint is compared to the market. The Big Three aggregate portfolio is not found to reduce its footprint relative to the market over time as the market “greenness” is improving at a faster rate. As the finding is the opposite to our hypothesis two, where we expected that the Big Three would reduce its footprint faster than the market given the Big Three commitment to align its funds with net zero transition.

Answering our first research question, the Big Three do not reduce their footprint relative over time relative to the market. However, as a starting point, or in absolute terms, the Big Three has lower footprint in terms of CO2 emission per $AUM. Yet, the relative reduction is decreasing over time, meaning that market greenness is improving at a faster rate. In simple terms, a dollar invested in Big Three aggregate portfolio is associated with less CO2 emissions, yet over time relative greenness is becoming less significant. Furthermore, Big Three exposure to carbon intensive companies, measured by CO2 per $Sales, remains unchanged relative to the market.

Further, we find that green-branded funds charge 11 basis points higher fees, when we control for fund size, age, type and investment style. Since green funds tend to have almost identical portfolio composition to broad-based funds, there are also expected to have identical return profile. As the regression model does not account for return similarity, we construct a correlation matrix and do a pairwise comparison of green funds and non-green broad-based funds. We find that green funds charge 10-30 basis points more in fees than their non-green competitor with an identical return profile over the period examined. Importantly, we find the extra fee charged for green-branded funds is decreasing over time, dropping by approximately 20 basis points over five years examined.

In the demand side analysis, we find that green branding of the fund amplifies the investor demand sensitivity to fund performance – flow-return sensitivity is 0.5082 pp higher for green-branded funds which support our hypothesis five. If a green fund is exhibiting better performance, it can expect higher inflows in the quarter than a non-green fund. Furthermore, we find evidence that green branding matters more than emissions the investor owns per $1 invested in the fund. The finding provides partial support the hypothesis seven that stated that green branded funds have higher sensitivity to performance than comparable funds that have lower footprint measured as CO2 emission per $AUM.

Considering the fee-flow sensitivity, we find that green-branding has an additional effect on the investors fee-flow sensitivity, making the flows 0.087 pp less responsive to the changes in fees. The finding supports our hypothesis four that stated that demand for green branded funds is less sensitive to price changes. Unfortunately, we cannot conclude whether the sensitivity for green branded funds is higher than that of the fund with lower footprint, as the effects move in the same direction, leaving our hypothesis six inconclusive.

Answering our second research question, investor demand is indeed more affected by green branding than actual footprint of the fund when it comes to fund changes in fund performance. Considering the changes in fees, the results are inconclusive likely to the stickiness of the fee and infrequent observations of the changes in fees.

Further research could bring additional light to understanding how investor demand for fund is affected by green branding of the fund. Considering that the Big Three pledged to facilitate net-zero transition only in 2020, we see our study as a base for the further research highlighting the power green branding has on fund demand before even before the commitment on the asset manager level. Further research could use the 2020 commitments as a trigger for the event-based study analysis, as it may well be that the demand sensitivity would become even more significant, while fund performance in terms of footprint could become comparable to the market.

Overall, green branding is affecting fund flows and amplifying the investor response to performance, therefore, it is important for regulators to make sure that green pledges of the asset managers correspond to where the money invested is being directed and what footprint it represents.

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Appendices

Appendix 1. Derivation of CO2 emission per $AUM calculation

$$(value\ of\ shares\ held)_{i,j,t} = w_{i,j,t} * TNA_{j,t}$$

$$ownership_{i,j,t} = \frac{value\ of\ shares\ held_{i,j,t}}{Market\ Cap_{i,t}} = \frac{w_{i,j,t} * TNA_{j,t}}{Market\ Cap_{i,t}}$$

$$(stock'sCO2\ emissions\ owned\ by\ the\ fund)_{i,j,t} = ownership_{i,j,t} * CO2\ Emission_{i,t}$$

$$= \frac{w_{i,j,t} * TNA_{j,t}}{Market\ Cap_{i,t}} * CO2\ Emission_{i,t}$$

$$(stock's\ CO2\ emissions\ owned\ by\ the\ fund\ per\ \$TNA)_{i,j,t}$$

$$= \frac{\frac{w_{i,j,t} * TNA_{j,t}}{Market\ Cap_{i,t}} * CO2\ Emissions_{i,t}}{TNA_{j,t}}$$

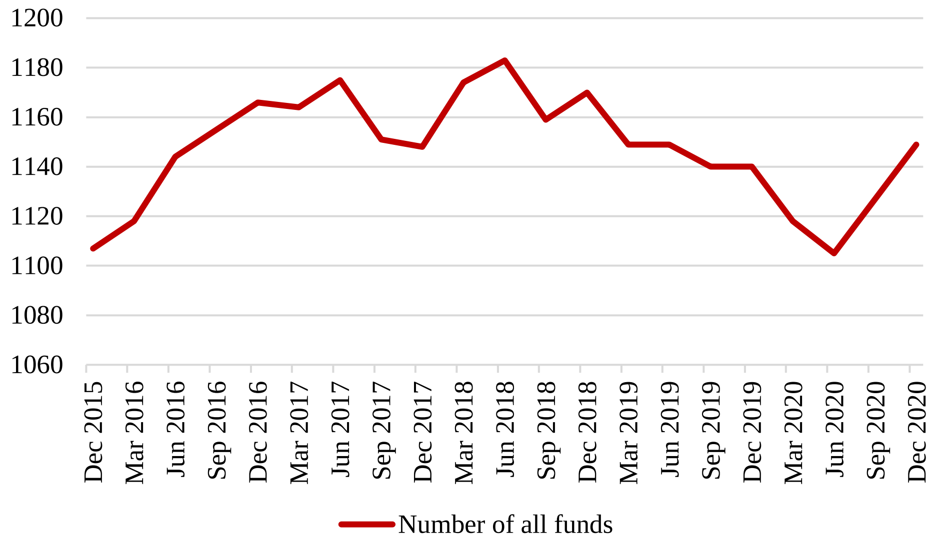
$$= \frac{w_{i,j,t} * CO2\ Emissions_{i,t}}{Market\ Cap_{i,t}}$$

$$CO2\ emission\ per\ \$AUM_{j,t} = \Sigma \frac{w_{i,j,t} * CO2\ Emission_{i,t}}{Market\ Cap_{i,t}}$$

where *w* is the weight of stock *i* in portfolio *j* at time *t*, *CO2 Emission* is the estimated level of CO2 emissions for stock *i* in the year that corresponds to time *t*, *Market Cap* is market capitalization of stock *i* at time *t*, *TNA* is total net assets of portfolio *j* in time *t*.

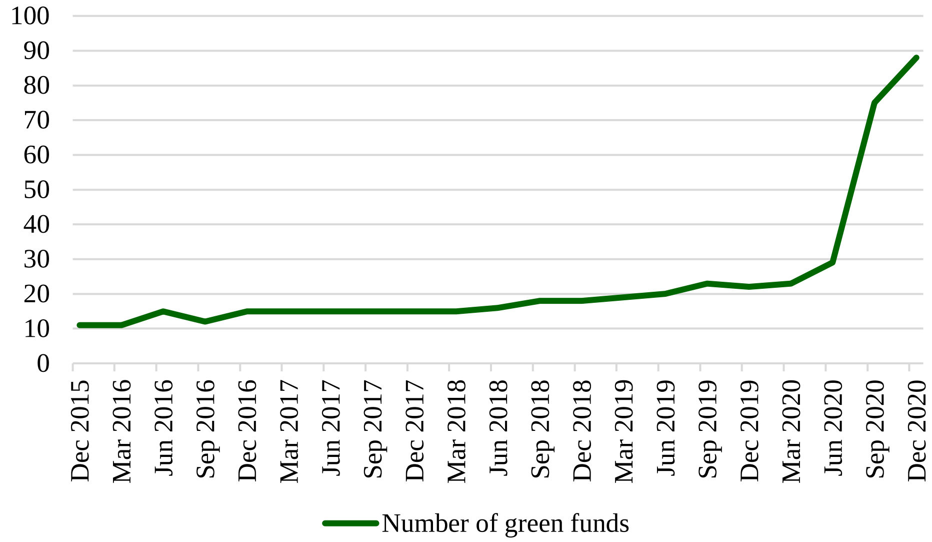
Appendix 2. Number of distinct funds of the Big Three in each quarter

The number of distinct Big Three funds does not show a particular trend over time between December 2015 and December 2020. The graph is based on data from the WRDS database for mutual funds (CRSP) and is constructed by the authors.



Appendix 3. Number of distinct green-branded funds of the Big Three in each quarter

The number of distinct green-branded Big Three funds shows a clear upward trend over time between December 2015 and December 2020. The graph is based on data from the WRDS database for mutual funds (CRSP) and the authors' own classification. Constructed by the authors.



Appendix 4. Median portfolio weight that has data on CO2 emissions per $AUM and per $Sales

The graph suggests that the quality of CO2 emissions fund-level data (per $AUM and per $Sales) is increasing in time period between December 2015 and December 2020. The median portfolio weight that has data on CO2 emissions was calculated by the authors based on raw data from WRDS database for mutual funds (CRSP) and Refinitiv database. Constructed by the authors.