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How do the Characteristics of Self-Declared ESG Mutual Funds Compare to Conventional Mutual Funds?

by
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Résumé

Ce document examine comment les caractéristiques du portefeuille des fonds mutuels autodéclarés ESG se comparent aux fonds mutuels conventionnels de 2006 à 2020. L'objectif est également de répondre aux questions par rapport à l'origine de la performance et si les fonds mutuels ESG sont plus risqués que ceux conventionnels. Les fonds sont comparés par rapport à des caractéristiques telles que : La pollution, la répartition sectorielle et la performance financière. Les émissions de carbone sont utilisées afin d'étudier les actions environnementales au niveau de la répartition sectorielle des fonds mutuels qui prétendent être ESG. La performance financière est analysée par rapport à la répartition sectorielle du portefeuille afin de déterminer des facteurs explicatifs potentiels du rendement et du risque. Au niveau des portefeuilles, les fonds mutuels ESG ont en général une exposition plus faible par rapport à la pollution. Le niveau moyen de pollution du portefeuille, quel que soit le type de fonds, est déterminé par deux secteurs principaux : Les services publics et l'énergie. Ces industries sont à l'origine des différences principales en termes de répartition d'actifs nets totale, de performance financière, et du risque entre les portefeuilles ESG et conventionnels. Cette analyse révèle que le désinvestissement au niveau des industries les plus polluantes, telles que les services publics et l'énergie, ne serait-ce que pour un faible pourcentage de l'allocation d'actifs nets totale, entraîne une diminution significative de la pollution totale du portefeuille.

Mots clés : Fonds mutuels, Fonds mutuels ESG, Finance durable, Investissement ESG, Pollution, Répartition sectorielle, Performance financière, Régression OLS, T-test, Modèles factoriels.

Abstract

This paper examines how the portfolio characteristics of self-declared ESG mutual funds compare to conventional mutual funds from 2006 to 2020. The objective is also to answer the questions of where performance comes from and whether ESG mutual funds are riskier than conventional mutual funds. Funds are compared on characteristics such as pollution, industry allocation, and financial performance. Carbon emissions are used to study actual environmental action in portfolio allocation of mutual funds that claim to be ESG. Financial performance is analyzed in relation to portfolio industry allocation to determine possible explanatory factors for returns and risk. At the portfolio level, ESG mutual funds have lower pollution exposure overall. Average portfolio pollution regardless of fund type is driven by two industries: utilities and energy. These industries account for the largest differences in total net asset allocation, financial performance, and riskiness between ESG and conventional portfolios. This analysis reveals that divestment of top polluting industries such as utilities and energy by even a small percentage of total net asset allocation results in significantly less total portfolio pollution.

Keywords: Mutual funds, ESG mutual funds, Sustainable finance, ESG investing, Pollution, Industry allocation, Financial performance, OLS regression, T-test, Factor models.

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1 Introduction

It has become increasingly mainstream for organizations to incorporate sustainable finance in their overall strategy, especially as climate risk becomes more prevalent. Sustainable finance is defined by investment decisions that consider environmental, social, and governance (ESG) factors of a financial activity. Environmental factors refer to the response to climate change and the conservation of nature which involves the use of sustainable resources. Social factors are related to the consideration of human rights and relationships as well as consumer protection. Governance factors refer to the standards for managing a company and economy and include the management and employee relations practices of organizations.

The launch of the Principles of Responsible Investment (PRI) in 2006 brought widespread attention to ESG issues in investment decisions. The PRI represents a network of investors supported by the United Nations that promotes responsible investment by taking ESG issues into consideration. The network provides resources to investors to adopt sustainable investment practices for better performance and risk management in order to contribute to a more sustainable global financial system, and ultimately for the environment and society as a whole (PRI, 2022). Another event that prompted wider adoption of sustainable finance practices was the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) in 2015. The agreement is an international treaty negotiated by 196 parties to address climate change mitigation with a goal to control the rise in average global temperature to below 2 degrees Celsius (UNFCCC, 2022). It aims to support countries in adapting to climate change effects, accumulating enough finance, and requiring countries to regularly report on its emissions contributions. Canada’s target is to transition to a low-carbon economy with net-zero emissions by 2050. The

United States has set a target for 2030 to reduce the country's greenhouse gas emissions by 50-52% from 2005 levels. Such targets demand substantial and long-term investment from both the public and private sectors.

The financial sector therefore plays an important role in funding and raising awareness on sustainability issues. There has been a growing trend in the mutual fund industry that involves using ESG criteria. In the United States, investments in funds using ESG data nearly doubled to over $40 trillion between 2016 and 2020 (Curtis, Fisch, and Robertson, 2021). The US mutual fund industry is the largest in the world, representing $23.9 trillion in total net assets as of the end of 2020, where 53% consisted of equity funds. Equity mutual funds had net outflows of $646 billion that year which were mainly from domestic equity funds (ICI, 2021).

Fund managers employ various long-term strategies to enhance performance and manage risk. For example, the COVID-19 pandemic in 2020 caused a significant decline in economic activity because of strict government mandates, leading to US stocks to drop by 35% in March 2020. The pandemic is one illustration of how an unprecedented global event can impact financial markets and why fund managers must be prepared with a defensible investment strategy. In the same fashion, sustainability issues such as climate change present growing risks for financial markets and require an action plan to reduce portfolio exposure to threats like climate risk. There has been increasing research related to ESG investments in recent years that have contributed to the academic literature on the roles of various economic actors in reducing greenhouse gas emissions. While many have investigated this issue at the governmental or firm level, few have considered institutional investors which are key economic agents that have influence in the financial sector. The number and size of ESG mutual funds have grown over the last two decades and with this growth comes both opportunities and potential concerns.

A common concern is greenwashing which is when self-declared ESG funds may falsely represent themselves as funds that incorporate ESG criteria in their investment strategy to attract investors or to be perceived as "doing good". The mutual fund industry has become strongly influenced by investor preferences for ESG investing, with total net asset flows into ESG funds having more than doubled from 2019 to 2020 (Curtis et al., 2021). With the lack of consistent data and standardized procedures for ESG reporting, it is difficult to evaluate the ESG-orientation of a fund and how it differs from traditional mutual funds.

This paper will discuss sustainable finance in the context of US domestic equity mutual funds to study the differences between ESG funds and conventional funds. The main objective is to determine how the characteristics of self-declared ESG mutual funds compare to conventional mutual funds. This study will compare the differences in the characteristics of mutual funds considering ESG factors in their portfolio allocations to those of traditional mutual funds. The results will provide new insights on ESG investments at the mutual fund portfolio level. The results will also answer the questions of where portfolio performance comes from and whether ESG investments are riskier.

In order to analyze the ESG characteristics of mutual funds in their portfolio allocations, this paper focuses only on the "E" factor to study funds' environmental impact using greenhouse gas (GHG) emissions. Emissions are a well-defined and meaningful metric used in studies by Jagannathan, Ravikumar, and Sammon (2018) and Humphrey and Li (2021) for similar reasons. The importance of emissions in contributing to climate change and its irreversible environmental damage has become a greater concern to society as a threat to human well-being and economic productivity. Along with changes in regulations and market responses, firms and investors have begun to develop strategies to address these changes. Since the mutual fund industry is an important player in financial markets, focusing on GHG emissions demonstrates the contribution of mutual funds in the fight against climate change.

Another reason for studying emissions is that it allows for the examination of actual environmental action in mutual funds that claim to be ESG. Emissions serve as quantifiable variable in assessing the environmental impact of mutual funds that deters the existing ambiguity surrounding ESG measurement that stems from the divergence in ESG ratings from rating agencies. This issue is investigated by Dimson, Marsh, and Staunton (2020), Kotsantonis and Serafeim (2019), and Berg, Koelbel, and Rigobon (2019), who each study the limitations of ESG data and the sources of disagreement among rating agencies. A main source of disagreement is the lack of regulation and consistency in ESG data measurement by companies and rating providers.

This paper characterizes US domestic equity mutual funds into two groups: ESG funds and conventional funds. ESG funds are identified using two methods – funds that are signatories of the PRI and funds that self-declare as ESG in their fund name. The analysis begins with a pollution analysis comparing the emissions that the different fund types are responsible for. It is followed by an industry analysis that compares the industry allocations of the fund portfolios, and finally a return analysis that assesses the risk and performance of the different fund types.

The rest of this paper is as follows. Section 2 includes a literature review of relevant studies. Section 3 presents the data used in this paper on mutual funds, emissions, and industry classification. Section 4 describes the methodology of the data coverage, pollution, industry, return, and risk analyses. Section 5 presents the results of these analyses and Section 6 is the conclusion.

2 Literature Review

The main objective of this paper is to determine the differences between the characteristics of mutual funds considering ESG factors in their portfolio allocations and those of conventional mutual funds. Such an analysis is based on the methods presented in the literature. There has been increasing research related to sustainable finance in recent years that investigates the implications of ESG consideration in investment strategies and the legitimacy of mutual funds that claim to be ESG. While many studies have investigated ESG investing, few have specifically studied it in the context of mutual funds.

One of the main studies that motivated the objective and methodology of this paper by Humphrey and Li (2021). The objective of their paper is to investigate whether mutual fund families that become PRI signatories purposefully decrease their portfolios exposure to GHG emissions. The reason for studying mutual fund families is to examine an important segment of financial markets and its role in the fight against climate change. Signing the PRI is taken as a proxy for pro-environmental action and emissions are used as a measure of such action in comparison to non-signatory fund families. Focusing on emissions reduction allows for the study of actual measurable environmental action rather than reported behavior or an ESG rating, which is facilitated by using quantitative data such as emissions. The authors test two hypotheses regarding which mechanisms contribute to a mutual fund family's reduction of portfolio emissions. The first hypothesis states that a main mechanism is a fund family's access to information and tools provided by the PRI, and the second states that another mechanism is the attitude of a fund family's stakeholders towards the environment. Their methodology consists of propensity score matching to create a control group of funds and calculate fund emissions. A univariate analysis is also conducted between the emissions of signatory and non-signatory funds, and economic implications are studied by calculating the change in fund flow to families that reduce emissions. The authors find that fund families that are PRI signatories have significantly lower portfolio emissions after signing compared to those who are not signatories. Their findings support both hypotheses in which this reduction of emissions occurs because of two mechanisms. They also find that fund families that sign the PRI and reduce emissions experience increased fund flow. This paper contributes to the literature on green finance and provides empirical evidence that there are funds which consciously reduce their portfolio exposure to GHG emissions.

Jagannathan, Ravikumar, and Sammon (2018) examine why ESG criteria should be considered by money managers in their investment decisions. Like Humphrey and Li (2021), the authors focus on the environmental pillar of ESG using carbon emissions, but they focus on the impact of commodities such as coal and palm oil on the environment and the consequent response of governments and consumers that can cause volatility in asset prices. These factors influence investor behavior because of the possibility of sudden changes in regulations and consumer preferences, and so firms would act accordingly in response to ESG-related issues. While Humphrey and Li (2021) find that emissions are reduced after funds become PRI signatories, Jagannathan et al. (2018) find that many firms voluntarily lower emissions even without impending regulations. This is explained by a firm's preparation for potential future regulations as well as a firm's corporate social responsibility regarding consumer demand. The authors find that incorporating ESG criteria is likely to be advantageous to investors since it signifies a proactive selection of holdings in firms that are well prepared to deal with such changes, which reduces a portfolio's exposure to potentially large downside risk. They argue that returns are not compromised when ESG criteria is considered in investment strategies and firms with high ESG ratings are more likely to outperform because of improved environmental practices and proactive risk management.

Nitsche and Schroder (2015) present a similar objective as Humphrey and Li (2021) in their study of whether socially responsible investment (SRI) mutual funds invest according to their ESG objectives. While Humphrey and Li (2021) identify such funds based on their membership to the PRI, Nitsche and Schroder (2015) identify SRI funds by filtering on relevant keywords in the fund names that would suggest ESG objectives in a fund's investment strategy. In addition, instead of applying a specific measure such as GHG emissions, the authors evaluate a fund's social responsibility by comparing SRI funds to conventional funds based on ESG corporate ratings from different rating agencies. Their results from the rating analysis and cross-sectional regressions demonstrate that SRI fund holdings have higher average ESG ratings than non-SRI funds and that the absolute rating differences between the funds are statistically significant. They conclude that SRI funds are not conventional funds in disguise and they invest in line with their ESG objectives since they place significantly greater weight on firms with a relatively high ESG rating. However, SRI funds may be taking a best-in-class approach by which they invest in the best-rated company of an industry that has poor sustainability characteristics. This gives motivation for studying the industry composition of fund portfolio holdings in order to address this limitation.

While ratings are a useful tool to assess a firm's ESG performance, they should not be treated as a black box. Dimson, Marsh, and Staunton (2020) address the issue of disagreement among different rating providers. Divergence in ESG ratings is caused by several reasons such as different methodologies and a lack of well-defined standardized ESG metrics. The authors find that there is low correlation when the E, S, and G pillars of each provider's ratings are taken separately. This finding motivates the reason for concentrating on one pillar and one that can be evaluated with a quantifiable metric in order to obtain more informative results when studying the effects of ESG screening. Similar to studies by Humphrey and Li (2021) and Nitsche and Schroder (2015), Dimson et al. (2020) include a comparison between ESG and conventional funds in their analysis in terms of fund performance. However, there is no evidence of ESG outperformance in the long run when compared to both conventional funds and index funds. In their analysis of investment opportunities related to climate change, the authors test the hypothesis that there is a reward for sustainable investing, or the existence of a "green factor premium". Unlike Jagannathan, Ravikumar, and Sammon (2018), they do not find enough evidence to conclude that a strategy focused on low-carbon investments is linked to more favorable returns. They conclude that more evidence is needed to determine that ESG screening increases expected return or decreases risk for long-term investments.

Concerning the inconsistencies across ESG rating providers, Kotsantonis and Serafeim (2019) provide explanations for the inconsistency and demonstrate other challenges in ESG measurement and data. Their methodology consists of analyzing the distribution of the performance of a group of companies in relation to an ESG metric as a normal distribution. They create a random sample of 50 Fortune 500 companies from various industries and gathered data on how they report Employee Health and Safety. The findings show over 20 different data reporting methods consisting of different terminology and units of measure. This represents one of the limitations in ESG data because it renders comparisons between companies more challenging and undermines the validity of certain metrics. These findings serve as an additional motivation for concentrating on emissions because there is little room for data inconsistency when using a well-defined metric that enhances comparability across companies and time. In addition to data inconsistency, Kotsantonis and Serafeim (2019) present data imputation as an important issue in ESG data that largely explains divergence across ratings. Data imputation consists of replacing missing data with substituted values which is necessary for rating providers because disclosure of ESG data tends to be much more limited in smaller firms, causing many “data gaps”. The authors argue that imputation has a direct effect on firm rankings on ESG metrics since there are various imputation approaches used among providers. Popular approaches described in the paper include a rules-based approach, an input-output model, and a statistical approach. The rules-based approach consists of creating ad hoc rules for a given ESG metric that are used to arbitrarily assess missing data. The input-output model is the approach used by Trucost and is based on relevant data at the industry and macroeconomic level that is inputted in an estimate of the environmental impact of a firm’s business activities. Lastly, the statistical approach imputes data over several iterations by conducting statistical analyses, such as regression methods and predictive mean matching, on each imputed dataset and then aggregating them into one set of estimates. The conclusions on data imputation motivate the investigation of company disclosure and data coverage in this thesis in order to better understand the emissions data retrieved from Trucost.

Berg, Koelbel, and Rigobon (2019) present an empirical study to address the divergence of ESG ratings much like Kotsantonis and Serafeim (2019). Their approach is different in that instead of studying inconsistencies in data and ESG measurement, they aim to explain rating divergence by focusing on rating methodologies. They create a framework to compare rating methodologies based on three components that constitute sources of divergence, namely scope, measurement, and weight. Scope divergence stems from ratings being based on different sets of attributes, such as carbon emissions and labor practices. Measurement divergence occurs because even if rating agencies use the same attribute, it may be measured using different indicators. Weight divergence is based on the different levels of relative importance that agencies assign to attributes. The authors find a low average correlation between ratings, suggesting that there is divergence among ratings and that the information provided by ratings is relatively noisy. The main source of rating inconsistency is measurement divergence, implying that there are considerations to be taken when using ratings in terms of what is measured and how. This supports the argument that Dimson et al. (2020) similarly provide evidence for in which ESG ratings should not be treated as a black box. Furthermore, Berg et al. (2019) determine the presence of potential bias in ratings caused by a rater effect that drives measurement divergence. The rater effect exists when a firm that receives a high score for one attribute is more likely to receive high scores in all other attributes from the same rating agency. One explanation for this effect is that the workload of agency analysts tends to be divided by firm instead of by attribute or category. Overall, rating divergence presents a challenge for empirical research by potentially compromising results depending on which rater is used because of disagreements about underlying data. This further supports the reasoning for using a well-defined and transparent attribute such as emissions to measure ESG performance.

Another way to analyze ESG performance of mutual funds is by studying the industry composition of their portfolios. In a paper released by MSCI on carbon footprinting, Frankel, Shakdwipee, and Nishikawa (2015) examine the application of carbon metrics to portfolio analysis in order to understand the investment implications of climate change. They conduct a market consultation with top asset owners and managers to collect feedback about the establishment of a carbon footprinting standard in the market. The consultation revealed that participants agree there is a need for standards on metrics and methodology and that carbon footprint is important but more analysis is needed. Results demonstrate that company-reported data is not fully reliable which supports the analysis of data coverage before additional analyses to obtain an understanding of the quality and reliability of the data under study. Similar to Humphrey and Li (2021), the authors calculate carbon footprint based on Scope 1 and 2 emissions as defined by the GHG protocol. Instead of comparing mutual funds, they focus on MSCI indexes that hold equity portfolios and compare a conventional index to a low carbon target index at the portfolio and company level. The indexes are compared on carbon emissions per million dollars invested, total carbon emissions, carbon intensity, and weighted average carbon intensity. Frankel et al. (2015) outline the strong and weak points of each metric and reveal that weighted average carbon intensity has the most strengths in terms of its applicability across asset classes, intuitive calculation, and its enablement of simple portfolio decomposition analysis. However, it does not capture investor responsibility and it is sensitive to outliers. The authors also use portfolio decomposition to examine sector weights and their contribution to carbon emissions. This sector analysis is based on the GICS industry classification as it was developed by MSCI and Standard & Poors, however this classification is not as suitable for the purposes of an analysis using emissions as Trucost's industry classification, for example, which classifies industries at a more granular level and thus represents emissions more accurately. The paper demonstrates that emissions are mainly driven by three main sectors – utilities, energy, and materials – and finds that funds just underweight the most polluting industries. The authors find that these three sectors represent less than 15% of total portfolio weight in market value, but over 80% of the overall carbon footprint.

Curtis, Fisch, and Robertson (2021) carry out a study on ESG mutual funds with the objective of addressing the concerns presented by academics and policymakers about ESG funds relative to the whole mutual fund market. The two main concerns are that ESG funds are not what they claim to be and that they are less performing than non-ESG funds. The authors' methodology to identify ESG funds involves two screening methods applied to equity mutual fund data retrieved from CRSP Mutual Fund Database. The first method filters on funds according to their names by identifying those that contain one or more relevant keywords. This list is manually verified to ensure that all funds have an ESG connotation, and then they exclude funds for which there is missing data. The second method is based on Morningstar's list of ESG funds according to a "Sustainability Rating". This rating represents a firm's ESG risk score that measures the degree to which firms in the portfolio are exposed to financial risks from ESG issues, and then these scores are calculated at the portfolio level. As opposed to using a measure such as carbon emissions, the authors evaluate portfolio composition by calculating a funds "ESG tilt", an asset-weighted average of the ESG ratings of the fund's portfolio holdings. The accuracy and reliability of ESG ratings is widely debated in the literature, such as in studies by Berg et al. (2019) and Kotsantonis and Serafeim (2019). Curtis et al. (2021) acknowledge this issue due to varying approaches of measuring ESG, but determine that the patterns are relatively stable across providers. This is based on their "ESG tilt" measure being calculated by aggregating data from four different rating providers to obtain the ESG rating of each company that the fund invests in and then weighting them based on the proportional share that the company represents of the fund's total portfolio. They find that ESG funds represent a significant "ESG tilt" and their holdings have higher ESG ratings than non-ESG portfolio holdings. In addition, Curtis et al. (2021) examine the potential costs incurred by investors through a regression analysis of fund fees and expense ratios as well as returns. They find no evidence that ESG funds are more expensive than comparable non-ESG funds, or that they offer less returns. Overall, they conclude that ESG funds deliver on their promise to invest with ESG considerations and they do so without increasing costs or decreasing returns.

Another paper that studies ESG investments is by Hoepner, Oikonomou, Sautner, Starks, & Zhou (2022) but they do so in relation to risk. The authors find that ESG engagement can reduce a firm's downside risk measured using value at risk and lower partial moments to capture negative return fluctuations. Their results show a reduction in the value at risk of 9% of the standard deviation in firms who increased their ESG engagement. They also find that it is most successful when environmental issues are addressed such as climate change. These findings relate to those presented by Jagannathan et al. (2018) who argue that a portfolios exposure to potentially large downside risk is lowered when ESG criteria is incorporated an investors selection of holdings. Hoepner et al. (2022) contribute to the discussion regarding the riskiness of ESG investments in comparison to traditional investments, and demonstrate that there is the opportunity to mitigate downside risk through an ESG investment strategy.

3 Data

To study the characteristics of ESG funds against conventional funds, ESG mutual funds are identified using two methods. The first is based on PRI signatories and the second is based on ESG fund names. The mutual fund data is then matched to Trucost data in order to retrieve environmental variables such as emissions data. The data coverage and disclosure of emissions data is also reviewed in this section. In addition, the data is categorized according to Trucost's industry classification system.

3.1 Fund identification methods

Mutual fund data is retrieved from the Center for Research in Security Prices (CRSP) Mutual Fund Database through Wharton Research Data Services (WRDS). US domestic equity mutual funds are examined and filtered according to the CRSP Style Code for Equity (E), Domestic (D), Cap-based (C), and Style (Y) funds. Equity domestic index and sector funds are excluded from the sample. CRSP funds are identified by a unique Fund Identifier and are aggregated to the portfolio level using the CRSP Fund-Portfolio map linking table containing the Portfolio Identifier and report date, which represents the period end date as reported. The data is further aggregated to the holdings level using the CRSP Portfolio Holdings table from which holding identifiers such as security name, the primary permanent identifier (PERMNO), CUSIP, and ticker are extracted, as well as the number of security's shares and the security's percentage of portfolio total net assets. The CRSP Monthly Stock File is used to obtain additional company information such as share price, shares outstanding, and monthly returns.

Data on the firms that mutual funds hold in their portfolios is also retrieved from Compustat which contains annual fundamental and market information on public firms in North America.

Identifying information extracted from the annual Fundamentals table include company name, global company key (GVKEY), CUSIP, ticker, fiscal year, and data date, which represents the annual close of the fiscal period. Balance sheet items are extracted including total long-term debt and total current liabilities. Following Doshi, Elkamhi, and Simutin (2015), portfolios with less than 10 holdings are considered outliers and are dropped from for all analyses because there is low coverage in portfolios with few holdings, which skews coverage results.

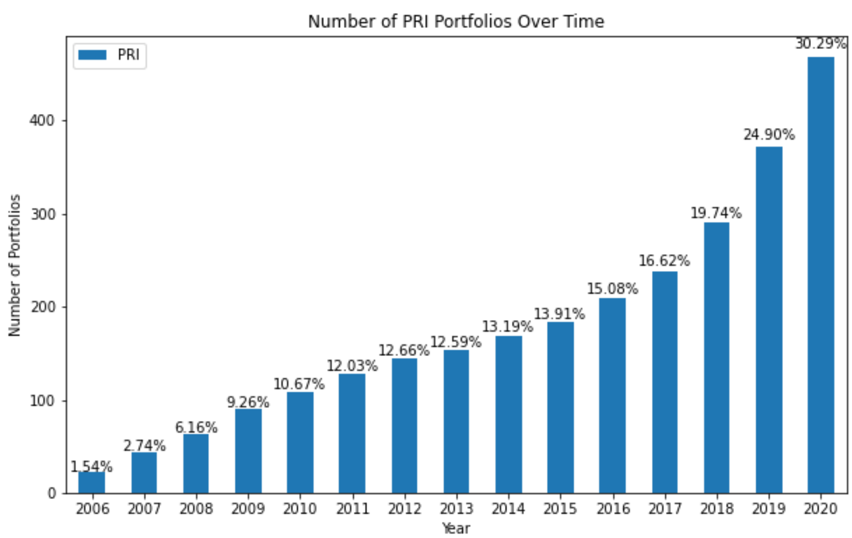
Among the US domestic equity funds, two methods are used to filter out those that are ESG. The first method to identify ESG funds is to take funds belonging to fund families that are signatories of the PRI. This strategy is used by Humphrey and Li (2021) who treat PRI membership as a proxy for pro-environmental action. The PRI is chosen as an ESG identification method because a fund that becomes a signatory must abide by minimum requirements in order to maintain their membership. Failure to meet these requirements within two years of signing results in the delisting of a fund from PRI membership. These requirements include mandatory annual reporting of responsible investment activities, responsible investment policy coverage of at least 50% of assets under management, and senior-level oversight of responsible investment policy. Requirements are put in place in order to ensure accountability of signatories over time, which supports the decision to use PRI membership as criteria for ESG fund identification (PRI, 2022).

A list of PRI signatories and their signature dates is obtained from the PRI website. PRI signatories are fund families and Ghoul and Karoui (2020) established that the management company name is a synonym for fund family name in their study on mutual fund flows, therefore the funds within these families are found by matching the family name obtained from the PRI signatory list to the management company name variable in the CRSP Mutual Fund Database. It is then with this mapping that data on portfolio holdings can be retrieved using the CRSP unique fund identifier (crsp_fundno) and portfolio identifier (crsp_portno). Signature dates are taken into account to compare fund GHG emissions to non-signatory funds, as well as to compare these funds before and after signing the PRI. The first signatories signed in 2006, so the sample period is 2006 to 2020. Figure 1 shows the number of PRI portfolios over time and the percentage of total portfolio net assets represented by PRI portfolios.

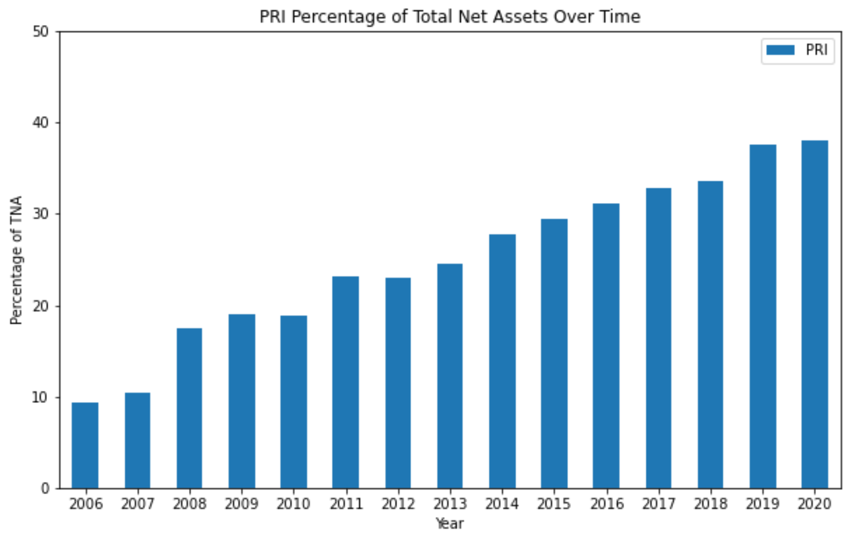
Figure 1: Number of PRI Fund Portfolios

This figure shows the number of fund portfolios in the sample of PRI signatory and non-signatory mutual funds over time. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. Panel A shows the number of PRI fund portfolios in the sample per year. The indicated percentages represent the fraction of all fund portfolios that are PRI signatories. Panel B shows the total net assets in millions of dollars that is represented by PRI fund portfolios. The indicated percentages represent the fraction of total net assets of all fund portfolios that are PRI signatories. The sample period is 2006 to 2020.

Panel A



Panel B

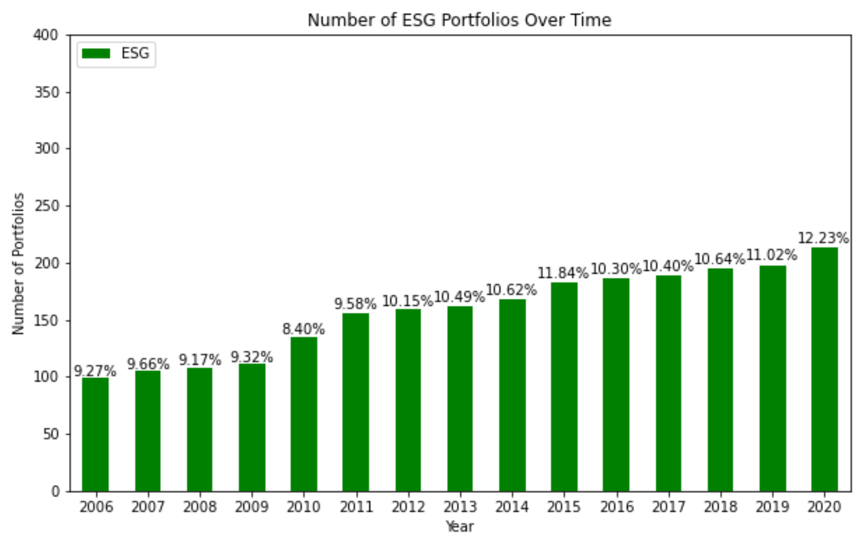


The second method is to identify self-declared ESG funds by using the fund names and filtering on those containing ESG keywords such as “ESG”, “SRI”, “sustainable”, “responsible”, and “green”. These funds are referred to as “ESG name” funds. This is a common identification method in the literature, used either as a primary or secondary method in studies by Nitsche and Schröder (2015), Curtis, Fisch and Robertson (2021), and Zytnick (2021). Relevant keywords are selected according to those used in the mentioned papers and according to the keywords in the fund names found in Morningstar’s ESG screener which filters investments by sustainability rating, low carbon designation, and sustainable investment by prospectus. The motivation for using this method in addition to the PRI method described above is mainly to compare results between different ESG identification criteria, but also because by 2020 there are many mutual funds that are PRI signatories, which leads to a smaller difference in pollution between PRI and non-PRI over time. This is demonstrated in Figure 10 in which the distributions of pollution per dollar in total net assets of PRI portfolios versus conventional portfolios become more similar over time as the means are closer by 2020. Figure 2 shows the number of ESG name portfolios over time and the percentage of total portfolio net assets represented by ESG name portfolios.

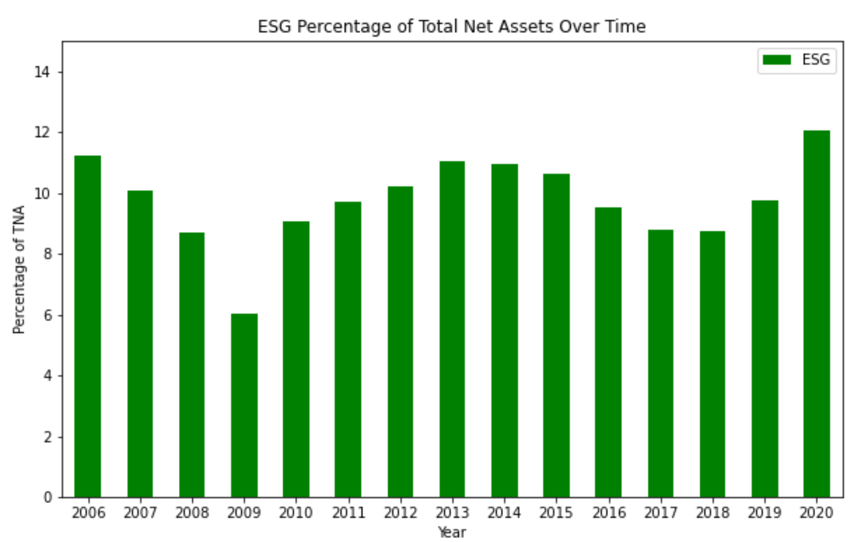
Figure 2: Number of ESG Name Fund Portfolios

This figure shows the number of fund portfolios in the sample of mutual funds over time. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that self-declare as ESG funds in their fund name and those that do not. Panel A shows the number of ESG name fund portfolios in the sample per year. The indicated percentages represent the fraction of all fund portfolios that belong to ESG name funds. Panel B shows the total net assets in millions of dollars that is represented by ESG name fund portfolios. The indicated percentages represent the fraction of total net assets of all fund portfolios that belong to ESG name funds. The sample period is 2006 to 2020.

Panel A



Panel B



3.2 Database matching

In order to obtain emissions data on the portfolio holdings of mutual funds, fund-level data from CRSP is matched to firm-level data from Compustat which is then used to match to emissions data from Trucost using each database's respective unique identifier. CRSP's primary permanent identifier at the company level is PERMNO and Compustat's unique identifier is GVKEY assigned to each company in the database. Both databases are matched on their secondary permanent identifier, which is CUSIP, and on fiscal year end date.

CRSP data is based on calendar dates while Compustat and Trucost data are based on fiscal period dates, so CRSPs date variable is converted to a fiscal period end date in order to ensure consistency and accurate mapping. CRSPs date variable is not end-of-month but instead the last trading day of each month, therefore an adjusted month-end date is created. The CRSP fiscal date is generated from the end-of-month calendar date according to Compustat's definition of fiscal year, which is as follows: one minus the current calendar year for companies whose last fiscal month for the period from January to May, and the fiscal year is the same as the calendar year for companies whose fiscal year end date between June and December. CRSP portfolio holdings data is then merged with Compustat using fiscal date to create a PERMNO-GVKEY link.

The GVKEY from Compustat-Capital IQ is used to create a link to the TCUID from Trucost, its unique company identifier. This link is created by matching both databases on ISIN, which is the common unique identifier, and fiscal year end dates in order to create a GVKEY-TCUID link. Using Compustat as an intermediary allows for a mapping between CRSP and Trucost so that emissions data is obtained for portfolio holdings. The PERMNO-GVKEY mapping is then merged with the GVKEY-TCUID mapping on GVKEY and fiscal year end date in order to obtain a dataset including the three unique identifiers for each company in each portfolio. Emissions data is retrieved from Trucost from 2005 to 2020 for all portfolio holdings. Since Trucost uses accounting year end, there is no need to convert the date variable and so the data is matched to the GVKEY-TCUID mapping on TCUID and fiscal date.

3.3 Emissions data

The Trucost data consists of Scope 1 and Scope 2 greenhouse gas emissions of each company as well as each firm's disclosure category. GHG emissions data is retrieved from the S&P Global Trucost database. Trucost's data covers a universe of more than 15,000 firms worldwide which represents approximately 99% of global market capitalization. In terms of historical coverage, data for about 3500 companies begins in the 2005 financial year and mainly consists of large cap developed market listed companies. In 2016, Trucost expanded its universe to 14,000 companies to include mid, small, and micro-cap companies in global, emerging, and frontier markets. Emissions data is available annually from 2005. Trucost's unique identifier is TCUID and is unique to each company in the database where each TCUID will have one value for each environmental variable for each financial year (Trucost, 2020).

Trucost's Scope 1 and 2 classifications of direct and indirect emissions are used. Scope 1 emissions are defined as GHG emissions originating from sources that are directly emitting and are owned or controlled by a firm – they derive directly from a firm's business activities. Scope 2 emissions are indirect emissions and are from the consumption of energy, such as purchased electricity or steam, that is generated upstream from a firm's direct operations (Trucost, 2020).

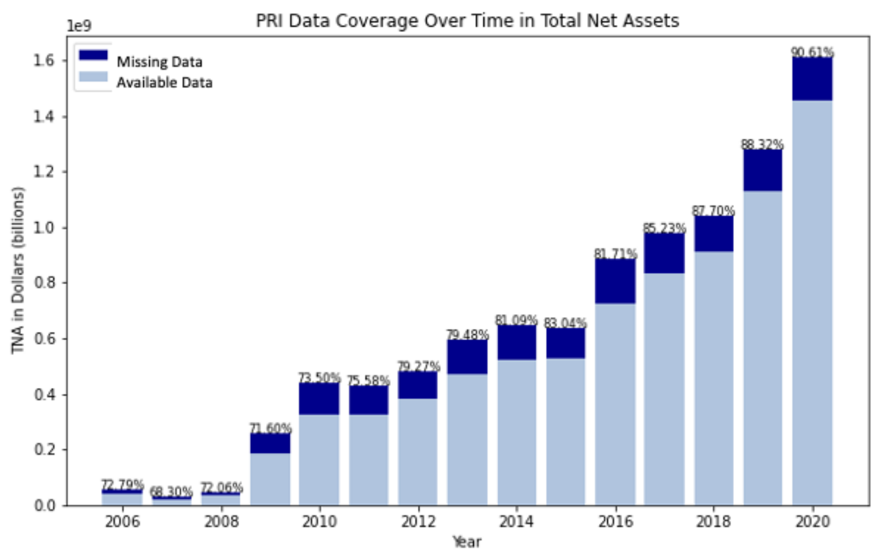
3.3.1 Disclosure

Disclosure data is also retrieved from Trucost and contains the various subcategories defined by Trucost for each of its main disclosure categories of full, partial, and no disclosure. As demonstrated by Kotsantonis and Serafeim (2019), there are challenges present in several aspects of ESG data. There is a lack of regulation and standardization in firm disclosure of ESG data, which leads to concerns about the data coverage of providers. To address these concerns, a variable is computed of the percentage of total net assets for which Scope 1 and 2 pollution data is available per year. Coverage is represented in terms of dollars to provide a quantifiable and comparable demonstration of available versus missing data. Figure 3 shows Trucost data coverage of fund portfolios over time in terms of total net assets from 2006 to 2020. Total net assets per year is calculated by summing portfolio total net assets of all portfolios per year. Total net assets for which there is data is calculated by computing an adjusted portfolio total net assets that excludes holdings with missing data and only accounts for holdings for which there is data.

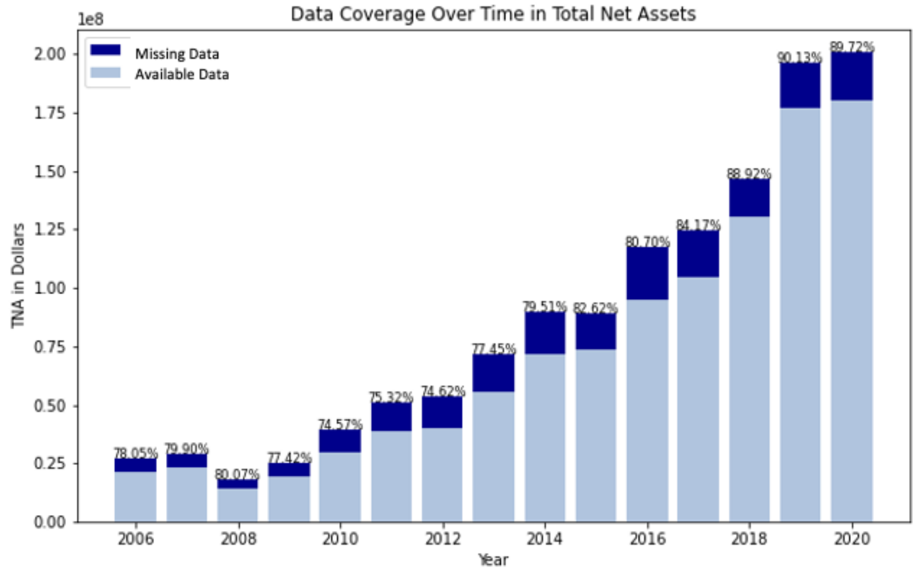
Figure 3: Data Coverage of Fund Portfolios in Total Net Assets

This figure shows data coverage of fund portfolios over time in terms of total net assets. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. Panel A shows the total net assets in millions of dollars for which Trucost data is available for PRI portfolios, compared to the total net assets of the portfolios. Panel B shows the average total net assets in millions of dollars for which Trucost pollution data is available for conventional non-PRI portfolios. The indicated percentages represent the fraction of total net assets for which data is covered. The sample period is 2006 to 2020.

Panel A



Panel B



Overall, coverage of fund portfolios increases over time. The percentage of coverage in total net assets of both PRI and non-PRI portfolios increase gradually over time. PRI portfolios have 91.75% coverage in 2020 while non-PRI conventional portfolios have a coverage of 91.22% in 2020. PRI portfolios generally have a higher coverage percentage per year than non-PRI portfolios. There is a jump in data in 2016 which is the year that Trucost expanded its universe beyond solely large cap firms.

While there has been an increase in the rate of disclosure of ESG data since 2005, there still exists the concern of data imputation that Kotsantonis and Serafeim (2019) consider as one of the main limitations in ESG data. A common imputation approach is the input-output model which is based on industry-specific data, macroeconomic level data, and an estimate of a firm's impact of its business activities. To demonstrate pollution data coverage on a more granular level, firms are categorized according to disclosure status in order to determine the fraction of Trucost data that is estimated versus reported.

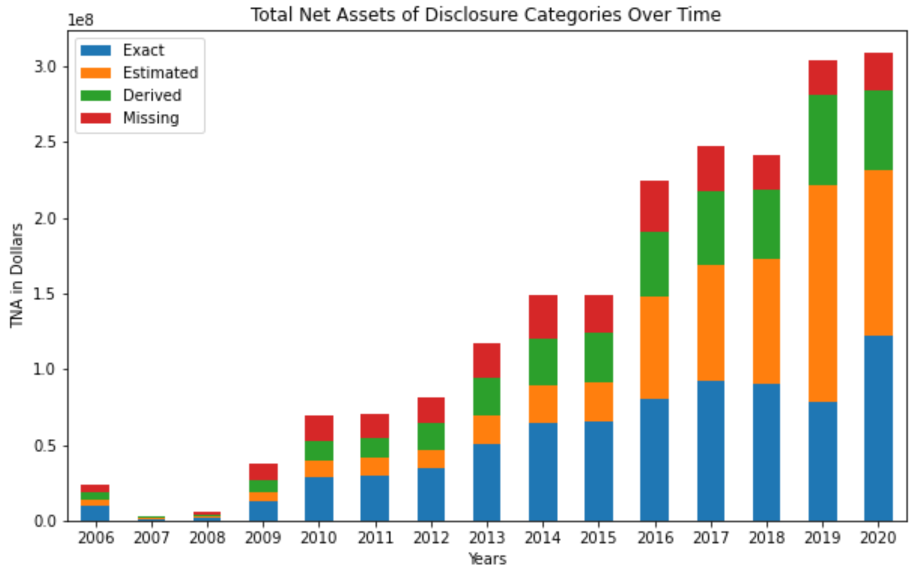
Trucost defines three main categories of disclosure status: full disclosure, partial disclosure, and no disclosure. Full disclosure signifies that the disclosed data exactly matches Trucost's criteria for inclusion and is available in firm annual reports, sustainability reports, the Carbon Disclosure Project (CDP), or the firm website. Partial disclosure means that the disclosed data is derived from firm disclosure but Trucost made additional standardizations to match their inclusion criteria. In the absence of disclosure, Trucost estimates data by using prior disclosure or its environmentally extended input-output (EEIO) model to estimate environmental impacts. The EEIO model uses data on industry-specific environmental impacts along with macroeconomic data on the flow of economic activity between different sectors in order to calculate environmental impact per million US dollars in revenue for each business activity (Trucost, 2020).

Figure 4 shows data coverage of fund portfolios over time by disclosure category in terms of percentage of total net assets. Trucost breaks down its disclosure categories into more specific subcategories so these were divided into the three main categories values according to keywords of "exact", "derived", and "estimated" (See Appendix A). Portfolio holdings are divided according to these three categories, in addition to a fourth category for missing data to account for companies for which Trucost does not have emissions data. Net assets are summed for each category to calculate each category's percentage of total net assets covered.

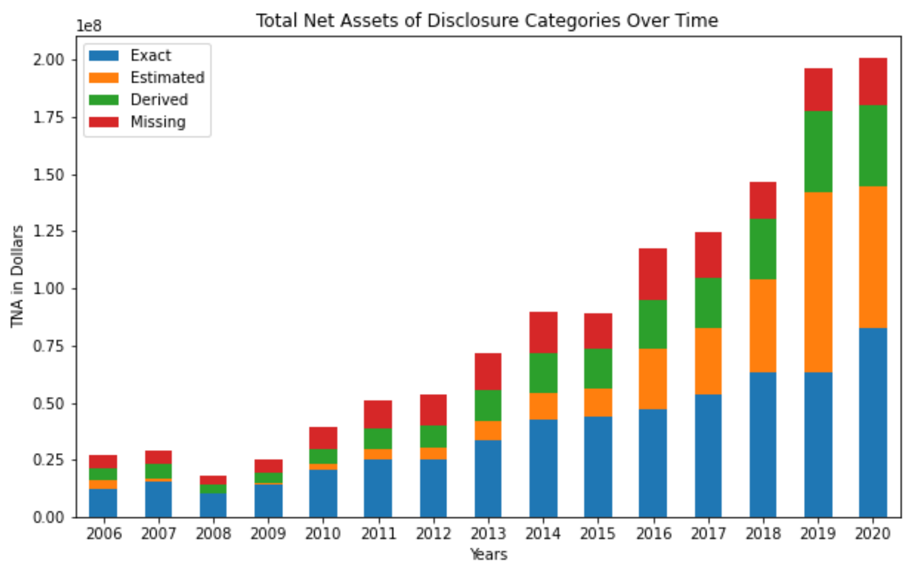
Figure 4: Data Coverage of Fund Portfolios by Disclosure Category

This figure shows data coverage of fund portfolios over time by disclosure category in terms of percentage of total net assets. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. Three main categories of disclosure status are defined by Trucost as the following: full disclosure (exact value), partial disclosure (derived value), and no disclosure (estimated value). A fourth category is added to include missing values. Panel A shows the percentage of total net assets represented by each disclosure category of PRI portfolios. Panel B shows the percentage of total net assets represented by each disclosure category of conventional non-PRI portfolios. The sample period is 2006 to 2020.

Panel A



Panel B



There is a trend of the amount of exact data (full disclosure) increasing gradually over time. Estimated data also increases, more significantly after 2016, because Trucost added more small stocks. This relates to Kotsantonis and Serafeim's (2019) finding that smaller firms tend to report less than larger firms, therefore there is a greater need to estimate data for these firms. Smaller cap firms historically have data coverage issues due to various reasons such as a lack of resources for adequate reporting. PRI and non-PRI portfolios generally demonstrate the same distribution in disclosure categories over time and there are no major differences.

Table 1 shows descriptive statistics on data coverage in terms of total net assets and by disclosure category. Portfolio total net assets represent the latest month-end total net assets at the portfolio level and are reported in millions of dollars. Covered total net assets represent the total net assets for which Trucost emissions data is available at the portfolio level and are reported in millions of dollars. Total coverage is the percentage of total net assets for which there is Trucost data. Coverage is broken down into three disclosure categories defined by Trucost as full disclosure (exact value), partial disclosure (derived value), and no disclosure (estimated value). A fourth category is added to include missing values. Each category in the table represents the percentage of total net assets for which there is exact data, estimated data, derived data, and missing data, respectively. Portfolio holdings are divided according to these categories and net assets are summed for each category to calculate each category's percentage of total net assets covered per year.

Table 1: Descriptive Statistics – Coverage in Total Net Assets

This table presents descriptive statistics on data coverage in terms of total net assets of PRI and non-PRI fund portfolios. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. Three main categories of disclosure status are defined by Trucost as the following: full disclosure (exact value), partial disclosure (derived value), and no disclosure (estimated value). A fourth category is added to include missing values. Panel A shows the data coverage of PRI funds in millions of total net assets and in percentage of total disclosure. Panel B shows the data coverage of conventional funds in millions of total net assets and in percentage of total disclosure. The sample period is 2006 to 2020.

Panel A: Data Coverage of PRI Funds

	Obs	Mean	Std Dev	Min	Median	Max
Portfolio TNA	1587	1.2812	3.0289	0.0480	1.5481	27.0569
Covered TNA	1587	1.1109	2.6699	0.0390	1.2658	2.4673
Total coverage	1587	0.8671	0.8815	0.8125	0.8176	0.9119
Exact data	623	0.3926	0.0498	0.2594	0.4042	0.4451
Estimated data	355	0.2236	0.1030	0.1284	0.1661	0.4690
Derived data	313	0.1970	0.0142	0.1712	0.1947	0.2179
Missing data	297	0.1869	0.0722	0.0751	0.1969	0.3124

Panel B: Data Coverage of Conventional Funds

	Obs	Mean	Std Dev	Min	Median	Max
Portfolio TNA	2176	7.5251	7.6864	0.0689	2.3999	197.9876
Covered TNA	2176	6.3008	6.6304	0.0541	2.0391	180.9360
Total coverage	2176	0.8373	0.8626	0.7253	0.8497	0.9139
Exact data	913	0.4197	0.0499	0.2951	0.4278	0.5115
Estimated data	396	0.1820	0.1091	0.0822	0.1400	0.4326
Derived data	401	0.1843	0.0170	0.1407	0.1869	0.2094
Missing data	466	0.2141	0.0624	0.0925	0.2313	0.2890

PRI fund portfolios have a mean total coverage rate of 86.71%, which is slightly higher than the total coverage of conventional non-PRI fund portfolios at 83.73%. PRI fund portfolios have a greater average percentage of total net assets for which data is estimated and derived, which refers to partial disclosure. Conventional fund portfolios have a greater average percentage of total net assets that is represented by both exact data and missing data.

3.4 Industry classification

An industry analysis is carried out to study the portfolio composition according to Trucost's industry classification system. Trucost defines business activities based on the North American Industrial Classification System (NAICS) and further breaks them down to a subsector level (See Appendix B). There are 464 business activities that are used to classify firms and to estimate the environmental impact of firms that lack environmental reporting. Trucost groups these business activities into 11 main industries.

While Fama and French (1997) industry classification is commonly used in the literature, this paper uses the system provided by Trucost because of its greater granularity regarding sectors such as utilities and energy. Fama and French create 48 industry groups based on the Standard Industrial Classification (SIC) system. CRSP and Compustat do not contain data on Fama-French industries, but both include company SICH codes that could be matched to a Fama-French industry. Using textual files that include a link between SIC codes and Fama-French industries retrieved from Kenneth French's website, each portfolio holding is matched to a Fama-French industry using its SICH code retrieved from Compustat. Each industry's average level of emissions is then calculated to determine the most polluting industries invested in by the mutual fund portfolios. However, Fama and French's system is not ideal from a pollution standpoint because green and brown firms are placed in the same group. For example, a coal power generator and a wind power generator are both categorized under utilities but their levels of pollution are notably different, so unlike Fama and French, Trucost further categorizes these companies at a more specific subsector level.

The variables studied in the industry analysis are defined as follows. Pollution is measured in greenhouse gas emissions in tonnes of carbon dioxide equivalent. Average pollution per industry is calculated by taking the average emissions of portfolio holdings in each industry over the sample period. Total net assets per industry is calculated by grouping portfolio holdings by industry and summing the amount of net assets represented by these holdings for each industry over the sample period. The percentage of total net assets invested per industry is then calculated by dividing industry total net assets by portfolio total net assets for each industry. Carbon intensity is another variable used to represent emissions in dollar terms. It is defined by Trucost as a metric that denominates GHG emissions by a normalizing factor that is a firm's annual consolidated revenues in millions of U.S. dollars. It is useful when comparing companies within and across different sectors on their carbon efficiency and environmental impact since it represents emissions relative to revenue.

4 Methodology

The methodological approach in this paper follows a multi-level analysis of mutual fund portfolio data that begins with an analysis of coverage of Trucost environmental data and a pollution analysis of portfolio emissions. This is followed by an industry analysis by sector and subsector according to Trucost's industry classification, a return analysis of portfolio performance over the sample period, and finally a risk analysis of portfolio risk measures and factor loadings.

4.1 Data coverage analysis

The first step of analysis is studying the data coverage of ESG data provided by Trucost. The motivation is that there is a lack of regulation, standardization, and consistency in company disclosure of ESG data. Low data coverage may introduce a systematic bias because of the finding that smaller firms tend to have lower coverage. An example of this bias would be present in estimating the SMB size factor in Fama-French's factor models as low coverage would eliminate positions of small firms. Analyzing data coverage of mutual funds therefore facilitates the comparison of different fund types by assuring that differences are not driven by low coverage.

Market value is used as a proxy for firm size. Fund portfolios are ranked per year in deciles according to the weighted average total market value of firms invested in by the portfolio. Total market value is calculated by adding the market value of equity and the book value of debt of the firm, where the market value of equity is calculated by multiplying the firms share price by its shares outstanding and the book value of debt is calculated by adding total long-term debt and total current liabilities. The tenth decile represents bigger firms with the highest market values and the first decile represents smaller firms with the lowest market values.

4.2 Pollution analysis

The second step of analysis is studying the pollution emitted by firms held in fund portfolios. The purpose is to compare how environmental ESG fund portfolios are compared to conventional portfolios and to determine the differences in average emissions between the fund types. Using pollution to measure the "E" factor of ESG is a useful approach in evaluating the actual environmental behavior of funds that claim to be ESG.

Pollution is represented by GHG emissions and measured in tonnes of carbon dioxide equivalent. The results are presented for the total of Scope 1 and 2 emissions. Humphrey and Li (2021) also use the sum of Scope 1 and 2 emissions since they find a very high correlation between each scope and total emissions. To obtain a preliminary insight on the environmental impact of the funds under study, average portfolio pollution is calculated by taking the weighted average of Scope 1 and Scope 2 emissions of all holdings in the portfolio, where the weights are the fractions of firm market value of equity held by the portfolio. A value-weighted average is computed in order to determine the amount of total firm pollution that the portfolio is responsible for. A value-weighted average is more realistic for mutual fund portfolios than an equal-weighted average because of differences in portfolio allocations, so a value-weighted average makes a variable such as portfolio pollution more representative and more comparable across different funds.

Another representation of portfolio pollution is to demonstrate pollution in dollar terms where emissions are represented relative to total net assets. A pollution-to-total net assets (TNA) ratio is calculated by dividing portfolio pollution by the portfolio adjusted net assets. The weighted average pollution-to-TNA ratio of all portfolios is then computed per year. This variable is comparable to the weighted average carbon intensity metric presented by Frankel, Shakdwipee, and Nishikawa (2015) used to measure the carbon intensity of equity portfolios. It is calculated by taking the sum of Scope 1 and 2 emissions, dividing it by company sales in millions of dollars, and calculating the weighted average by portfolio weight.

A pollution-to-book value ratio is calculated by dividing portfolio pollution by portfolio book value. Portfolio book value is defined as the fraction of firm book value held by the portfolio, which is calculated by multiplying firm book value per share at fiscal year-end by the number of shares held by the portfolio. A ratio of pollution per dollar in book value provides a more stable representation than a ratio of pollution per dollar in total net assets because total net assets fluctuate more drastically with volatile market movements, such as during the 2008 financial crisis. In this instance for example, a firm's pollution-to-TNA ratio can be overstated for that year in which total net assets were considerably lower due to the significant withdrawal of funds from the industry. Such firms, and consequently the portfolios that hold them, can therefore seem to be more polluting than they actually are.

An alternative representation of portfolio pollution is to visualize the distributions of pollution data with kernel density estimation. The main motivation is to better demonstrate how pollution distributions of PRI versus non-PRI funds become more similar by 2020. Using the Seaborn distributions module, KDE plots are constructed to smooth the data with a Gaussian kernel, which has the shape of a normal distribution curve, in order to produce a continuous density estimate. The purpose is to compare PRI portfolio pollution to conventional portfolio pollution in terms of how the data is distributed per year in order to study how similar they become over time. A KDE plot is chosen to visualize the data instead of histograms because it facilitates the interpretation and comparison of layered distributions of different data subsets. However, there are disadvantages in using KDE plots because of the assumption that the underlying distribution is smooth and unbounded. This assumption mainly affects the interpretation of the plot when there are datapoints that are close to the bound, such as a variable with small values that cannot be negative, which would cause the KDE curve to extend to unrealistic values at the extremes of the distribution. The methods to address this include dropping extreme outliers from the sample and using the "cut" parameter in the Seaborn displot function to indicate how far the curve should extend beyond the extreme observations.

In addition, density normalization is applied to the data. Since the two subsets of fund data have a different number of observations, their distributions are compared in terms of density instead of counts by normalizing the counts of each subset independently. Also, the distributions are created using the pollution-to-total net assets ratio as opposed to using absolute pollution levels because this variable avoids misrepresentation by scaling pollution relative to total net assets. This improves the comparison of different fund types each year regardless of fund size.

PRI portfolio pollution is further analyzed by comparing differences before and after signing the PRI. Consistent with Humphrey and Li (2021), the motivation is to determine whether there is an observable improvement in pollution levels of the portfolios that become PRI signatories. This is to establish whether these signatories demonstrate an actual change through their actions and not just in reported behavior. An event study is used to compare pollution and pollution-to-total net assets where the event at $t = 0$ is the signature date. A dummy variable is created to indicate whether data is reported before or after the signature date where 0 represents pre signing and 1 represents post signing. The event window is $t = -2$ to $t = 2$ to represent two years prior to signing and two years post signing the PRI. This is the same event window examined by Humphrey and Li (2021) in their study of emissions reduction of mutual fund signatories. They conduct robustness tests between one-year and two-year event windows to find that reducing emissions is a long-term strategy for signatories.

4.3 Industry analysis

The primary motivation for an industry analysis is that analyzing pollution in terms of the industries that these funds invest in is helpful in finding potential material differences between funds that claim to be ESG and those that do not. In addition, this analysis aims to determine which industries are the most polluting. Similarly, one of the methods that Frankel, Shakdwipee, and Nishikawa (2015) use in their attempt to understand a fund's carbon footprint is portfolio decomposition in which they examine sector weights and their contribution to carbon emissions.

Another factor that is analyzed is the portfolio industry composition in terms of dollars invested by the fund. The hypothesis to test is whether PRI funds simply divest from polluting industries. This is determined by computing the percentage of total net assets invested in each industry by the portfolios compared to the industry's average pollution

To determine if the differences in total net asset allocation of PRI funds versus non-PRI funds are statistically significant, independent t-tests are conducted on the means of both groups. To test the null hypothesis that the two means are equal, the p-value is compared to a 1%, 5%, and 10% significance level in order to determine if the null hypothesis qualifies to be rejected. If it is rejected, it signifies that the mean of PRI portfolio pollution is significantly different from the mean of non-PRI portfolio pollution. The test also produces a t-value for which higher values suggest that the groups are different while lower values suggest that the groups are similar.

A deeper industry analysis is performed in which the two most polluting industries – utilities and energy – are broken down to the subsector level. This is to more deeply analyze the pollution emitted by each of these industries, and to demonstrate differences in subsectors in industries such as utilities and energy which each consist of a varied distribution of pollution when looking at the subsector level. Other variables include carbon intensity and percentage of total net assets. Carbon intensity as defined by Trucost is useful in achieving a more relative comparison across subsectors and between the different fund types. It is measured in GHG emissions in tonnes of carbon dioxide equivalent (tCO_2e) per million dollars in revenue. The percentage of total net assets invested by each type of fund serves to provide an additional insight into the industry allocation of the fund portfolios under study and to determine if ESG funds simply divest from polluting industries. The percentage of total net assets invested per industry subsector is calculated by dividing subsector total net assets by portfolio total net assets for each industry.

4.4 Return analysis

A return analysis is conducted to assess portfolio performance and compare ESG portfolio returns to those of conventional portfolios. Jagannathan, Ravikumar, & Sammon (2018) conduct a similar analysis and argue that money managers who incorporate ESG considerations in their investment strategy can do so without sacrificing high returns. They find that using ESG criteria in their portfolio allocation is a way in which they can manage their exposure to potentially large downside risk. Return data is retrieved from the CRSP Monthly Stock File where the "*ret*" variable represents a stocks holding period return from the beginning of the month to the end of the month. Stock returns are used instead of the fund returns provided by CRSPs Mutual Fund database because these returns take into account non-equity positions, therefore using these fund returns would be inconsistent with the equity-based analyses of this paper.

Portfolio returns are then calculated by computing the monthly weighted average of the return on each portfolio holding (stock), where the weights are the fractions of firm market value of equity held in the portfolio. Humphrey and Li (2021) apply a similar method to calculate portfolio returns, where the calculation is based on the weighted average of fund returns and the weights are the net assets of each share class. Firm market value of equity is calculated by multiplying the firms share price by its shares outstanding. In addition, stock market performance is used as a benchmark in the comparison of portfolio returns. Stock market data is retrieved from Yahoo Finance. Daily returns of the S&P 500 and the Russell 2000 are calculated by taking the daily percentage change of adjusted closing prices of each index during the sample period. Daily returns are then resampled on a monthly basis to obtain average monthly cumulative returns. Two indices are included in the analysis: the S&P 500 as a large-cap benchmark and the Russell 2000 as a small-cap benchmark.

The portfolio return analysis by fund type is followed by an industry return analysis in order to determine what drives overall performance by finding possible explanatory factors for returns. This is ultimately the motivation for an industry analysis similar to Frankel, Shakdwipee, and Nishikawa (2015). Returns per industry are calculated by taking average monthly returns and creating a value-weighted industry portfolio per fund type. The motivation for using value-weights instead of equal weights is that a value-weighted average is more realistic for mutual funds because of the variation in industry portfolio allocations. The weights are calculated by dividing firm market value of equity held in the portfolio by industry market value of equity. Firm market value of equity is defined as the product of the firms share price by its shares outstanding. Industry market value is defined as the sum of firm market value of equity of all firms within an industry per portfolio. Industry returns are then calculated by applying the industry weights per firm to monthly stock returns and then computing a weighted average of returns per portfolio.

Ordinary least squares (OLS) regressions of monthly industry return differences on industry weight differences are performed as a method to find explanatory factors for portfolio performance. OLS regression is estimated using the Python "statsmodels" module function for

OLS regression. The dependent variable is industry return difference, measured by subtracting ESG industry portfolio returns from conventional industry portfolio returns. The independent variable is weight difference, measured by subtracting ESG portfolio industry allocation percentage from conventional portfolio industry allocation percentage. Industry allocation percentage is calculated using the sum of total net assets invested in each industry per portfolio by the portfolio total net assets. Performance further broken down by analyzing the most polluting and carbon-intense industries to determine the effect on fund performance of investing in or divesting of these most polluting industries. These industries have the largest differences in total net asset allocation between the fund types, therefore OLS regressions of monthly industry returns on industry weight are performed. This is to statistically determine whether investment differences in industry allocations can explain return differences among the three fund types.

The return analysis is also carried out on different breakdowns of PRI portfolios. The first breakdown is comparing performance pre and post signing the PRI. The same event study parameters are used as in the pollution analysis in Section 4.2. The second breakdown is to study the performance of early signatories versus late signatories. The motivation is for dividing PRI into different subgroups is that looking at the overall average of all PRI funds may not be an accurate representation. The point of reference in early versus late analysis is the 2015 Paris Agreement on climate change because this event triggered a more widespread adoption of the use of ESG criteria in investment decisions.

4.5 Risk analysis

A risk analysis is performed to further compare the returns of ESG and conventional fund portfolios. The main question is whether ESG investments are riskier than conventional investments, and if differences in industry allocation are related to portfolio riskiness. Some of the popular statistical measures of mutual fund risk include alpha, beta, R-squared, standard deviation, the Sharpe ratio, and value at risk. Instead of using alpha by its definition, a return difference is calculated between ESG and conventional portfolio returns. Similarly, instead of beta, a standard deviation difference is calculated between the fund types. These measures are computed based on average monthly industry portfolio returns for each fund type. For return difference, standard deviation difference, and R-squared, the standard benchmark against which the coefficients are estimated is an index such as S&P500 to act as a proxy for the market. Since the purpose of this analysis is to determine whether ESG mutual funds are riskier than conventional mutual funds, the benchmark is conventional portfolio returns. Accordingly, the risk measures are defined as the following.

Return difference is the excess return of ESG portfolio returns relative to conventional portfolio returns. A high return difference signifies that ESG portfolios outperformed conventional portfolio. Standard deviation difference represents the tendency of ESG portfolio returns to respond to movements in conventional returns. Assuming that conventional portfolio returns have a standard deviation difference of one, an ESG portfolio with a difference greater than one would indicate that it is more volatile than conventional portfolios. R-squared signifies the percentage of the variation of ESG portfolio returns that is explained by conventional portfolio returns. Return difference, standard deviation difference, and R-squared are estimated with linear least-squares regression analysis using the Python “scipy.stats” module function for linear regression.

Other risk measures include standard deviation, the Sharpe ratio, and value at risk. Standard deviation is calculated using the Python “numpy” module function for standard deviation. The Sharpe ratio is a measure of risk-adjusted performance where the risk-free rate is assumed to be zero for simplicity and since interest rates are commonly very low. According to modern portfolio theory by Markowitz (1952) who argued that an optimal return on investment can be achieved within an acceptable level of risk, these five measures are historical predictors of investment risk and help determine a fund's performance against a benchmark.

A sixth measure – value at risk – is a measure of an investment's risk of loss over a given time period at a given confidence level. The motivation for adding value at risk is based on a common finding in the literature that ESG investments have less downside risk. Jagannathan, Ravikumar, & Sammon (2018) find that portfolios exposure to large downside risk is reduced when investors incorporate ESG criteria in their selection of portfolio holdings. Hoepner, Oikonomou, Sautner, Starks, & Sautner (2022) present a similar finding about the reduction of downside risk in portfolio firms for which the value at risk decreases after shareholder engagement on ESG issues. A one-month VaR is calculated at a confidence level of 99% using the non-parametric method which derives the VaR from a distribution created using historical data. This method requires sorting monthly portfolio returns from smallest to largest (worst to best) and taking the 1% quantile of the total count using the Python "numpy" quantile function.

Fund performance is further compared using three factor models: the Fama-French 3-factor model, the Carhart 4-factor model, and the Fama-French 5-factor model. These models are used to measure mutual fund portfolio performance based on alphas estimated from regressions. Factor data is retrieved from French's data library on his faculty personal webpage on Dartmouth's Tuck MBA program website. The Fama-French 3-factor model measures three factors which are the market risk premium ($R_M – R_F$), the size of firms (SMB), and the value premium (HML). This model expands on the capital asset pricing model (CAPM) by adding size and value risk factors to the market risk factor in order to adjust for the outperformance of small-cap and value stocks.

Small-cap firms are riskier and tend to outperform large-cap firms. Value stocks with high book-to-market value are undervalued and tend to outperform growth stocks.

The 3-factor model regression equation is:

$$r_i - r_f = \alpha + \beta_i(r_M - r_f) + \beta_{SMB}SMB + \beta_{HML}HML + \epsilon_i$$

Where r is the total return of a portfolio i; r_f is the risk-free rate of return; r_M is the total market portfolio return; α is the 3-factor alpha; β is the market beta; β_{SMB} is the SMB factor coefficient; *SMB* is the size premium (Small Minus Big); β_{HML} is the HML factor coefficient; *HML* (High Minus Low) is the value premium; and e_i is the error term of the regression. The term i represents the different portfolios for each fund type at time t.

The Carhart model is an extension of the Fama and French 3-factor model and measures a fourth factor which is momentum (MOM). Momentum is defined as the speed in which stock prices change. This additional factor improves the explanatory power of the multifactor model by accounting for the performance of stocks that demonstrate positive average returns over its prior 12 months or more.

The 4-factor model regression equation is:

$$r_i - r_f = \alpha + \beta_i(r_M - r_f) + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{MOM}MOM + \epsilon_i$$

Where r is the total return of a portfolio i; r_f is the risk-free rate of return; r_M is the total market portfolio return; α is the 4-factor alpha; β is the market beta; β_{SMB} is the SMB factor coefficient; *SMB* is the size premium; β_{HML} is the HML factor coefficient; *HML* is the value premium; β_{MOM} is the MOM factor coefficient; MOM is the momentum factor; and e_i is the error term of the regression. The term i represents the different portfolios for each fund type at time t.

The Fama-French 5-factor model expands on the 3-factor model by incorporating two additional factors which are profitability (RMW) and investment (CMA) to account for the outperformance of stocks that report higher future earnings and stocks that invest conservatively in growth projects. The profitability factor suggests that firms with higher operating profitability and have better performance. The investment factor suggests that firms with higher total asset growth have less than average returns.

The 5-factor model regression is:

$$r_i - r_f = \alpha + \beta_i(r_M - r_f) + \beta_{SMB}SMB + \beta_{HML}HML + \beta_{RMW}RMW + \beta_{CMA}CMA + \epsilon_i$$

Where r is the total return of a portfolio i; r_f is the risk-free rate of return; r_M is the total market portfolio return; α is the t-factor alpha; β is the market beta; β_{SMB} is the SMB factor coefficient; *SMB* is the size premium; β_{HML} is the HML factor coefficient; *HML* is the value premium; β_{RMW} is the RMW factor coefficient; RMW is the profitability factor (Robust Minus Weak); β_{CMA} is the CMA factor coefficient; CMA is the investment factor (Conservative Minus Aggressive); and e_i is the error term of the regression. The term i represents the different portfolios for each fund type at time t.

The alpha of each model is estimated using an ordinary least squares (OLS) regression. The dependent variable is excess return, measured by subtracting the risk-free rate from the portfolio return. The independent variables are the risk factors. Statistical significance is measured using the p-value under the null hypothesis that alpha is equal to 0. The p-value is compared to a 1%, 5%, and 10% significance level.

5 Results

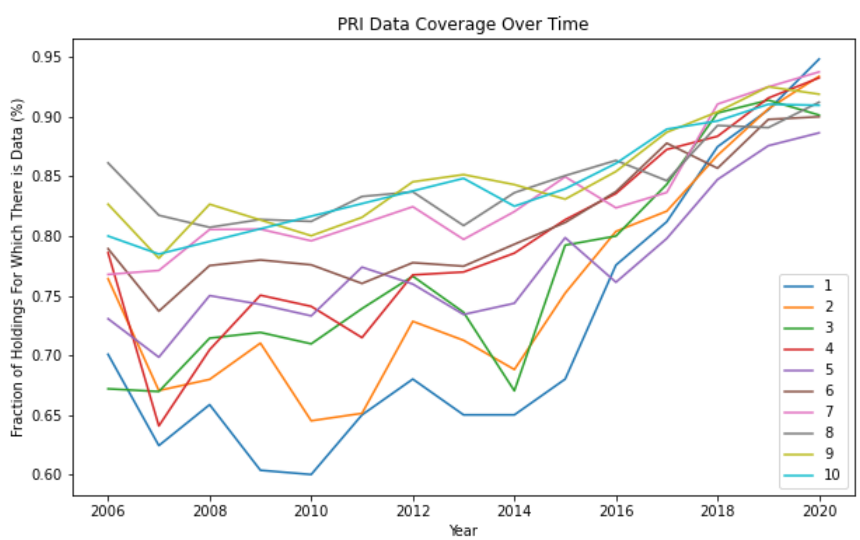
5.1 Data coverage analysis

To demonstrate that ESG disclosure is more limited in smaller cap firms, market value is used to analyze trends in data coverage over time in terms of firm size as shown in Figure 5. Fund portfolios are ranked per year in deciles according to the weighted average total market value of firms invested in by the portfolio, where total market value is the sum of the market value of equity and the book value of debt of the firm. The tenth decile represents bigger firms with the highest market values and the first decile represents smaller firms with the lowest market values.

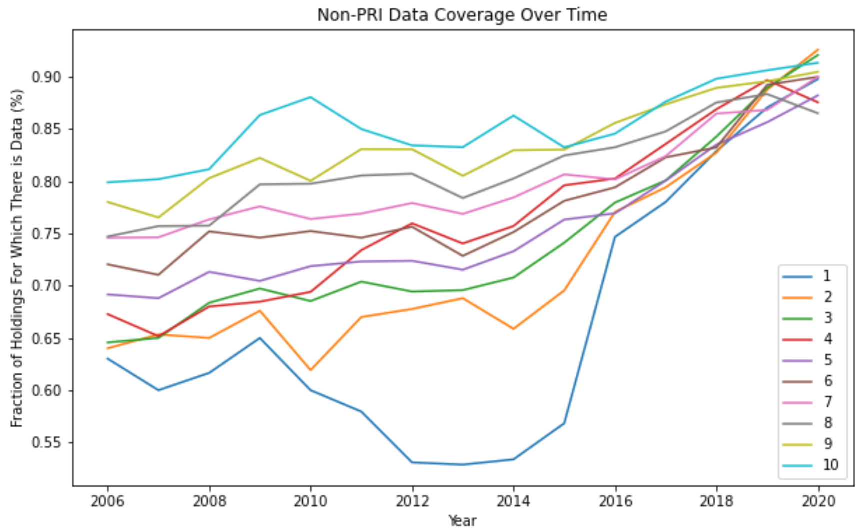
Figure 5: Data Coverage of Fund Portfolios by Deciles of Firm Market Value

This figure shows the trends in emissions data coverage of fund portfolios over time. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. Panel A shows the percentage of PRI fund portfolio holdings for which Trucost emissions data is available, ranked by the weighted average market value of firms invested by the fund. Panel B shows the percentage of conventional non-PRI fund portfolio holdings for which Trucost data is available. Decile 10 represents portfolios with the highest weighted average firm market value and Decile 1 represents portfolios with the lowest weighted average firm market value. The sample period is 2006 to 2020.

Panel A



Panel B



Overall, coverage tends increases over time. The portfolios with more volatile coverage are those in lower deciles, namely portfolios that invest in smaller stocks. Coverage of conventional non-PRI portfolios is less volatile than PRI portfolios, but both reach close to 95% coverage by 2020. This demonstrates that data coverage issues decrease over time and most companies are disclosing pollution data by 2020 regardless of their size.

Descriptive statistics on data coverage by decile of weighted average firm market value are found in Appendix C. For both types of funds, mean coverage over the sample period generally increases as the decile rank increases. This demonstrates that larger-cap firms have better data coverage than smaller-cap firms. Coverage per decile in PRI fund portfolios tends to be higher than in conventional fund portfolios, however they are relatively similar. The topmost decile of PRI portfolio holdings has an average coverage of 91.92% and that of conventional portfolio holdings has an average coverage of 89.41%. The bottommost decile of PRI portfolio holdings has an average coverage of 75.17% and that of conventional portfolio holdings has an average coverage of 75.88%.

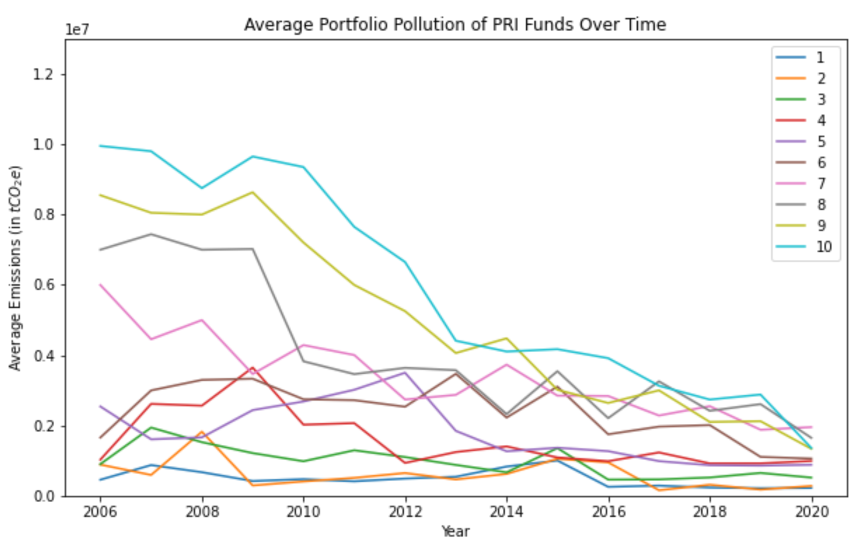
5.2 Pollution analysis

Pollution is represented by greenhouse gas emissions and measured in tonnes of carbon dioxide equivalent. Average portfolio pollution is defined as the weighted average of Scope 1 and Scope 2 emissions of all holdings in the portfolio, where the weights are the fractions of firm market value of equity held by the portfolio. A hypothesis regarding portfolio pollution is that portfolios that invest in larger firms are more polluting than those than invest in smaller firms. Firm market value is therefore used to represent firm size and test this assumption. As shown in Figure 6, fund portfolios are ranked per year in deciles according to the weighted average market value of firms invested in by the portfolio.

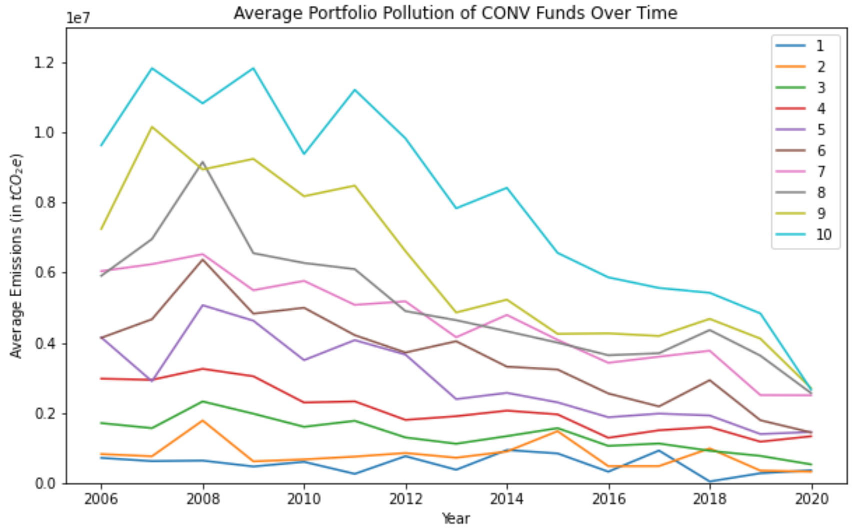
Figure 6: Average Pollution of Fund Portfolios by Deciles of Firm Market Value

This figure shows the value-weighted average pollution of fund portfolios over time. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. Panel A shows the average emissions of PRI fund portfolio holdings, ranked by the weighted average market value of firms invested by the fund. Panel B shows the average emissions of conventional non-PRI fund portfolio holdings. Decile 10 represents portfolios with the highest weighted average firm market value and Decile 1 represents portfolios with the lowest weighted average firm market value. The sample period is 2006 to 2020.

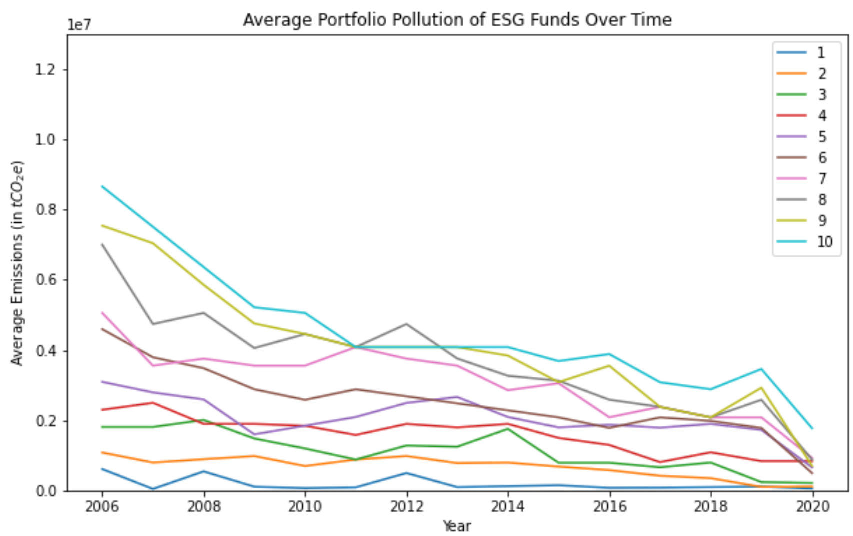
Panel A



Panel B



Panel C



Overall, average pollution tends to decrease over time for both types of funds. Larger firms, which are those in the tenth decile, have the highest pollution level in all fund type portfolios. The hypothesis is therefore accepted since the figure shows the trend that the higher the decile rank, the higher the average emissions produced. Average pollution is rather similar between both fund types, but the main difference can be seen in the tenth decile where conventional portfolios reach an emissions level of approximately 12 million tonnes of carbon dioxide equivalent while PRI ad ESG name portfolios remain under 10 million tonnes. This demonstrates that portfolios investing in larger firms are more polluting, and the difference between ESG and conventional portfolio pollution is mainly observed in the tenth decile of firm size.

Another representation of portfolio pollution is to demonstrate pollution in dollar terms. A pollution-to-total net assets (TNA) ratio is defined as portfolio pollution divided by portfolio adjusted net assets. The weighted average pollution-to-TNA ratio of all portfolios is then computed per year. The average pollution-to-TNA ratio of PRI portfolios in comparison to that of ESG name portfolios and conventional portfolios is shown in Appendix D. The pollution-to-total net assets ratio of the three fund types generally decreases over time, meaning fund portfolio managers are investing in companies that are less polluting. ESG name portfolios emit the least pollution per dollar invested of the three fund types over time, and demonstrates the most stable level since 2006, suggesting that they have lived up to their name since the beginning and have continued to do so. For all fund types, there are two main peaks around 2008 and again in 2012 explained by economic slowdowns in the US during which portfolio total net assets were significantly lower. By 2020, portfolio emissions are more similar amongst the three fund types.

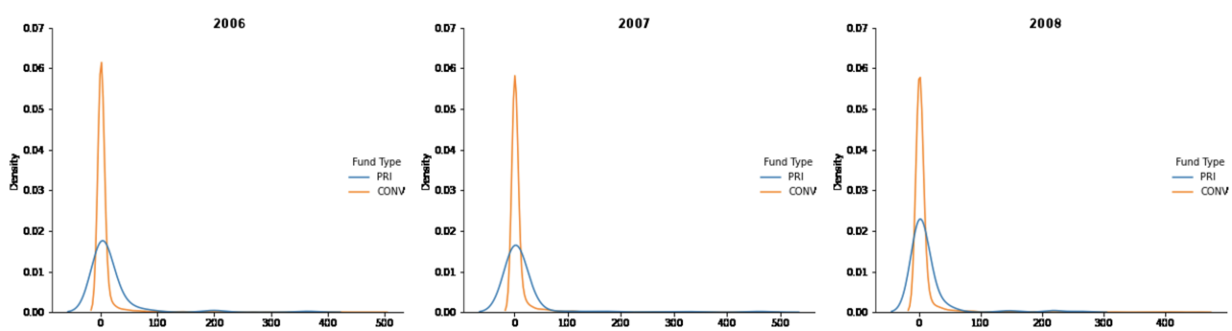
In addition, a pollution-to-book value ratio is calculated by dividing portfolio pollution by portfolio book value. Portfolio book value is defined as the fraction of firm book value held by the portfolio, which is defined as firm book value per share at fiscal year-end and the number of shares held by the portfolio (See Appendix D). The pollution-to-book value ratio is more stable over time as it is less impacted by financial crises, which would skew the data. This is because book value is more of a constant variable since it does not fluctuate as much as total net assets in response to volatile market movements. Conventional non-ESG portfolios have the highest emissions per dollar in book value, followed by ESG name portfolios and PRI portfolios.

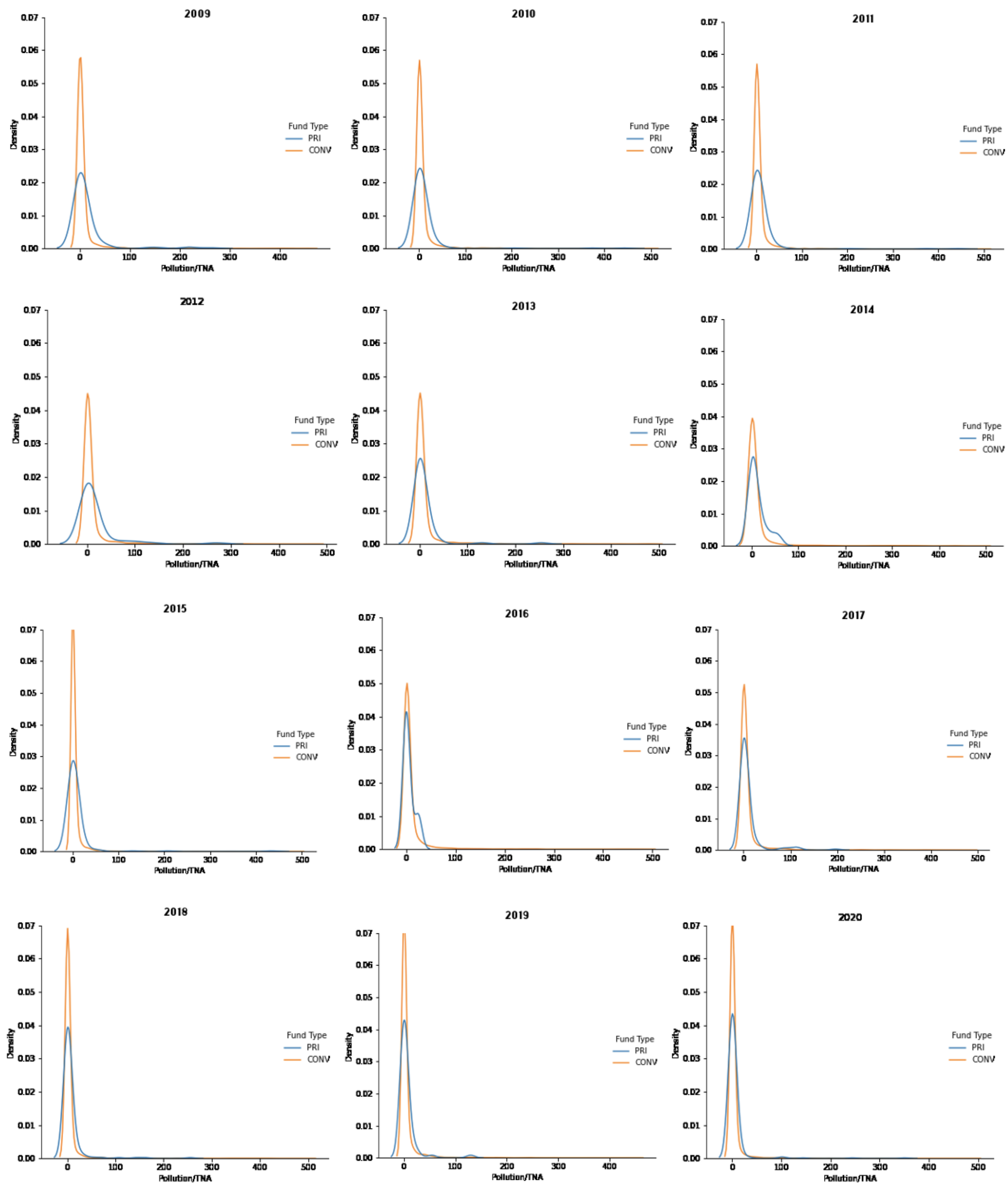
Appendix E shows descriptive statistics on total portfolio pollution and pollution relative to portfolio total net assets in millions. PRI fund portfolios emit less pollution than non-PRI fund portfolios on average over the sample period and have a lower pollution-to-TNA ratio. ESG fund portfolios emit significantly less absolute pollution than conventional fund portfolios on average over the sample period and have a lower pollution-to-TNA ratio. ESG funds also emit less pollution than PRI portfolios, making them the least polluting fund type in terms of emissions and pollution-to-TNA.

An alternative representation of portfolio pollution over time is to visualize the distributions of pollution data with kernel density estimation in order to facilitate the comparison of different fund types each year regardless of fund size. Figure 7 shows the distributions of portfolio pollution for PRI and conventional funds each year in terms of the pollution-to-total net assets ratio.

Figure 7: Portfolio Pollution Distributions Over Time

This figure shows the distribution of pollution per dollar in total net assets of fund portfolios over time by fund type. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are conventional non-PRI funds. PRI fund data is taken as of the PRI signature date. Pollution is represented by greenhouse gas (GHG) emissions in tonnes of carbon dioxide equivalent (tCO_2e). The distributions are constructed using kernel density estimation to compare the portfolio-to-total net assets ratio of PRI and conventional portfolios per year. The sample period is 2006 to 2020.





The distribution comparison of PRI portfolio pollution to that of conventional portfolios shows that portfolio emissions per dollar in total net assets is quite similar overall between the two fund types. In earlier years, the means are wider apart, suggesting that early PRI signatories starting from 2006 are responsible for less GHG emissions relative to their total net assets than conventional funds. Over time, their means become closer, demonstrating that PRI and non-PRI portfolio pollution is not that different by 2020. In addition, the PRI portfolio curve becomes larger which represents the increase in the number of funds that become PRI signatories each year. The increase in the conventional portfolio curve relative to the PRI curve in 2015 can be explained by an increase in the sample size due to Trucost's expansion of its universe of companies in that year.

The environmental impact of PRI portfolios can further be analyzed by examining the emissions produced pre-signing and post-signing the PRI. Table 2 presents descriptive statistics on PRI portfolio pollution over the sample period.

Table 2: Descriptive Statistics – Portfolio Pollution Pre and Post Signing the PRI

This table presents descriptive statistics on portfolio pollution of PRI funds prior to and post signing the PRI. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. For those that are signatories, pollution is compared prior to and post signing the PRI. Pollution is represented by greenhouse gas (GHG) emissions in millions of tonnes of carbon dioxide equivalent (tCO_2e). Pollution-to-TNA is the ratio of portfolio pollution per dollar in total net assets of the portfolio. The sample period is 2006 to 2020.

	Obs	Mean	Std Dev	Min	Median	Max
Pre Signing						
Emissions	390	200.4878	169.6793	0.13271	14.8448	1407.2810
Pollution/TNA	390	34.5009	188.0687	0.0098	0.9111	2818.7990
Post Signing						
Emissions	896	96.5186	318.7537	706.1589	37.3519	1872.4845
Pollution/TNA	896	21.1332	126.2612	0.0075	0.7878	1978.3305

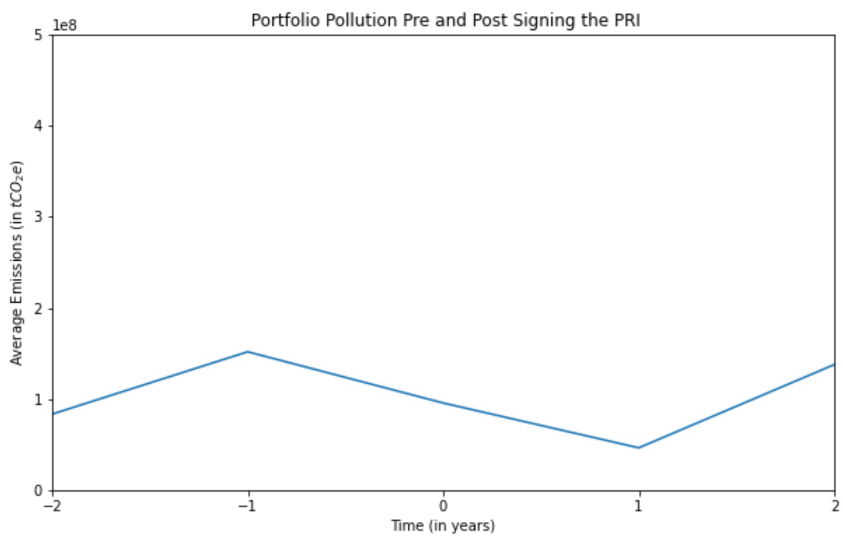
Humphrey and Li (2021) find that mutual fund families decrease their portfolios exposure to emissions after becoming signatories. The mean and median portfolio emissions are smaller post signing the PRI than prior to signing, as well as the minimum and maximum emissions values. The standard deviation is high, meaning there is high dispersion among PRI signatories. In terms of the pollution-to-TNA ratio, the mean is noticeably lower after signing the PRI compared to before signing. This suggest that after signing the PRI, these funds emit less pollution per dollar in total net assets as they seem to make an effort to hold less polluting firms in their portfolios.

An event study is used to compare pollution and pollution-to-total net assets where the event at t = 0 is the signature date. The event window is t = -2 to t = 2 to represent two years prior to signing and two years post signing the PRI. Figure 8 shows PRI portfolio pollution within an event window of two years.

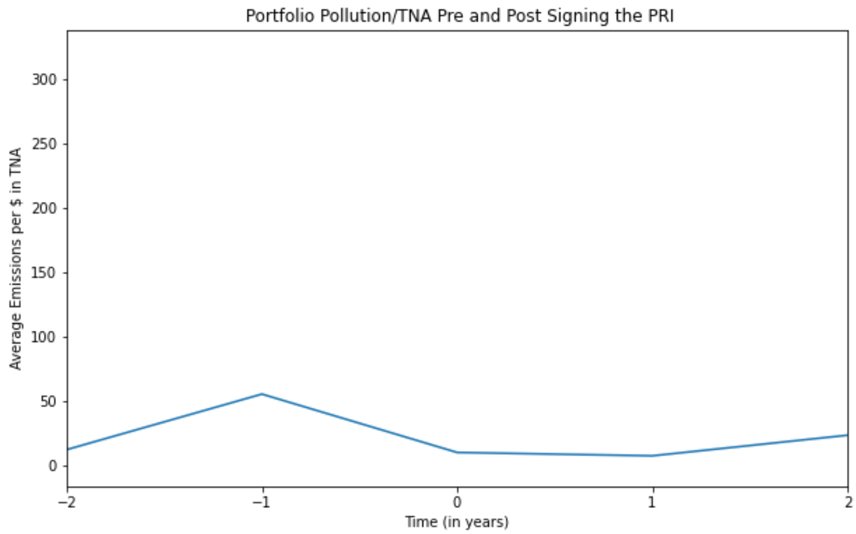
Figure 8: Portfolio Pollution Pre and Post Signing the PRI

This figure shows the trends in portfolio pollution of PRI funds prior to and post signing the PRI over time. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. For those that are signatories, pollution is compared prior to and post signing the PRI using an event study where the event at t = 0 is the signature date. Panel A shows the average emissions of PRI fund portfolio holdings prior to and post signing. Panel B shows the average pollution-to-total net assets ratio of PRI fund portfolio holdings prior to and post signing the PRI. The sample period is 2006 to 2020.

Panel A



Panel B



Average portfolio pollution declines one year before signing the PRI but increases two years after to pre-PRI levels. As for portfolio pollution-to-TNA, there is a noticeable decline one year prior to signing and this level remains relatively stable two years after signing. This implies that there is some change in portfolio investment strategy to hold less-polluting firms but this behavior seems to be more consistent in terms of pollution per dollar in total net assets.

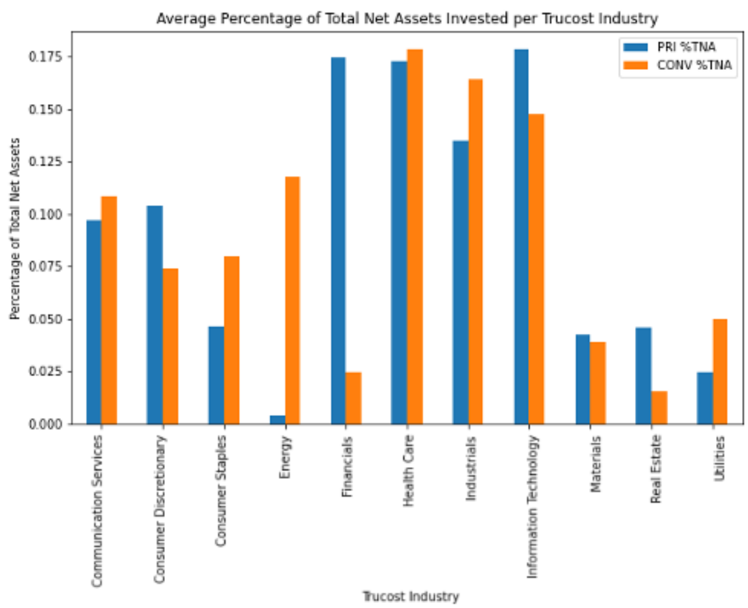
5.3 Industry analysis

The industry analysis compares the average pollution produced by ESG versus conventional funds to determine their differences as well as which industries are the most polluting. Figure 9 shows the average pollution of each Trucost industry invested in by the fund portfolios in the sample in Panel A and the percentage of total net assets invested in each industry by the portfolios in Panel B.

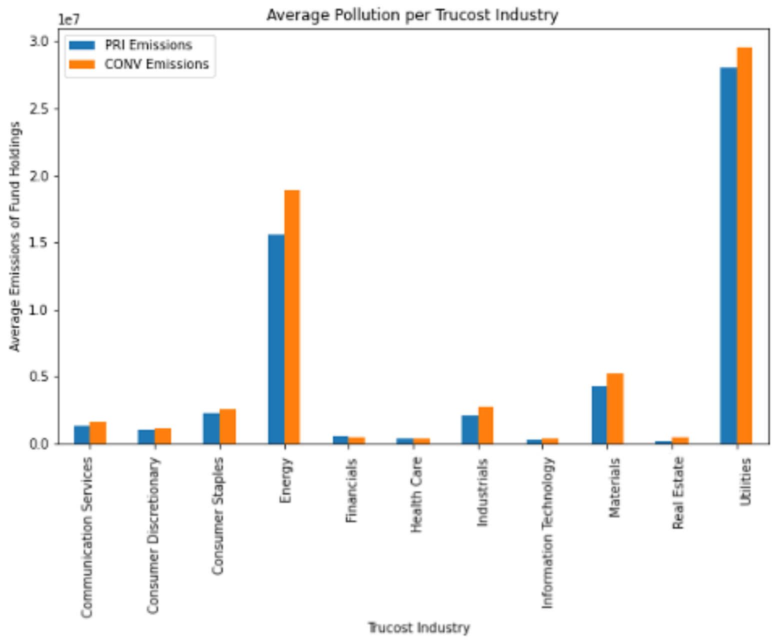
Figure 9: Average Pollution versus Percentage of Portfolio Total Net Assets per Industry

This figure shows the average pollution of each Trucost industry invested in by the mutual funds under study compared to its percentage of portfolio total net assets. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. Pollution is represented by greenhouse gas (GHG) emissions in tonnes of carbon dioxide equivalent (tCO_2e). The industries used are according to Trucost's classification of business activities. Panel A shows the average percentage of total net assets invested per industry of PRI fund portfolios compared to non-PRI fund portfolios. Panel B shows the average pollution per industry of PRI fund portfolios compared to non-PRI fund portfolios. The sample period is 2006 to 2020.

Panel A



Panel B



PRI portfolio holdings are similar in pollution to non-PRI portfolio holdings overall but non-PRI holdings are consistently more polluting. The most polluting industries are utilities and energy and are significantly more polluting than other industries. Materials is the third most polluting industry. These results demonstrate that regardless of the type of fund, average portfolio pollution is largely driven by three industries.

PRI fund portfolios allocate the largest percentage of total net assets to the financials, health care, information technology industries. These are also three of the lowest polluting industries. The smallest percentage of total net assets of PRI fund portfolios is invested in the most polluting industries, which are utilities and energy. This could indicate that these funds simply divest from polluting industries overall. While PRI funds hold one of the lowest percentages of total net assets in the energy industry, this industry represents the fourth largest percentage of total net assets for non-PRI funds. This shows that if funds invest less in polluting industries such as utilities by even a small amount, it results in significantly less portfolio pollution given that there are not many other differences in industry allocation between both fund types. Despite the use of a different industry classification system, this is a similar finding as Frankel, Shakdwipee, and Nishikawa (2015).

The same analysis is conducted for ESG name portfolios and are compared to conventional fund portfolios (See Appendix F). The most polluting industries are utilities, energy, and materials, and are significantly more polluting than other industries. The results for ESG name portfolios holdings are similar to the comparison between PRI and non-PRI portfolios, suggesting that PRI signatory funds behave similarly to ESG name funds at the industry level. ESG name fund portfolios allocate the largest percentage of total net assets to the information technology, health care, financials, and industrials industries. These are also among the lowest polluting industries except industrials. The smallest percentage of total net assets of ESG name fund portfolios is invested in the most polluting industry which is utilities. The results are similar to PRI portfolios which shows that both ESG fund types demonstrate an effort to reduce their portfolio exposure to pollution.

To determine if the differences in total net asset allocation of PRI funds versus non-PRI funds are statistically significant, t-tests are conducted on the means of both groups. Table 3 shows the results of the t-tests.

Table 3: Differences in Percentage of Total Net Assets Invested in Each Industry

This table presents a comparison of the percentage of total net assets invested in each Trucost industry by PRI and conventional non-PRI fund portfolios. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. "Mean %TNA" is defined as the percentage of portfolio total net assets invested in each industry. The industries used are according to Trucost's classification of business activities. "Difference" represents the difference in percentage of total net assets between PRI and non-PRI fund portfolios. Significance is tested using *t* tests and *t* statistics are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The sample period is 2006 to 2020.

Industry	CONV Mean %TNA	PRI Mean %TNA	Difference
Communication Services	0.1085	0.0971	0.0113
			(0.5750)
Consumer Discretionary	0.0741	0.1039	-0.0298
			(-1.6149)
Consumer Staples	0.0801	0.0465	0.0336***
			(3.3451)
Energy	0.1177	0.0043	0.1134***
			(3.8021)
Financials	0.0245	0.1748	-0.1504***
			(-8.5471)
Health Care	0.1784	0.1729	0.0054
			(0.3187)
Industrials	0.1645	0.1349	0.0296**
			(2.0804)
Information Technology	0.1475	0.1784	-0.0309
			(-1.4935)
Materials	0.0393	0.0423	-0.003
			(-0.4207)
Real Estate	0.0155	0.0458	-0.0303***
			(-4.5586)
Utilities	0.0500	0.0246	0.0253***
			(4.1845)

PRI portfolios invest a smaller average fraction of their total net assets than conventional portfolios in polluting industries such as energy and utilities. The industry with the largest difference in percentage invested is energy and is statistically significant at the 1% confidence level. This could suggest that there is some effort by PRI funds to divest from more polluting industries. Differences are statistically significant in consumer staples, energy, financials, real estate, and utilities, indicating the percentage of total net assets of the two fund groups are different.

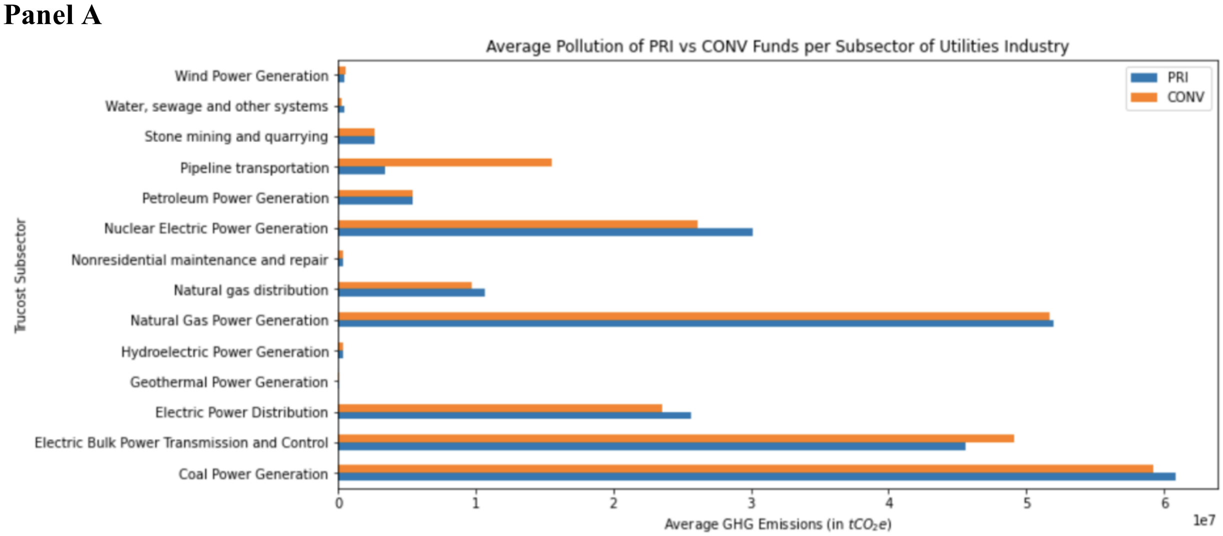
The same analysis is carried out for ESG name portfolios and are compared to conventional fund portfolios (See Appendix G). Comparable to the results for PRI, ESG name portfolios invest less in polluting industries than conventional portfolios on average, namely energy and utilities. Energy is the industry with the largest positive difference in percentage invested between the two fund types at 6.39% and is statistically significant at the 1% confidence level. This suggests a divestment strategy in ESG name portfolios from highly polluting industries. There are other large differences in industries such as communication services, financials, and industrials, all of which are statistically significant at the 1% confidence level. It can be concluded that the percentage of total net assets between the two fund types are different.

The two most polluting industries – utilities and energy – are broken down to the subsector level in order to have a better representation of portfolio pollution drivers. Figure 10 shows the average absolute pollution of the utilities and energy industries in PRI funds compared to non-PRI funds.

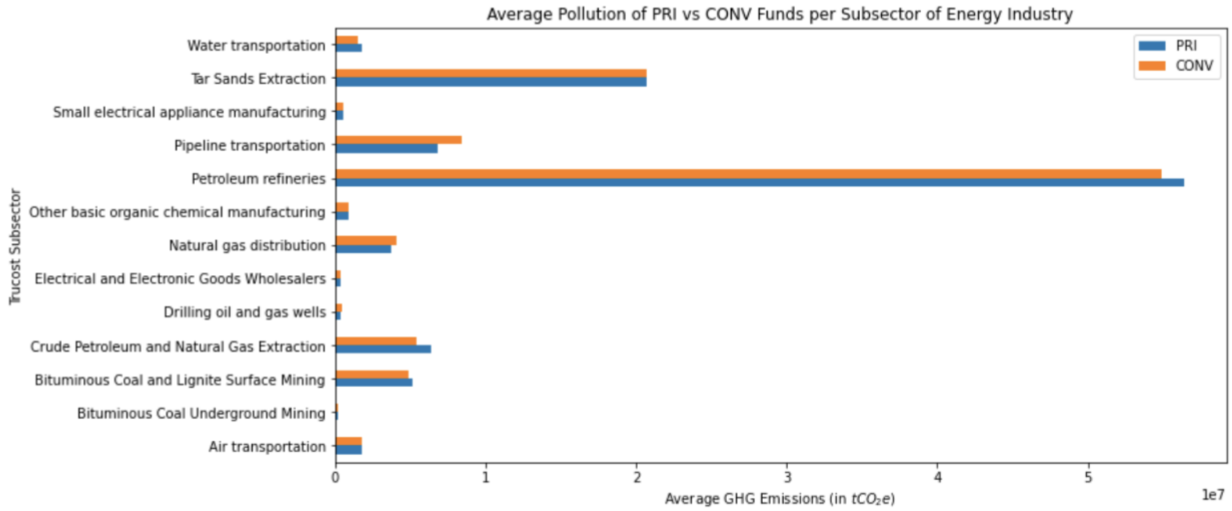
Figure 10: Average Pollution of Utilities and Energy Industries

This figure shows the average pollution of the Trucost subsectors of the utilities and energy industries. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. Pollution is represented by greenhouse gas (GHG) emissions in tonnes of carbon dioxide equivalent (tCO_2e). The industries used are according to Trucost's classification of business activities. Panel A shows the average pollution per subsector of the utilities industry for PRI fund portfolios compared to conventional non-PRI fund portfolios. Panel B shows the average pollution per subsector of the energy industry for PRI fund portfolios compared to conventional non-PRI fund portfolios. The sample period is 2006 to 2020.

Panel A



Panel B



For the utilities industry, coal power generation is the most polluting subsector, followed by natural gas power generation. Sectors such as wind power generation and geothermal power generation are significantly less polluting. For the energy industry, the petroleum refineries subsector is much more significantly polluting than other energy subsectors. The next most polluting sector is tar sands extraction, which is less than half the pollution of petroleum refineries. This demonstrates the importance of Trucost's more granular industry classification because a few very polluting subsectors can misrepresent results by accounting for most of the average total pollution of the industry. PRI portfolios holdings are similar in pollution to non-PRI portfolio holdings overall.

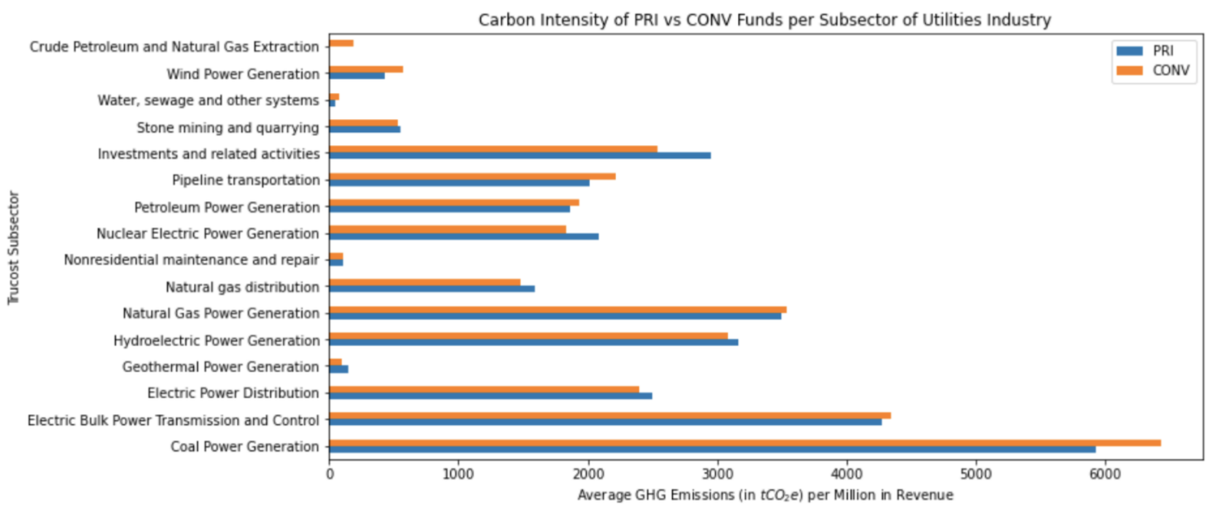
The same analysis is conducted for ESG name portfolios and are compared to conventional fund portfolios (See Appendix H). Overall, ESG name portfolios holdings are similar in pollution to conventional portfolio holdings. For the utilities industry, the most polluting subsectors are pipeline transportation, coal power generation, gas power generation, and electric bulk transmission and control. For the energy industry, the petroleum refineries subsector is much more significantly polluting than other energy subsectors.

The most polluting industries can also be studied by comparing subsector carbon intensity. Figure 11 presents the average carbon intensity of the utilities and energy industries in PRI funds compared to non-PRI funds.

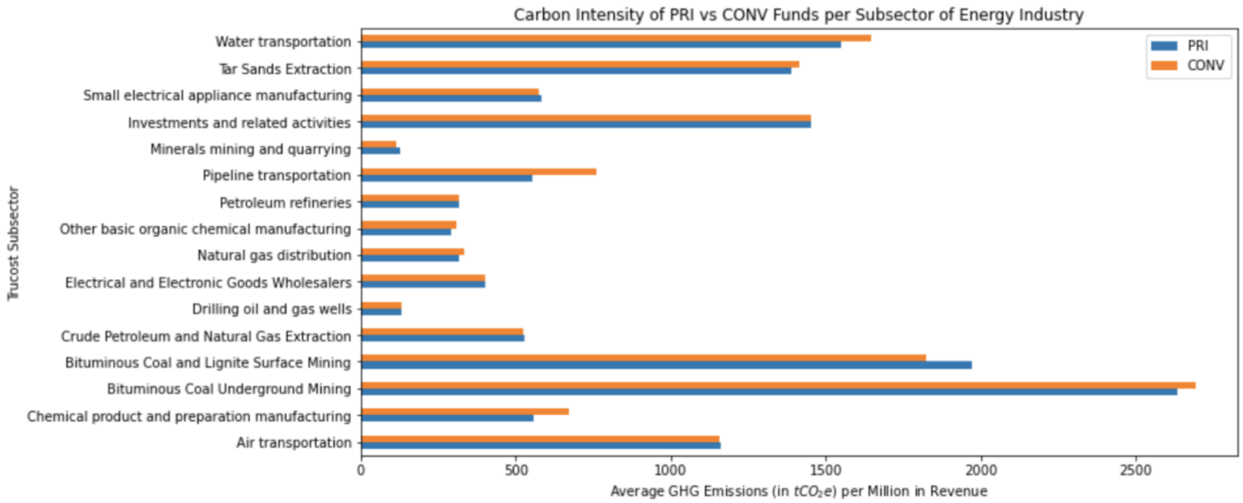
Figure 11: Average Carbon Intensity of Utilities and Energy Industries

This figure shows the average carbon intensity of portfolio holdings in the Trucost subsectors of the utilities and energy industries. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. Carbon intensity is represented by greenhouse gas (GHG) emissions in tonnes of carbon dioxide equivalent (tCO_2e) per million dollars in revenue. The industries used are according to Trucost's classification of business activities. Panel A shows the average carbon intensity of portfolio holdings per subsector of the utilities industry for PRI fund portfolios compared to conventional non-PRI fund portfolios. Panel B shows the average carbon intensity of portfolio holdings per subsector of the energy industry for PRI fund portfolios compared to conventional non-PRI fund portfolios. The sample period is 2006 to 2020.

Panel A



Panel B



For the utilities industry, the subsector with the highest carbon intensity is coal power generation for both PRI and non-PRI funds, which also has the highest absolute pollution. For the energy industry, the subsectors with the highest carbon intensity for both PRI and non-PRI funds are bituminous coal surface mining, bituminous coal underground mining, water transportation, and tar sands extraction. While bituminous coal underground mining does not have the highest absolute pollution, it does have the highest carbon intensity, which demonstrates the importance of evaluating carbon efficiency using a control variable such as carbon intensity. PRI funds carbon intensity also tends to be lower than non-PRI funds for these top carbon intensive sectors, but overall carbon intensity is similar between both types of funds.

The same analysis is conducted for ESG name portfolios and are compared to conventional fund portfolios (See Appendix I). For the utilities industry, the subsector with the highest carbon intensity is pipeline transportation for ESG name funds, followed by coal power generation for both types of funds. For the energy industry, the subsectors with the highest carbon intensity for both ESG and conventional funds are bituminous coal underground mining, water transportation, and securities and commodity contracts securities and related activities. Conventional funds carbon intensity also tends to be higher than ESG name funds for these top carbon intensive sectors.

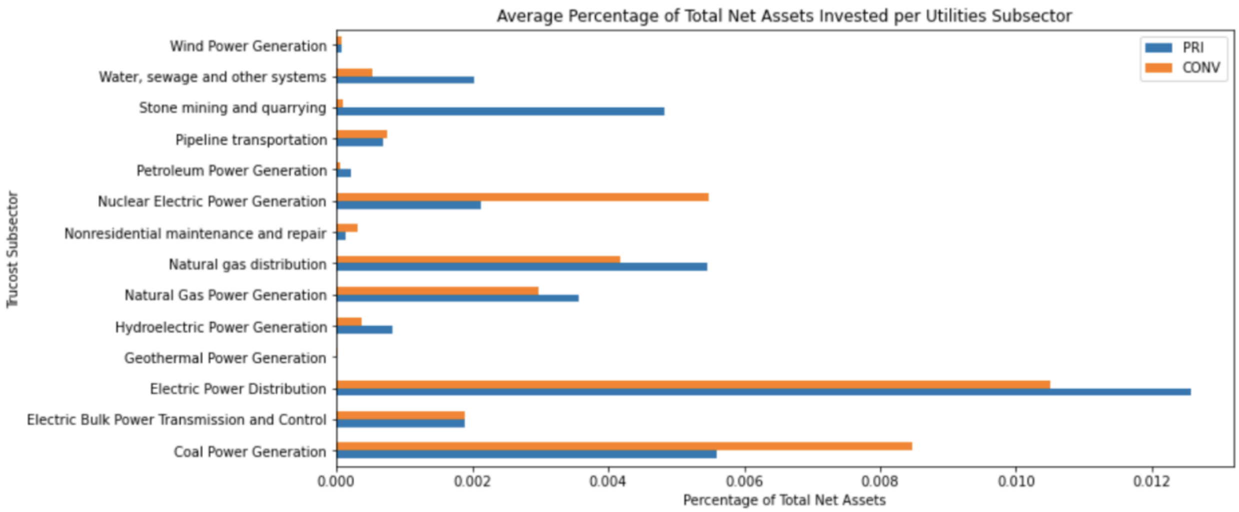
Appendix J shows descriptive statistics on the emissions level and carbon intensity of the utilities and energy industries. For the utilities industry, PRI and ESG name fund portfolios invest in firms with lower mean emissions and lower mean carbon intensity than conventional portfolios for firms. This demonstrates that while utilities is one of the most polluting industries, when it is broken down to the holding level, ESG funds seem to select firms with lower emissions and carbon intensities. For the energy industry, mean emissions of both ESG portfolio holdings are less than those of conventional portfolio holdings. However, the mean carbon intensity of PRI holdings is slightly higher than that of non-PRI holdings but emissions per million dollars in revenue does not differ greatly between the two fund types.

The percentage of total net assets invested per industry subsector is calculated by dividing subsector total net assets by portfolio total net assets for each industry, as shown in Figure 12.

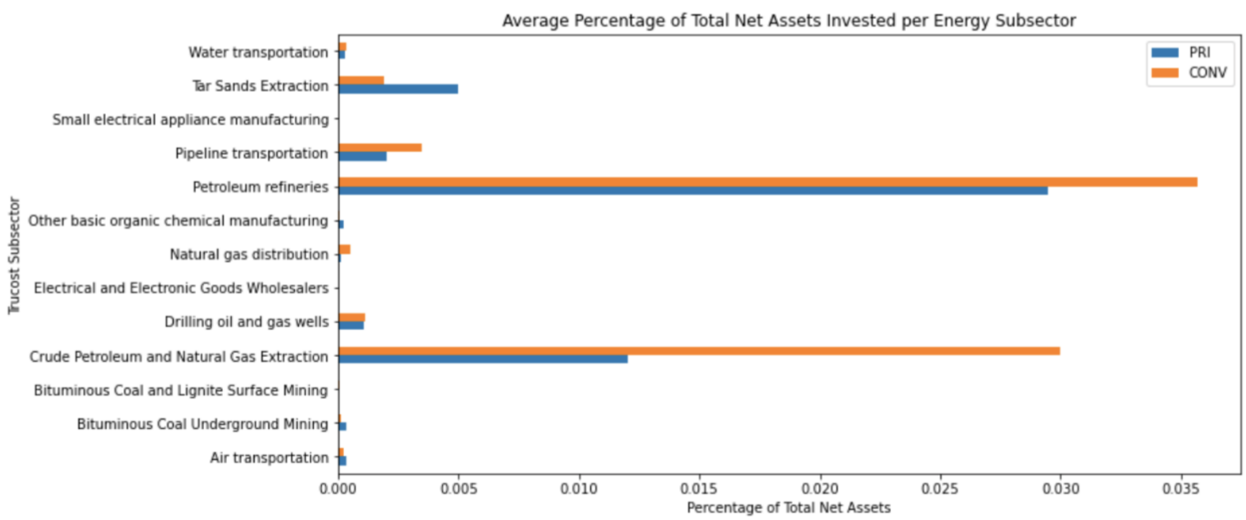
Figure 12: Average Percentage of Portfolio Total Net Assets of Utilities and Energy Industries

This figure shows the average percentage of portfolio total net assets invested in each Trucost subsector of the utilities and energy industries. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. The industries used are according to Trucost's classification of business activities. Panel A shows the percentage of portfolio total net assets invested per subsector of the utilities industry for PRI fund portfolios compared to conventional non-PRI fund portfolios. Panel B shows the percentage of portfolio total net assets invested per subsector of the energy industry for PRI fund portfolios compared to conventional non-PRI fund portfolios. The sample period is 2006 to 2020.

Panel A



Panel B



Within the utilities industry, the largest differences in total net asset allocation between the fund types are in the coal power generation, electric power distribution, and natural gas power generation subsectors. Non-PRI portfolios invest more in these subsectors than PRI portfolios, and these subsectors are amongst the most polluting and carbon intense within the utilities industry. In the energy industry, the largest differences in total net asset allocation are in petroleum refineries, tar sands extraction, crude petroleum and natural gas extraction, and pipeline transportation. Non-PRI portfolios invest more in each of these subsectors except tar sands extraction. Petroleum refineries is the most polluting subsector within the energy industry, followed by tar sands extraction. These subsectors are also among those with the highest average carbon intensity.

The same analysis is conducted for ESG name portfolios and are compared to conventional fund portfolios (See Appendix K). Within the utilities industry, the largest differences in total net asset allocation between the fund types are in the electric power distribution, coal power generation, and natural gas power generation subsectors. Conventional portfolios invest more in these subsectors than ESG portfolios, and these subsectors are amongst the most polluting and carbon intense within the utilities industry. Within the energy industry, the largest differences in total net asset allocation are in petroleum refineries, support activities for oil and gas, and crude petroleum and natural gas extraction. Conventional portfolios invest more in each of these subsectors. Petroleum refineries is the most polluting subsector within the energy industry and these subsectors are also among those with the highest average carbon intensity. While ESG name funds still invest largely in these polluting subsectors, it is still a smaller percentage of their total net assets than that of conventional funds.

Another representation of the environmental impact of the most polluting industries invested in by the portfolios is to compare their average pollution over time (See Appendix L). The motivation for presenting pollution over time is that the percentage of funds that are PRI signatories has increased over the years, which is not illustrated when looking at subsector pollution across the entire time period. Average pollution of both industries decreases over time for all three fund types at a similar rate. This demonstrates that PRI and ESG name portfolios hold firms that are similarly polluting as those held by conventional non-ESG portfolios. While average emissions are generally lower for PRI and ESG name portfolios over time, they are not much different from the emissions of conventional portfolios, particularly for the utilities industry. This suggests the possibility that, for the utilities industry, little to no special screening is performed at the company level by funds with an ESG focus compared to conventional funds.

Consistent with Frankel, Shakdwipee, and Nishikawa's (2015) results, the materials industry is the third most polluting industry invested in by mutual fund portfolios. It is less polluting than the utilities and energy industries, but it is still interesting to break it down in a similar fashion in order to gain further insights on the industry allocation of ESG portfolios (See Appendix M). The most polluting subsectors of the materials industry are pump and pumping equipment manufacturing and soap and cleaning compound manufacturing. While soap and cleaning compound manufacturing relatively less carbon intense, pump and pumping equipment has the highest carbon intensity. Both types of funds invest the most in high polluting but low carbon intense sectors. The largest differences in percentage of total net assets between both fund types are in the plastics product manufacturing, syrup and concentrate manufacturing, and soap and cleaning compound manufacturing, in which non-PRI funds invest more than PRI funds. The materials industry is interesting because it seems to be one where portfolios do not demonstrate negative screening even though it is a top polluting industry.

The same analysis is conducted for ESG name portfolios and are compared to conventional fund portfolios (See Appendix N). The most polluting subsectors of the materials industry are carbon black manufacturing, treated paper manufacturing, and ferrous metal manufacturing. ESG name portfolios invest the most in chemical product and preparation manufacturing and soap and cleaning compound manufacturing, which are both relatively lower in carbon intensity. These two subsectors also represent the largest differences in percentage invested by ESG name funds versus conventional funds. This suggests that ESG name funds make some effort to select less carbon intense companies for their portfolios.

5.4 Return analysis

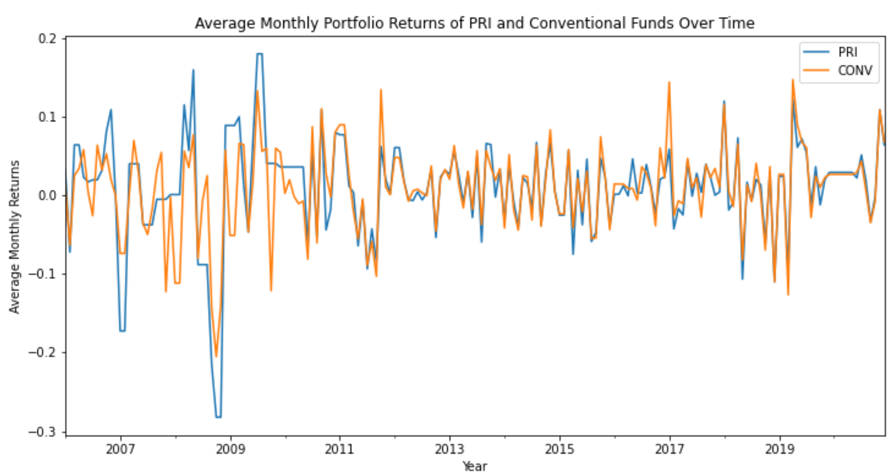
The return analysis is performed to determine how performing ESG funds are compared to conventional funds and to answer the question of where performance comes from. Performance is analyzed in relation to portfolio industry allocation to find possible explanatory factors for returns.

Stock market returns based on the S&P500 and the Russell 2000 are included in the analysis to serve as a benchmark against which portfolio performance can be evaluated. Figure 13 presents the average monthly returns of the three fund types over time and a comparison of portfolio returns to stock market performance.

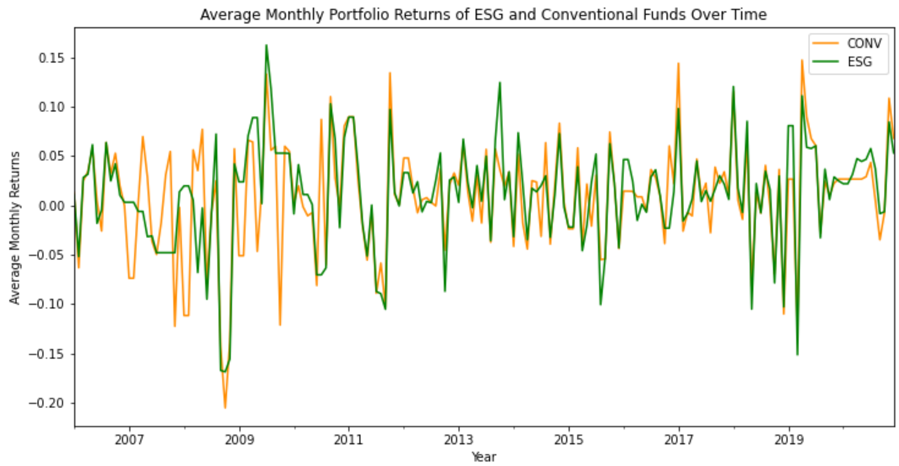
Figure 13: Average Monthly Portfolio Returns Over Time

This figure shows the average monthly portfolio returns over time. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. PRI fund data is taken as of the PRI signature date. Panel A shows the average monthly returns of PRI portfolios compared to the average returns of conventional non-PRI portfolios. Panel B shows the average monthly returns of ESG name portfolios compared to the average returns of conventional non-PRI portfolios. Panel C shows the average monthly returns of fund portfolios compared to two stock market indexes: the S&P 500 and the Russell 2000. The sample period is 2006 to 2020.

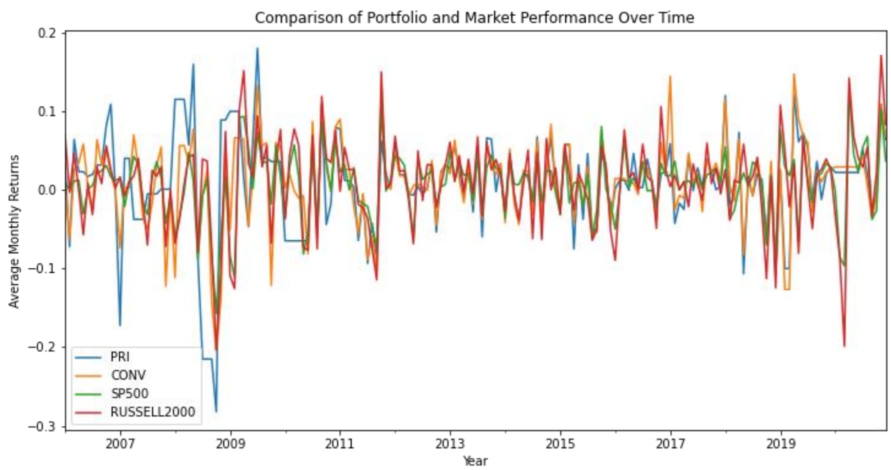
Panel A



Panel B



Panel C



The portfolio returns of PRI and ESG name funds are generally similar to conventional portfolio returns over time but do experience higher volatility in some periods, such as in 2008-2009. This can be attributed to less portfolio diversification in early PRI signatories. All portfolio returns experience a larger dip during 2008, which is explained by the financial crisis of 2008 during which there was a significant withdrawal of funds from the industry. Portfolio returns closely follow the stock market performance over time but are generally less volatile than the Russell 2000 particularly after 2010.

While PRI portfolio returns are similar to non-PRI returns on average, it is interesting to compare portfolio returns of signatory funds prior to and post signing the PRI and to determine whether there is a positive effect on performance once a fund becomes a signatory. The point of reference in this analysis is the funds signature date. Table 4 presents descriptive statistics on monthly portfolio returns of PRI portfolios pre and post signing the PRI.

Table 4: Descriptive Statistics – Portfolio Returns Pre and Post Signing the PRI

This table presents descriptive statistics on monthly portfolio returns of PRI funds prior to and post signing the PRI. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. The sample period is 2006 to 2020.

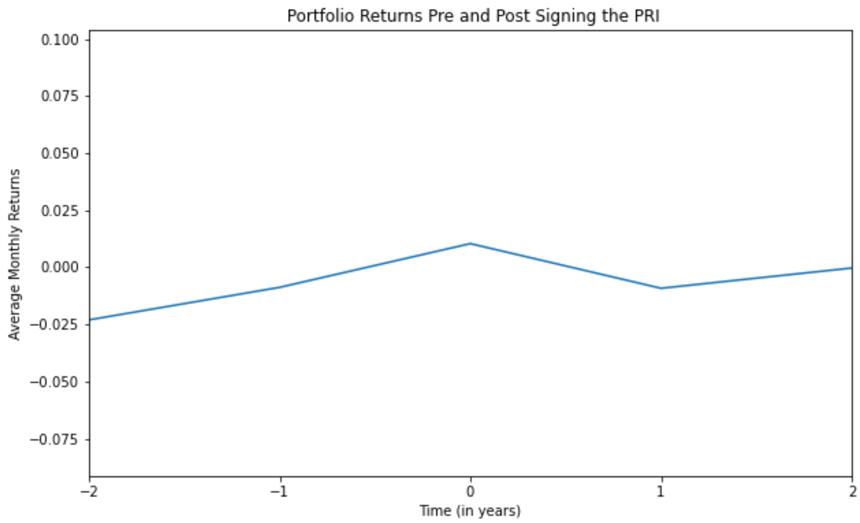
	Obs	Mean	Std Dev	Min	Median	Max
Pre Signing	35	0.0033	0.0666	-0.1912	0.0142	0.1153
Post Signing	29	0.0014	0.0497	-0.1081	0.0045	0.1107

Overall, the mean and median monthly portfolio returns decrease over the sample period after a fund signs the PRI. However, standard deviation decreases for portfolios post signing and the minimum monthly portfolio return increases, which reveals that becoming a signatory generally lowers a portfolios risk and consequently this comes with lower returns.

To analyze the effect more closely on portfolio returns before and after becoming a PRI signatory, an event study based on the PRI signature date is carried out in which a dummy variable is used to represent portfolio data before and after the signature date where 0 represents pre signing and 1 represents post signing. The event window is t = -2 to t = 2 to represent two years prior to signing and two years post signing the PRI. Figure 14 shows average portfolio returns two years before and two years after signing the PRI.

Figure 14: Portfolio Returns Pre and Post Signing the PRI

This figure shows the trends in monthly portfolio returns of PRI funds prior to and post signing the PRI over time. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. For those that are signatories, average monthly portfolio returns are compared prior to and post signing the PRI using an event study where the event at t = 0 is the signature date. The sample period is 2006 to 2020.



Average monthly portfolio returns gradually increase over the two years before signing the PRI but decrease one year after signing the PRI. Two years after signing, average monthly returns increase again to a level closer to pre-signing returns, suggesting that becoming a signatory causes a temporary decline in performance before returning to average levels. This can be explained by the additional resources and strategy restructuring that is required once a fund becomes a PRI signatory.

An alternative breakdown of PRI funds is to study the performance of early signatories versus late signatories shown in Table 5. The point of reference in early versus late analysis is the 2015 Paris Agreement on climate change.

Table 5: Descriptive Statistics – Portfolio Returns of Early versus Late PRI Signatories

This table presents descriptive statistics on monthly portfolio returns of early PRI signatories compared to late PRI signatories. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. For those that are signatories, average monthly portfolio returns are compared between early signatories who signed before 2015 and late signatories who signed after 2015. The sample period is 2006 to 2020.

	Obs	Mean	Std Dev	Min	Median	Max
Early Signatories	37	0.0082	0.0653	-0.1912	0.0119	0.1379
Late Signatories	37	0.0062	0.0639	-0.1912	0.0145	0.1336

The mean monthly portfolio returns of early signatories are greater than those of late signatories over the sample period, with a higher standard deviation and maximum monthly portfolio return. This implies that funds that signed the PRI before 2015 experienced more reward for taking on the possible risks that can be associated with becoming a signatory before the implications of ESG investing was more recognized and mainstream.

The next focus of the return analysis is looking at performance in terms of portfolio industry allocations among the different fund types. Table 6 presents descriptive statistics of monthly portfolio returns per Trucost industry for each fund type.

Table 6: Descriptive Statistics – Portfolio Performance per Industry

This table present descriptive statistics on monthly portfolio returns per industry for the three fund types over the sample period. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. PRI fund data is taken as of the PRI signature date. Panel A shows descriptive statistics on monthly returns of PRI portfolios per industry. Panel B shows descriptive statistics on monthly returns of ESG portfolios per industry. Panel C shows descriptive statistics on monthly returns of conventional portfolios per industry. The industries used are according to Trucost's classification of business activities. The sample period is 2006 to 2020.

Panel A: Monthly Industry Returns of PRI Funds

	Obs	Mean	Std Dev	Min	Median	Max
Communication Services	180	0.0145	0.0401	-0.0750	0.0161	0.1153
Consumer Discretionary	180	-0.0019	0.0748	-0.2346	0.0007	0.1460
Consumer Staples	180	-0.0090	0.0475	-0.1156	-0.0090	0.0859
Energy	180	-0.0275	0.1119	-0.3124	0.0010	0.1131
Financials	180	-0.0014	0.0722	-0.1975	0.0030	0.1271
Health Care	180	-0.0008	0.0406	-0.0800	-0.0047	0.0951
Industrials	180	-0.0087	0.0625	-0.1578	0.0040	0.1302
Information Technology	180	0.0054	0.0789	-0.2592	0.0185	0.1595
Materials	180	0.0051	0.0950	-0.2599	0.0282	0.1705
Real Estate	180	0.0089	0.0482	-0.0626	0.0002	0.1513
Utilities	180	0.0033	0.0387	-0.1220	0.0032	0.0637

Panel B: Monthly Industry Returns of ESG Name Funds

	Obs	Mean	Std Dev	Min	Median	Max
Communication Services	180	0.0179	0.0469	-0.0720	0.0172	0.1255
Consumer Discretionary	180	-0.0021	0.0750	-0.2319	0.0046	0.1114
Consumer Staples	180	-0.0043	0.0471	-0.0852	-0.0085	0.1319
Energy	180	-0.0183	0.1157	-0.2880	0.0100	0.1131
Financials	180	0.0000	0.0765	-0.1696	-0.0017	0.1341
Health Care	180	-0.0053	0.0598	-0.1458	-0.0046	0.1111
Industrials	180	-0.0115	0.0632	-0.1577	0.0020	0.1355
Information Technology	180	0.0100	0.0810	-0.3031	0.0237	0.1638
Materials	180	0.0103	0.0979	-0.2047	0.0132	0.2872
Real Estate	180	0.0144	0.0436	-0.0651	0.0193	0.0932
Utilities	180	0.0090	0.0708	-0.2007	0.0080	0.2135

Panel C: Monthly Industry Returns of Conventional Funds

	Obs	Mean	Std Dev	Min	Median	Max
Communication Services	180	0.0154	0.0577	-0.1703	0.0146	0.2348
Consumer Discretionary	180	0.0058	0.0794	-0.2808	0.0138	0.2901
Consumer Staples	180	0.0096	0.0517	-0.1595	0.0190	0.1452
Energy	180	0.0037	0.1209	-0.3124	0.0254	0.2069
Financials	180	0.0045	0.0599	-0.2215	0.0059	0.1727
Health Care	180	0.0029	0.0893	-0.5162	0.0082	0.2654
Industrials	180	0.0063	0.0719	-0.2039	0.0101	0.3862
Information Technology	180	0.0191	0.0782	-0.2365	0.0241	0.1832
Materials	180	0.0062	0.0960	-0.3816	0.0079	0.2769
Real Estate	180	-0.0029	0.0672	-0.2800	-0.0024	0.0969
Utilities	180	0.0015	0.0474	-0.1243	0.0063	0.1108

For PRI funds, overall performance is mainly driven by the communications services industry with a mean monthly return of 1.45%. The industry with the lowest mean return is the energy industry with a mean monthly return of -2.75%. However, this industry has the highest standard deviation which can possibly be explained by PRI funds attempting to divest from polluting industries such as energy. For ESG name funds, the industries with the highest mean returns are the communications services industry with a mean return of 1.79%. The industry with the lowest mean return is energy with a mean return of -1.83% and has the highest standard deviation. For conventional funds, the main drivers of performance are the information technology industry with a mean monthly return of 1.91%. The industry with the lowest mean return is real estate at -0.29% and is the only negative mean industry return for conventional funds. This is one example of evidence showing that there are differences in industry allocation between ESG and conventional mutual funds because real estate is one of the main drivers of PRI and ESG name fund performance while it is the smallest for conventional funds. A common result among the three fund types is that the energy industry mean returns have the highest standard deviation. This can be explained by a greater dispersion within the industry and offers motivation for a breakdown of this industry at the subsector level to determine where the dispersion is coming from.

Figure 15 compares the average monthly portfolio returns per Trucost industry over time for PRI, ESG name, and conventional fund portfolios.

Figure 15: Average Monthly Portfolio Returns per Industry Over Time

This figure shows the average monthly portfolio returns per industry over time for the three fund types. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. PRI fund data is taken as of the PRI signature date. Each panel shows the average monthly returns of PRI and ESG name portfolios compared to the average returns of conventional portfolios per industry, as follows: (1) Communication Services, (2) Consumer Discretionary, (3) Consumer (4) Staples, Energy, (5) Financials, (6) Health Care, (7) Industrials, (8) Information Technology, (9) Materials, (10) Real Estate, and (11) Utilities. The industries used are according to Trucost's classification of business activities. The sample period is 2006 to 2020.

Across all industries, performance of the three fund types generally resemble each other over time, especially among the ESG funds, but conventional funds tend to experience higher volatility. This can suggest that the differences in industry allocations between ESG portfolios and conventional portfolios do not have a significant effect on average monthly returns over the sample period, but ESG funds may be better at managing downside risk. This can especially be seen in the health care and materials industries where conventional portfolio returns dropped more drastically in 2009. In terms of ESG funds, the results show that PRI returns and volatility are very similar to that of ESG name funds. There is greater correspondence between the two ESG funds than with conventional funds.

The results of industry analysis in the previous section demonstrate that the utilities and energy industries are the most polluting and carbon intense in terms of GHG emissions and have the greatest differences in percentage invested by ESG versus conventional portfolios. Following from the industry analysis, the utilities subsectors with the largest differences in total net asset allocation are coal power generation, electric power distribution, and natural gas power generation. Conventional fund portfolios invest more in these subsectors than PRI and ESG name portfolios and are amongst the most polluting and carbon intense subsectors. For the energy industry, the subsectors with the largest total net allocation difference are petroleum refineries, crude petroleum and natural gas extraction, and pipeline transportation. Conventional portfolios invest more in these subsectors than both PRI and ESG name portfolios, and they are the most polluting subsectors with the highest carbon intensity. Therefore, the following analyses will focus on these subsectors to study the effect of weight differences on explain return differences between the three fund types. Table 7 presents descriptive statistics of monthly portfolio returns per Trucost subsector of the utilities and energy industries for each fund type.

Table 7: Descriptive Statistics –Portfolio Performance of Utilities and Energy Industries

This table present descriptive statistics on monthly portfolio returns per Trucost subsector of the utilities and energy industries for the three fund types over the sample period. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. PRI fund data is taken as of the PRI signature date. Panel A shows descriptive statistics on monthly returns of PRI portfolios per subsector. Panel B shows descriptive statistics on monthly returns of ESG portfolios per subsector. Panel C shows descriptive statistics on monthly returns of conventional portfolios per subsector. The industries used are according to Trucost's classification of business activities. The sample period is 2006 to 2020.

Panel A: Monthly Subsector Returns of Utilities Industry

		Obs	Mean	Std Dev	Min	Median	Max
PRI	Coal Power Generation	180	0.0117	0.0273	-0.0447	0.0149	0.0402
	Electric Power Distribution	180	0.0074	0.0275	-0.0393	0.0115	0.0416
	Natural Gas Power Generation	180	0.0190	0.0293	-0.0487	0.0271	0.0484
ESG	Coal Power Generation	180	0.0112	0.0356	-0.0485	0.0190	0.0648
	Electric Power Distribution	180	0.0176	0.0326	-0.0400	0.0112	0.0654
	Natural Gas Power Generation	180	0.0149	0.0313	-0.0466	0.0236	0.0484
CONV	Coal Power Generation	180	0.0123	0.0357	-0.0577	0.0152	0.0630
	Electric Power Distribution	180	0.0094	0.0471	-0.0886	0.0133	0.1108
	Natural Gas Power Generation	180	0.0203	0.0357	-0.0461	0.0248	0.0981

Panel B: Monthly Subsector Returns of Energy Industry

		Obs	Mean	Std Dev	Min	Median	Max
PRI	Petroleum Refineries	180	0.0021	0.0577	-0.1131	-0.0006	0.0843
	Crude Petroleum & Natural Gas Extraction	180	0.0223	0.0862	-0.1257	0.0225	0.1308
	Pipeline Transportation	180	-0.0152	0.0631	-0.1005	0.0062	0.0537
ESG	Petroleum Refineries	180	0.0003	0.0591	-0.1131	0.0011	0.0848
	Crude Petroleum & Natural Gas Extraction	180	0.0118	0.0865	-0.1360	0.0163	0.1211
	Pipeline Transportation	180	-0.0094	0.1026	-0.2405	0.0272	0.0892
CONV	Petroleum Refineries	180	0.0091	0.0526	-0.1120	0.0208	0.0859
	Crude Petroleum & Natural Gas Extraction	180	0.0310	0.0860	-0.1331	0.0225	0.1866
	Pipeline Transportation	180	0.0097	0.0708	-0.1613	0.0342	0.0807

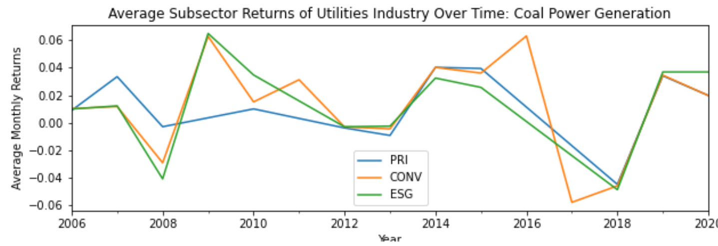
For the utilities industry, the subsector with the highest mean returns natural is gas power generation for PRI and conventional funds at 1.90% and 2.03% respectively, and electric power distribution for ESG name funds at 1.76%. For the energy industry, the subsector with the highest mean returns is crude petroleum and natural gas extraction for PRI, ESG name, and conventional funds at 2.23%, 1.18%, and 3.10% respectively.

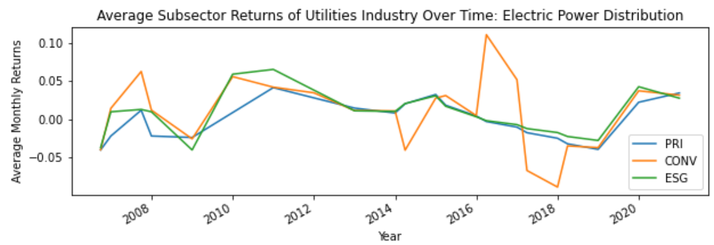
Figure 16 compares the average monthly portfolio returns per Trucost subsector of the utilities and energy industries for each fund type over time.

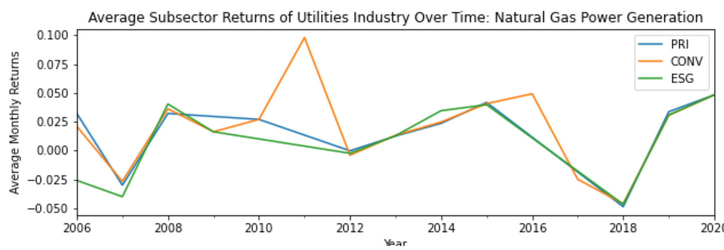
Figure 16:Average Monthly Portfolio Returns of Utilities and Energy Industries Over Time

This figure shows the average monthly portfolio returns per Trucost subsector of the utilities and energy industries for the three fund types over time. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. PRI fund data is taken as of the PRI signature date. Panel A shows the average monthly returns of returns of PRI and ESG name portfolios compared to the average returns of conventional portfolios per subsector of the utilities industry, as follows: (1) Coal power generation, (2) Electric power distribution, and (3) Natural gas power generation. Panel B shows the average monthly returns of returns of PRI and ESG name portfolios compared to the average returns of conventional portfolios per subsector of the energy industry, as follows: (1) Petroleum refineries, (2) Crude petroleum and natural gas extraction, and (3) Pipeline transportation. The industries used are according to Trucost's classification of business activities. The sample period is 2006 to 2020.

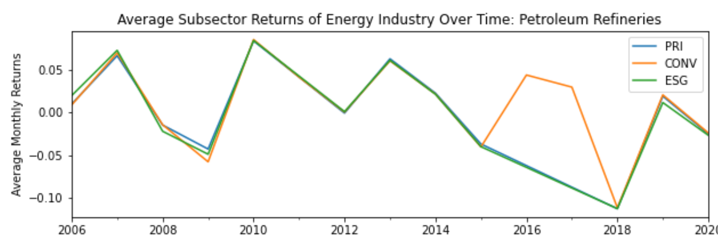
Panel A

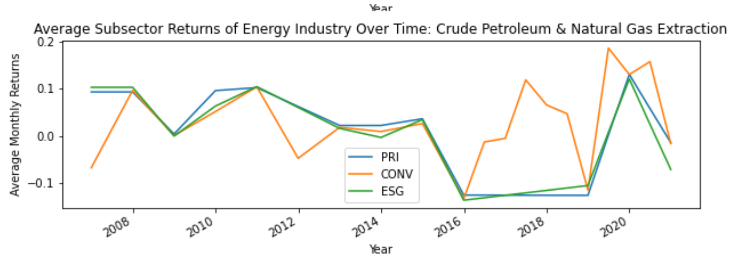


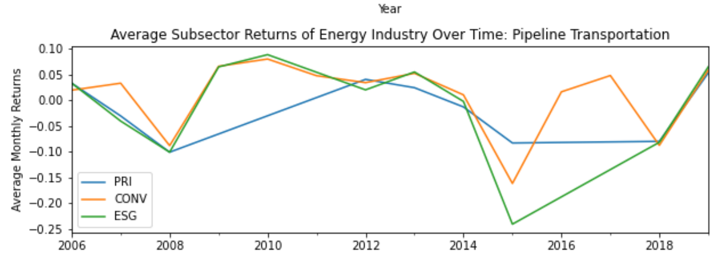




Panel B







For the utilities industry, the returns of the three most polluting subsectors tend to move closely together for the three fund types, especially between PRI and ESG name funds. Conventional fund performance is more volatile over the years. This can suggest that PRI and ESG name funds have similar strategies and may be more hedged against downside risk than conventional funds for these high polluting industries. For the energy industry, there are comparable results as the three fund types are very similar in performance over time, particularly for the petroleum refineries subsector. Again, conventional fund performance demonstrates the most deviation from the other funds. Overall, despite having the largest differences in percentage invested in utilities and energy subsectors between the three fund types, their returns are not that different based on these results.

To find explanatory factors for portfolio performance, OLS regressions are carried out of monthly industry returns on industry weight. Regression results are shown in Table 8.

Table 8: Industry Return Analysis

This table presents the regression results of industry return differences between ESG and conventional funds on their industry weight differences. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. The table shows the coefficients and t-statistics of the OLS regression of industry return differences on industry weight differences between PRI and conventional portfolios (A), and between ESG name and conventional portfolios (B) for the full sample. *t* statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The sample period is 2006 to 2020.

	A	B
Constant	0.01126***	0.01077***
	(2.7063)	(2.6883)
Weight Diff	0.01767	-0.06808*
	(0.5593)	(-1.7472)
R-Squared	0.00211	0.02034
Observations	150	150

t statistics are reported in parentheses.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

In both regressions A and B, the constant coefficient is significantly significant at the 1% level, meaning the average expected mean return difference is 1.126% and 1.077% respectively for an industry with no weight difference between PRI and conventional portfolios and between ESG name and conventional portfolios. In regression B, the coefficient for weight difference is statistically significant at the 10% level which implies that there is a statistically significant association between return difference and weight difference. For regression B between ESG name and conventional funds, this means that each additional percentage point in weight difference is associated with an average decrease in return difference of -6.808% across all industries. The t-values overall are relatively small, suggesting that there is not a significant difference between return difference and weight difference. In terms of R-squared, both regressions have small values but regression B has a greater percentage of the variation in return difference explained by weight difference than regression A. However, it is still only 2.034% of the variation in return difference that can be explained by weight difference between ESG name and conventional portfolios for all industries. Overall, the regression results demonstrate that there is not enough evidence to conclude that industry return differences can be explained by industry weight differences.

Table 9 shows regression results of industry return differences between ESG and conventional funds on their industry weight differences for the utilities and energy industries.

Table 9: Utilities and Energy Industry Return Analysis

This table presents the regression results of industry return differences between ESG and conventional funds on their industry weight differences for the utilities and energy industries. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. The table shows the coefficients and t-statistics of the OLS regression of industry return differences on industry weight differences between PRI and conventional portfolios (A) for the utilities and energy industries, and between ESG name and conventional portfolios (B) for the utilities and energy industries. *t* statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The sample period is 2006 to 2020.

	A		B	
	Utilities	*Energy*	*Utilities*	*Energy*
Constant	0.00737	0.04564**	0.00994	0.02733
	(1.5187)	(2.6098)	(1.4273)	(1.2029)
Weight Diff	-0.3602***	0.3986	-0.7282***	-1.00127
	(-4.2835)	(1.3488)	(-5.3112)	(-1.2569)
R-Squared	0.5853	0.1228	0.6845	0.1084
Observations	15	15	15	15

t statistics are reported in parentheses.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

In regression A for the energy industry, the constant coefficient is statistically significant at the 5% level, which suggests that the average expected mean return difference is 4.564% when there is no weight difference between PRI and conventional portfolios. In both regressions A and B for the utilities industry, the weight difference coefficient is statistically significant at the 1% level. This means that there is a statistically significant relationship between return difference and weight difference within the utilities industry. Between PRI and conventional portfolios, each additional percentage point in weight difference is related to an average decrease in return difference of 36.02%, meaning the more conventional portfolios invest in the utilities industry than PRI portfolios, the less of a return difference there is between the two fund types. The same result can be seen between ESG name and conventional portfolios, except that the average decrease in return difference is larger. Both regressions on the utilities industry have a relatively higher t-value than for the energy industry, meaning there is a difference between return difference and weight difference. The R-squared is also higher in both utilities regressions where 58.53% of the variation in return difference between PRI and conventional portfolios can be explained by their weight difference, whereas the weight difference explains 68.45% of the variation in return difference between ESG name and conventional portfolios. Overall, there is enough evidence to conclude that return differences can be explained by weight differences within the utilities industry.

5.5 Risk analysis

The risk analysis presents a comparison of the portfolio riskiness of ESG investments and conventional investments, and if differences in industry allocation are related to portfolio riskiness. Some of the popular statistical measures of mutual fund risk include R-squared, standard deviation, the Sharpe ratio, and value at risk. Return difference and standard deviation difference are also used. Table 10 presents a summary table of portfolio risk characteristics per industry for the three fund types using conventional portfolio industry returns as the benchmark.

Table 10: Portfolio Risk Characteristics per Industry

This table presents portfolio risk characteristics per Trucost industry for the three fund types based on monthly value-weighted portfolio returns. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the PRI, those that have an ESG fund name, and those that are conventional funds. The table shows the industry weight difference in total net asset allocation between ESG and conventional funds as well as six risk measures. "Weight Diff" is calculated as the average total net assets invested in each industry by conventional portfolios minus the average total net assets invested in each industry by PRI portfolios. The six risk measures are: (1) "Ret Diff", (2) "Std Dev Diff", (3) R-squared, (4) Standard deviation, (5) Sharpe ratio, (6) Value at risk. Panel A shows the risk characteristics of PRI fund portfolios versus conventional fund portfolios as the benchmark. Panel B shows the risk characteristics of ESG name funds versus conventional funds. The characteristics in Panel B are defined the same as in Panel A but with respect to ESG name portfolios instead of PRI. Panel C shows the risk characteristics of conventional funds. The sample period is 2006 to 2020.

Panel A: Risk Characteristics of PRI Funds

	Weight Diff	Ret Diff	Std Dev Diff	R-Squared	Std Dev	Sharpe Ratio	VaR
Communication Services	0.0113	0.0046	0.2538	0.4056	0.0401	0.3616	-0.0694
Consumer Discretionary	-0.0298	-0.0047	0.1025	0.1378	0.0748	-0.0254	-0.1702
Consumer Staples	0.0336	-0.0199	0.0379	0.0541	0.0475	-0.1895	-0.1083
Energy	0.1134	-0.0307	0.4681	0.5957	0.1119	-0.2458	-0.2995
Financials	-0.1504	-0.0115	0.3802	0.3607	0.0722	-0.0194	-0.1732
Health Care	0.0054	-0.0059	0.0051	0.0133	0.0406	-0.0197	-0.0766
Industrials	0.0296	-0.0164	0.1700	0.2454	0.0625	-0.1392	-0.1166
Information Technology	-0.0309	-0.0017	-0.0067	-0.0087	0.0789	0.0684	-0.2027
Materials	-0.0030	-0.0079	0.3320	0.4145	0.0950	0.0537	-0.2491
Real Estate	-0.0303	-0.0020	0.3438	0.5314	0.0482	0.1846	-0.0607
Utilities	0.0253	-0.0023	0.4662	0.6170	0.0387	0.0853	-0.1075

Panel B: Risk Characteristics of ESG Name Funds

	Weight Diff	Ret Diff	Std Dev Diff	R-Squared	Std Dev	Sharpe Ratio	VaR
Communication Services	0.0344	0.0068	0.2885	0.4291	0.0469	0.3817	-0.0656
Consumer Discretionary	-0.0080	-0.0132	0.1481	0.2018	0.0750	-0.0280	-0.1701
Consumer Staples	-0.0001	-0.0143	0.1723	0.2579	0.0471	-0.0913	-0.0727
Energy	0.0639	-0.0160	0.3574	0.4936	0.1157	-0.1582	-0.2646
Financials	-0.1095	-0.0194	0.3479	0.3369	0.0765	0.0000	-0.1598
Health Care	-0.0087	-0.0078	0.1526	0.2807	0.0598	-0.0886	-0.1406
Industrials	0.0402	-0.0164	0.1045	0.1522	0.0632	-0.1820	-0.1428
Information Technology	-0.1067	-0.0011	0.1740	0.2191	0.0810	0.1235	-0.2096
Materials	0.0044	-0.0026	0.2573	0.3473	0.0979	0.1052	-0.1577
Real Estate	-0.0080	0.0019	0.3227	0.5900	0.0436	0.3303	-0.0629
Utilities	0.0323	-0.0042	0.7666	0.6106	0.0708	0.1271	-0.1770

Panel C: Risk Characteristics of Conventional Funds

	Std Dev	Sharpe Ratio	VaR
Communication Services	0.0577	0.2669	-0.1462
Consumer Discretionary	0.0794	0.0730	-0.1601
Consumer Staples	0.0517	0.1857	-0.1151
Energy	0.1209	0.0306	-0.2995
Financials	0.0599	0.0751	-0.1716
Health Care	0.0893	0.0325	-0.1923
Industrials	0.0719	0.0876	-0.1844
Information Technology	0.0782	0.2442	-0.2220
Materials	0.0960	0.0646	-0.2330
Real Estate	0.0672	-0.0432	-0.2286
Utilities	0.0474	0.0316	-0.1042

For PRI funds, average monthly portfolio returns for all industries except for the communication services industry have a negative small return difference, suggesting that PRI portfolios underperformed conventional portfolios. Communication services industry returns outperformed the benchmark on a monthly basis by 0.46%, while the most underperforming PRI industry was the energy industry at -3.07%. This is also the industry with the largest positive investment weight difference, which suggests that divesting from energy may result in lower returns. When looking at standard deviation difference, the results for all PRI industries are less than 1, indicating that PRI returns are less volatile than conventional returns. The industries with the highest differences are energy and utilities, suggesting that they are the most volatile industries in PRI portfolios. The energy and utilities industries are the PRI industries with the highest R-squared. This suggests that 59.57% and 61.70% of the movements of PRI energy and utilities industry returns respectively can be explained by movements of conventional returns, but they are not closely correlated. In terms of standard deviation, the results also demonstrate that PRI energy industry returns are the most volatile with a value of 0.1119. Conventional industry returns demonstrate the same result with the energy and materials industries being the most volatile. Using the Sharpe ratio shows that the communication services industry has the best risk-adjusted performance of all PRI industry returns with a Sharpe ratio of 0.3616. The same industry has the highest Sharpe ratio in conventional portfolios at 0.2669, which suggests that PRI is a better investment for this industry because its high returns do not come with too much additional risk. As for the energy and utilities industries, the Sharpe ratio is higher in conventional portfolios for energy and higher in PRI portfolios for utilities. Lastly, the results for VaR demonstrate that the energy industry has the largest 99% one-month VaR for both PRI and conventional portfolios. This means that there is a 99% chance that the maximum losses will not exceed -29.95% in value for both PRI and conventional portfolios in one month. The utilities industry has a one-month VaR of -10.75% and -10.42% for PRI and conventional portfolios respectively. Overall, PRI portfolio industry returns are less performing and less volatile than conventional portfolio industry returns across all industries except for the energy industry which has the highest R-squared and standard deviation. It also has a higher VaR in PRI portfolios than in conventional portfolios.

For ESG name funds, average monthly portfolio returns for all industries have a negative small return difference except for the communication services and real estate. This is similar to PRI return differences and suggests that ESG name portfolios underperformed conventional portfolios. The energy industry is the third most underperforming industry after financials and industrials at -1.60%. While the energy industry in ESG name portfolios is not as underperforming as it is in PRI portfolios, it has the greatest weight difference with conventional portfolios like it does between PRI and conventional portfolios, meaning underperformance may be due to a smaller allocation to energy in ESG name portfolios. The results for standard deviation difference are similar to those regarding PRI portfolios in that all industry returns are less volatile in ESG name portfolios than conventional portfolios. Moreover, the industries with the highest differences are the same as PRI. As for R-squared, energy and utilities are among the highest of all industries, which closely resembles PRI results. In addition, standard deviation resembles that for PRI portfolios, with energy and materials having the largest standard deviation. The Sharpe ratio demonstrates similar results as well, particularly for the communication services industry which has a ratio of 0.3817 and therefore also implies better risk-adjusted performance than both PRI and conventional portfolios. Finally, the VaR numbers for ESG name portfolios are similar to those of PRI portfolios and the energy industry has the largest 99% one-month VaR, meaning that there is a 99% chance that the maximum losses will not exceed -26.46%. Overall, the risk measures of ESG name portfolio industry returns closely resemble PRI portfolios. They are less performing and less volatile than conventional industry returns except for the energy and utilities industry which have the highest R-squared and standard deviation.

Another method to evaluate the risk of ESG mutual funds in comparison to conventional mutual fund is through the use of factor models. The three models used are those most commonly used in the literature, namely Fama and French's 3-factor model and 5-factor model, as well as Carhart's 4-factor model. Table 11 presents the results from the model regressions comparing the monthly returns of ESG and non-ESG fund portfolios.

Table 11: Portfolio Factor Loadings per Fund Type

This table presents the regression results of monthly portfolio returns using Fama-French and Carhart factor models for the three fund types. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the PRI, those that have an ESG fund name, and those that are conventional funds. Panel A shows the regression results for PRI portfolio factor loadings. Panel B shows the regression results for ESG name portfolio factor loadings. Panel C shows the regression results for conventional portfolio factor loadings. Regression A shows the coefficients and t-statistics of the OLS regression on 3 factors: the market risk premium ($R_M - R_F$), the size of firms (SMB), and the value premium (HML) according to the Fama-French 3-factor model. Regression B shows the coefficients and t-statistics of the OLS regression on 4 factors: the market risk premium ($R_M - R_F$), the size of firms (SMB), the value premium (HML), and momentum (MOM) according to the Carhart model. Regression C shows the coefficients and t-statistics of the OLS regression on 5 factors: the market risk premium ($R_M - R_F$), the size of firms (SMB), the value premium (HML), profitability (RMW), and investment (CMA) according to the Fama-French 5-factor model. *t* statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The sample period is 2006 to 2020.

Panel A: Regression Results for Factor Models of PRI Funds

	A	B	C
Constant	-0.0011	-0.0014	0.0006
	(-0.2776)	(-0.3667)	(0.1557)
$R_M - R_f$	0.9193***	1.0528***	0.9140***
	(9.0743)	(9.8845)	(8.599399)
SMB	0.1159	0.1174	0.0185
	(0.6629)	(0.6929)	(0.1031)
HML	0.0879	0.3917**	-0.5930
	(0.5162)	(2.0742)	(-0.2825)
MOM		0.3315***	
		(3.2889)	
RMW			-0.3955
			(-1.3828)
CMA			0.3722
			(1.1180)
R-Squared	0.4247	0.4634	0.4336
Observations	146.0	146.0	146.0

t statistics are reported in parentheses.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Panel B: Regression Results for Factor Models of ESG Name Funds

	A	B	C
Constant	0.0043	0.0052	0.0057
	(-0.2776)	(1.4629)	(0.1557)
$R_M - R_f$	0.7621***	0.7506***	0.7941***
	(9.0743)	(8.3932)	(8.5994)
SMB	0.0387	0.3106	-0.7932
	(0.6629)	(0.1936)	(0.1031)
HML	0.0077	-0.0115	-0.1404
	(0.5162)	(-0.0826)	(-0.2825)
MOM		-0.0323	
		(-0.3659)	
RMW			-0.4887**
			(-1.3828)
CMA			0.5797**
			(1.1180)
R-Squared	0.3997	0.3988	0.4326
Observations	159.0	159.0	159.0

t statistics are reported in parentheses.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Panel C: Regression Results for Factor Models of Conventional Funds

	A	B	C
Constant	-0.0004	0.0004	0.0013
	(-0.2776)	(0.1139)	(0.1557)
$R_M - R_f$	0.8960***	0.9419***	0.8872***
	(9.0743)	(11.5799)	(8.5994)
SMB	0.2253	0.1466*	0.1352
	(0.6629)	(1.6695)	(0.1031)
HML	0.0737	0.1925	-0.9636
	(0.5162)	(1.4569)	(-0.2825)
MOM		0.1625**	
		(2.1058)	
RMW			-0.4252
			(-1.9503)
CMA			0.4182
			(1.6497)
R-Squared	0.5215	0.5323	0.5368
Observations	167.0	167.0	167.0

t statistics are reported in parentheses.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

For PRI portfolios, the market factor is statistically significant at the 1% confidence level in all three models. In the three models, market risk is close to one, meaning market risk in PRI portfolio returns is comparable to that of the market. In the four-factor model, the HML and MOM loadings are both statistically significant at the 5% and 1% confidence level respectively. The value factor (HML) demonstrates that PRI portfolios are mainly value funds that contain firms with high book-to-market and tend to outperform growth firms. The momentum factor (MOM) demonstrates that PRI portfolios hold more high-momentum firms than low-momentum firms. According to the four-factor model, PRI portfolio performance can be attributed to its holdings with high book-to-market values and high momentum, two attributes that contribute to better portfolio performance. In the five-factor model, the RMW and CMA loadings suggest that PRI portfolio contain firms with a greater operating profitability and smaller total asset growth, but they are both not statistically significant so they do not have any explanatory power. Overall, R-squared is similar between the three models in which the percentage of portfolio returns explained by the factors is 42%, 46%, and 43% respectively.

For ESG name portfolios, the market factor is statistically significant at the 1% confidence level in all three models like for PRI portfolios. The only other factors that are statistically significant are in the five-factor model are the profitability (RMW) and investment (CMA) factors, both at the 5% confidence level. Unlike PRI portfolios, the RMW loading suggests that ESG name portfolios contain more firms with low operating profitability. The CMA loading suggests that there are more holdings that invest conservatively. According to the five-factor model, ESG name portfolio underperformance can be attributed to its holdings with weak profitability and overperformance can be attributed to lower total asset growth. Overall, R-squared is almost equal between the three models and to PRI portfolios at around 40% of portfolio returns being explained by the factors.

For conventional portfolios, the market factor is statistically significant at the 1% confidence level in all three models like for PRI and ESG name portfolios. Also, like PRI and ESG name portfolios, risk is close to that of the market. PRI portfolio market risk is closer to conventional portfolio market risk. In the four-factor model, the SMB and MOM factors are statistically significant at the 10% and 5% levels respectively. The size (SMB) loading suggests that conventional portfolios hold more small-cap firms which tend to outperform large-cap firms and are riskier. The momentum loading suggests that there are more positive advancing firms. According to the four-factor model, conventional portfolio performance can be attributed to small-cap holdings and those with high momentum. Overall, R-squared is almost equal between the three models at around 50% of portfolio performance being explained by the factors.

The same risk analysis using factor models is performed on the different PRI subgroups in order to analyze how factor loadings differ within the PRI fund type. The first subgroup studied is pre versus post signing the PRI. A regression of average monthly portfolio returns on factors based on the Fama-French 5-factor, 4-factor, and 3-factor models is conducted to determine if becoming a signatory has an effect on portfolios factor loadings. Table 12 presents the results from the model regressions comparing the monthly returns of PRI fund portfolios pre and posting signing the PRI.

Table 12: Portfolio Factor Loadings Pre and Post Signing the PRI

This table presents the regression results of monthly portfolio returns using Fama-French and Carhart factor models comparing PRI funds prior to and post signing the PRI. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the PRI, those that have an ESG fund name, and those that are conventional funds. Panel A shows the regression results for PRI portfolio factor loadings before signing the PRI. Panel B shows the regression results for PRI portfolio factor loadings after signing the PRI. Regression A shows the coefficients and t-statistics of the OLS regression on 3 factors: the market risk premium ($R_M - R_F$), the size of firms (SMB), and the value premium (HML) according to the Fama-French 3-factor model. Regression B shows the coefficients and t-statistics of the OLS regression on 4 factors: the market risk premium ($R_M - R_F$), the size of firms (SMB), the value premium (HML), and momentum (MOM) according to the Carhart model. Regression C shows the coefficients and t-statistics of the OLS regression on 5 factors: the market risk premium ($R_M - R_F$), the size of firms (SMB), the value premium (HML), profitability (RMW), and investment (CMA) according to the Fama-French 5-factor model. *t* statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The sample period is 2006 to 2020.

Panel A: Regression Results for Factor Models of PRI Pre Signing

	A	B	C
Constant	-0.0028	-0.0034	-0.0024
	(-0.4026)	(-0.4662)	(-0.3038)
$R_M - R_f$	0.9261***	1.0003***	0.9507***
	(4.9982)	(4.8281)	(4.4212)
SMB	0.1172**	0.1347**	0.0192**
	(0.8364)	(0.6334)	(0.3565)
HML	-0.0514	0.7997	-0.1553
	(-0.1948)	(0.2629)	(-0.3933)
MOM		0.1968	
		(0.8657)	
RMW			-0.0742
			(-0.1475)
CMA			-0.0874
			(-0.1088)
R-Squared	0.6760	0.6805	0.6629
Observations	35	35	35

t statistics are reported in parentheses.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Panel B: Regression Results for Factor Models of PRI Post Signing

	A	B	C
Constant	-0.0034	-0.0033	-0.0060
	(-0.7463)	(-0.7032)	(-1.2756)
$R_M - R_f$	0.6598***	0.6880***	0.6230***
	(5.2447)	(4.8637)	(4.6181)
SMB	0.2013**	0.1543**	0.0237**
	(0.6549)	(0.4231)	(0.4528)
HML	0.1771	0.2255	-0.1861
	(0.9825)	(1.1116)	(-0.7901)
MOM		0.0826	
		(0.5125)	
RMW			0.1381
			(0.4744)
CMA			0.7343
			(1.5668)
R-Squared	0.7953	0.7973	0.8185
Observations	29	29	29

t statistics are reported in parentheses.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

For portfolios pre-signing the PRI, the market factor is significantly significant at the 1% confidence level in the three models. The loading is close to one, meaning portfolio risk resembles the market, while market risk is higher according to the four-factor model. In all three models, the SMB loading is only other statistically significant factor. It is statistically significant at the 5% level and implies that performance of portfolios before signing the PRI can be attributed to the fact that there is little overweighting of small-cap holdings. Overall, R-squared is very similar among the three models where an average of 67% of portfolio returns prior to becoming a PRI signatory are explained by the factors, with the four-factor model having the largest R-squared of 68.05%.

After signing the PRI, the results demonstrate that portfolio returns have a statistically significant market factor in all three models at the 1% confidence level just as they do before the fund becomes a signatory. The results also show that the portfolio returns become less volatile than the market since the market loading is smaller post signing the PRI in all models. Similarly, the SMB loading is statistically significant at the 5% level for the three models. This suggests that portfolio weighting of small cap stocks after signing the PRI is similar to before signing and is the driver for performance according to the three models. Overall, R-squared increases after signing the PRI to an average of 80% of portfolio returns being explained by the factors, with the five-factor model having the largest R-squared of 81.85%.

As for the other factors, there are some differences after signing the PRI. The value factor is generally higher after signing compared to before signing, suggesting portfolios hold more firms with high book-to-market once they are a signatory which would contribute to better performance. However, these results are not statistically significant. In the four-factor model, the momentum factor decreases after signing, which suggests less high-momentum portfolio holdings, and in the five-factor model, the profitability and investment factors increase. This would suggest that there are more holdings with robust operating profitability and a conservative investing style post signing the PRI, both of which contribute to better performance according to the five-factor model. Again, however, these results are not statistically significant and so there is not enough evidence to support this hypothesis.

The second PRI subgroup studied is early versus late signatories. A regression of average monthly portfolio returns on factors based on the Fama-French 5-factor, 4-factor, and 3-factor models is conducted to determine if becoming an early signatory before 2015 has an effect on portfolio factor loadings. A dummy variable is created to indicate whether a fund is an early signatory that signed in or before 2015 or a late signatory that signed after 2015, where 0 represents late signatory and 1 represents early signatory. Table 13 presents the results from the model regressions comparing the monthly returns of PRI early and late signatory portfolios.

Table 13: Portfolio Factor Loadings of PRI Early versus Late Signatories

This table presents the regression results of monthly portfolio returns using Fama-French and Carhart factor models comparing PRI early and late signatories. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the PRI, those that have an ESG fund name, and those that are conventional funds. Regression A shows the coefficients and t-statistics of the OLS regression on 3 factors: the market risk premium ($R_M - R_F$), the size of firms (SMB), and the value premium (HML) according to the Fama-French 3-factor model. Regression B shows the coefficients and t-statistics of the OLS regression on 4 factors: the market risk premium ($R_M - R_F$), the size of firms (SMB), the value premium (HML), and momentum (UMD) according to the Carhart model. Regression C shows the coefficients and t-statistics of the OLS regression on 5 factors: the market risk premium ($R_M - R_F$), the size of firms (SMB), the value premium (HML), profitability (RMW), and investment (CMA) according to the Fama-French 5-factor model. An "Early/Late" factor is a dummy variable that indicates whether a fund is an early or late signatory. *t* statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The sample period is 2006 to 2020.

	A	B	C
Constant	-0.0037	-0.0042	-0.0041
	(-0.5921)	(-0.6524)	(-0.6162)
Early/Late	0.0036	0.0040	0.0036
	(0.4172)	(0.4669)	(0.4001)
$R_M - R_f$	0.9227***	0.9861***	0.9524***
	(7.5885)	(7.1522)	(6.9548)
SMB	0.1248**	0.1186**	0.0232**
	(1.7085)	(0.3665)	(0.9431)
HML	-0.1456	-0.0351	-0.3001
	(-0.8390)	(-0.1737)	(-1.2289)
MOM		0.1585	
		(1.0396)	
RMW			0.0469
			(0.1505)
CMA			0.0609
			(0.1229)
R-Squared	0.6854	0.6868	0.6771
Observations	74	74	74

t statistics are reported in parentheses.
***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

The market factor is statistically significant at the 1% level in all three models. The loading is close to one in the three-factor and five-factor models, meaning portfolio returns are as risky as the market. The SMB loading also shows comparable results between the models where it is statistically significant at the 5% level. Overall, R-squared is similar among the three models for which approximately 68% of portfolio returns can be explained by the factors. The "Early/Late" factor and t-statistic is relatively small for the three factor models, suggesting that returns of early and late signatories are similar. However, the results are not statistically significant and so there is not enough evidence to conclude there is a difference between early and late signatories.

6 Conclusion

The rise in preferences for sustainable investing has driven a trend in the mutual fund industry that involves the development and adoption of investment strategies that incorporate environmental, social, and governance criteria. This is becoming increasingly important as sustainability issues introduce new risks and exposures such as climate risk. While a fund's intentions to invest in accordance with ESG criteria may seem genuine, a fund that self-declares as ESG may be founded on false claims so as to appear more attractive to investors. The presence of greenwashing makes it difficult for investors to identify funds that follow an investment strategy that aligns with their preferences and objectives. In addition, the lack of regulation and standardization in disclosure of ESG data causes further difficulties in evaluating the ESG alignment of a mutual fund.

This paper studies ESG mutual funds in comparison to conventional mutual funds to determine the differences in portfolio characteristics related to pollution, industry allocation, and performance. The objective is to determine how ESG funds differ from conventional funds, and whether ESG funds are less performing or riskier. To address the challenges in ESG data measurement and reporting, carbon emissions are used to measure portfolio pollution since it is well-defined and commonly used in the literature. Studying emissions also addresses the greenwashing concern by enabling an evaluation of actual environmental action. The funds under study are US domestic equity mutual funds and ESG funds are defined in two ways – by a fund's membership in the PRI and by a fund name containing ESG keywords. In order to answer the questions raised above, analyses are performed at the portfolio level on several aspects including data coverage, pollution, industry allocation, returns, and risk.

Data coverage issues decrease over time and disclosure of pollution data is better in larger-cap firms than smaller-cap firms. By 2020, PRI and conventional portfolios have nearly 95% coverage regardless of the firm size of their holdings. Portfolio pollution of the three fund types declines at a similar rate over time, but PRI and ESG name portfolios are responsible for less pollution per year than conventional portfolios. A decreasing pollution-to-TNA ratio for all fund types demonstrates that fund managers select firms that are less polluting, and this is seen more in PRI and ESG name portfolios which have a lower ratio than conventional portfolios. However, a closer look at the pollution distributions of the different fund types shows that their portfolio pollution is not that different by 2020. For PRI portfolios, there is an observable change in fund strategy before versus after signing the PRI as less emissions are emitted per dollar in TNA after a fund becomes a PRI signatory.

The industry analysis establishes that pollution per industry is relatively similar among the two ESG funds overall and conventional portfolios are consistently more polluting. In all funds, average portfolio pollution is mainly driven by two industries – utilities and energy. The key difference is in total net asset allocation where PRI and ESG name portfolios allocate the largest percentage of total net assets to the lowest polluting industries, and the smallest percentage in the highest polluting industries. A subsector breakdown of the utilities and energy industries finds that the largest differences in total net asset allocation are amongst the most polluting and carbon intense subsectors in which conventional portfolios invest more than ESG portfolios. These findings reveal that a fund that divests of polluting industries such as utilities and energy by even a small percentage of total allocation results in significantly less total portfolio pollution.

The results from the return analysis determine that the performance of PRI, ESG name, and conventional portfolios is generally similar over the sample period. For PRI portfolios, monthly portfolio returns before versus after signing shows that becoming a signatory generally lowers portfolio risk while also lowering returns. In addition, early PRI signatories experienced higher risk and reward than late signatories which can be explained by the uncertainties associated with ESG investing before it became more mainstream. In terms of industries, PRI and ESG name portfolio performance is driven by low polluting industries and the smallest mean return is from a high polluting industry – energy – which is not the case for conventional portfolios. However, energy represents the industry with the highest volatility regardless of fund type. When analyzing utilities and energy industries at the subsector level, PRI and ESG name portfolios have similar investing strategies that hedge against downside risk more than conventional portfolios. For the utilities industry, regressions of industry return differences on industry weight differences establish that there is a statistically significant relationship between the two variables for both PRI and ESG name portfolios in relation to conventional portfolios, meaning that utilities industry return differences can be explained by weight differences.

Finally, the risk analysis reveals that overall PRI and ESG name portfolios underperformed conventional portfolios over the sample period, with the lowest industry return being the energy industry. Energy demonstrates the highest volatility for all fund portfolio returns in terms of standard deviation and value at risk, and it is more volatile in ESG portfolios than conventional. According to the Fama-French factor models, PRI portfolio returns have more market risk when considering additional factors and portfolio performance can be attributed to holdings with high book-to-market value and momentum. ESG name portfolio returns have less market risk than PRI portfolios and performance can be attributed to holdings with weak profitability and lower total asset growth. Conventional portfolio returns have similar market risk to PRI portfolios and performance can be attributed to those with high momentum.

This paper provides insights on the ESG characteristics of mutual funds that self-declare as ESG funds in comparison to conventional funds by focusing on the environmental factor of ESG. It contributes to the existing literature by investigating the differences between ESG and non-ESG funds, determining the drivers of performance and risk at the portfolio level, and measuring funds' environmental impact. It ultimately contributes to the discussion of whether ESG mutual funds are actually different from conventional funds regarding the environmental factor or there is greenwashing involved. The mutual fund industry has market power in financial markets and so successful initiatives to consciously reduce portfolio exposure to carbon emissions has a positive effect on the development of sustainable finance and the fight against climate change. The results show that there is a difference in ESG mutual funds in terms of lower pollution but this difference is mainly explained by underweighting or divesting of top polluting industries.

A possible limitation in this paper is the inability to draw statistically significant conclusions about the driving factors of portfolio performance and return differences between ESG and conventional portfolios. There is also a paradoxical implication of portfolios with highly polluting holdings because while this increases exposure to climate risk, higher risk generally implies higher returns. This contradiction can be further explored to determine the trade-off required to generate high returns with low climate risk. Further research can assess new methods to identify ESG mutual funds and other breakdowns of pollution using alternative measures to discover how results would change if a metric other than carbon emissions would be used. In addition, the risk analysis can be expanded by adding a sixth factor to the Fama-French five-factor model, such as pollution, to establish a statistically significant relationship between portfolio performance and pollution by testing whether a factor loading on pollution can explain returns.

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Appendix A

List of Trucost Disclosure Categories

Trucost Category	Definition	Trucost Subcategory
Full disclosure	Exact data	• Exact Value from CDP[1] • Exact Value from Environmental/CSR[2] Report • Exact Value from personal communication
Partial disclosure	Estimated data	• Estimate based on partial data disclosure in CDP • Estimate based on partial data disclosure in Environmental/CSR Report • Estimate used instead of disclosure - data does not cover global operations • Estimated data
	Derived data	• Data approximated from chart/graph in Environmental Report/CSR Report/Website • Derived from previous year • Value derived from data provided in Annual Report/Financial Accounts Disclosure • Value derived from data provided in CDP • Value derived from data provided in Environmental/CSR • Value derived from fuel use provided in Annual Report/Financial Accounts Disclosure • Value derived from fuel use provided in Environmental/CSR
No disclosure	No data	• None

[1] CDP = Carbon Disclosure Project
[2] CSR = Corporate Social Responsibility

Appendix B

List of Top Polluting Trucost Industries and Subsectors

Trucost Industry	**Trucost Subsector**
Energy	• Crude Petroleum and Natural Gas Extraction • Bituminous Coal Underground Mining • Drilling oil and gas wells • Water transportation • Tar Sands Extraction • Support activities for oil and gas operations • Mining and oil and gas field machinery manufacturing • Petroleum refineries • Gasoline Stations • Software publishers • Environmental and other technical consulting services • Uranium-Radium-Vanadium • Ore Mining • Watch, clock, and other measuring and controlling device manufacturing • Non-residential manufacturing structures • Commercial and industrial machinery and equipment rental and leasing • Support activities for other mining • Natural Gas Liquid Extraction • Other basic organic chemical manufacturing • Water, sewage, and other systems • Sand, gravel, clay, and ceramic and refractory minerals mining and quarrying • Petroleum, Chemical, and Allied Products Wholesalers • All other chemical product and preparation manufacturing • Ground or treated mineral and earth manufacturing • Pipeline transportation • All other basic inorganic chemical manufacturing • Air transportation • Architectural, engineering, and related services • Wood container and pallet manufacturing • Ship building and repairing • Non-residential commercial and health care structures • Bituminous Coal and Lignite Surface Mining

	• All other miscellaneous professional, scientific, and technical services • Natural gas distribution • Support activities for transportation • Iron and steel mills and ferroalloy manufacturing • Electrical and Electronic Goods Wholesalers • Small electrical appliance manufacturing • Air and gas compressor manufacturing • Motor Vehicle and Machinery, Equipment, and Supplies Wholesalers • Securities, commodity contracts, investments, and related activities • Scientific research and development services
Utilities	• Natural gas distribution • Pipeline transportation • Wind Power Generation • Hydroelectric Power Generation • Support activities for agriculture and forestry • Water, sewage, and other systems • Electric Power Distribution • Stone mining and quarrying • Coal Power Generation • Natural Gas Power Generation • Geothermal Power Generation • Other non-residential structures • Residential maintenance and repair • Support activities for transportation • Electric Bulk Power Transmission and Control • Securities, commodity contracts, investments, and related activities • Nuclear Electric Power Generation • Petroleum Power Generation • Non-residential maintenance and repair • Petroleum, Chemical, and Allied Products Wholesalers • Warehousing and storage • Crude Petroleum and Natural Gas Extraction • Turbine and turbine generator set units manufacturing • Support activities for oil and gas operations

Appendix C

Descriptive Statistics – Coverage by Deciles

This table presents descriptive statistics on data coverage by deciles of PRI and non-PRI fund portfolios. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. Panel A shows the percentage per decile of PRI fund portfolio holdings for which Trucost emissions data is available, ranked by the weighted average market value of firms invested by the fund. Panel B shows the percentage per decile of conventional non-PRI fund portfolio holdings for which Trucost data is available. The sample period is 2006 to 2020.

Panel A: Data Coverage of PRI Funds

Decile	Obs	Mean	Std Dev	Min	Median	Max
1	149	0.7517	0.1254	0.4118	0.7667	0.9731
2	149	0.7747	0.1219	0.3077	0.7742	0.9794
3	148	0.7884	0.1099	0.3200	0.7861	0.9907
4	146	0.7915	0.0904	0.5161	0.7899	0.9820
5	148	0.7887	0.1242	0.3556	0.7968	0.9857
6	149	0.7728	0.0871	0.4167	0.7727	0.9545
7	148	0.8309	0.0648	0.6338	0.8333	0.9762
8	149	0.8479	0.0679	0.6364	0.8553	0.9679
9	143	0.8730	0.0620	0.7027	0.8741	0.9934
10	143	0.9192	0.0504	0.7350	0.9306	0.9868

Panel B: Data Coverage of Conventional Funds

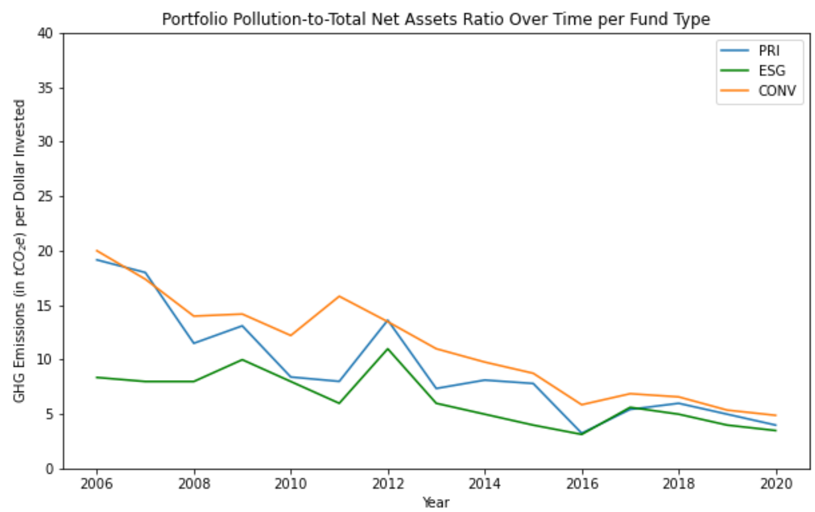
Decile	Obs	Mean	Std Dev	Min	Median	Max
1	174	0.7588	0.1300	0.3636	0.7809	0.9623
2	175	0.7760	0.1225	0.4167	0.7959	0.9821
3	175	0.7611	0.1214	0.3000	0.7627	0.9800
4	175	0.7767	0.1118	0.5000	0.7778	0.9714
5	174	0.7372	0.1295	0.2727	0.7419	0.9630
6	169	0.7625	0.0850	0.4545	0.7692	0.9767
7	177	0.7996	0.0808	0.5385	0.8049	0.9524
8	172	0.8216	0.0787	0.6000	0.8279	0.9815
9	170	0.8587	0.0759	0.6364	0.8712	0.9892
10	167	0.8941	0.0614	0.6316	0.9062	0.9894

Appendix D

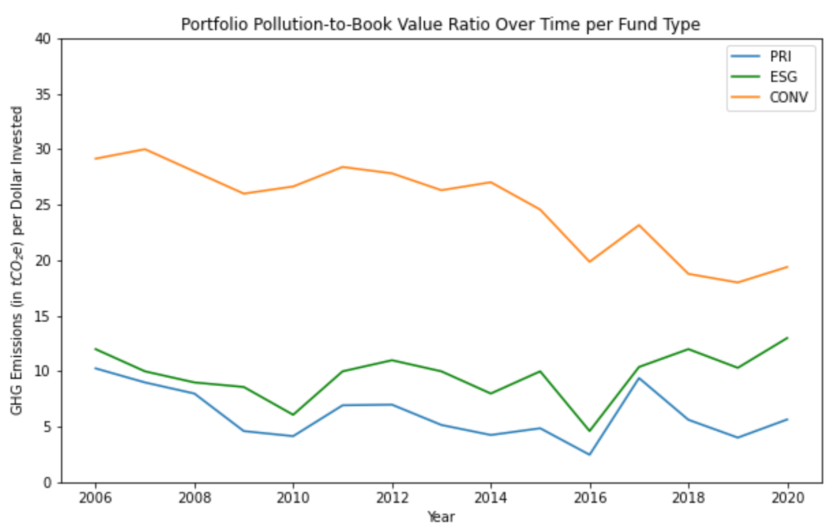
Portfolio Pollution-to-Total Net Assets and Pollution-to-Book Value Ratios Over Time

This figure shows the value-weighted average pollution per dollar in total net assets and in firm book value of fund portfolios over time by fund type. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. PRI fund data is taken as of the PRI signature date. Pollution is represented by greenhouse gas (GHG) emissions in tonnes of carbon dioxide equivalent (tCO_2e). Panel A shows the ratio of portfolio pollution per dollar in total net assets of PRI and ESG name portfolios compared to conventional portfolios per year. Panel B shows the ratio of portfolio pollution per dollar in book value of PRI and ESG name portfolios compared to conventional portfolios per year. The sample period is 2006 to 2020.

Panel A



Panel B



Appendix E

Descriptive Statistics – Portfolio Pollution

This table presents descriptive statistics on portfolio pollution of fund portfolios over time by fund type. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. PRI fund data is taken as of the PRI signature date. Pollution is represented by greenhouse gas (GHG) emissions in millions of tonnes of carbon dioxide equivalent (tCO_2e). Pollution-to-TNA is the ratio of portfolio pollution per dollar in total net assets of the portfolio. The sample period is 2006 to 2020.

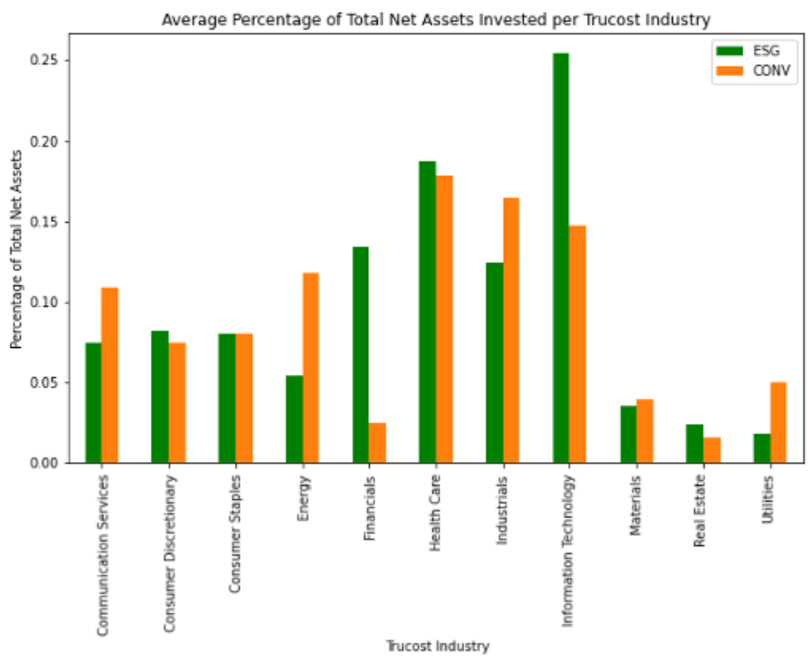
	Obs	Mean	Std Dev	Min	Median	Max
PRI Funds						
Emissions	896	200.4878	318.7538	0.0007	37.3517	1872.4845
Pollution/TNA	896	21.1356	126.2603	0.0006	0.7849	1978.3373
ESG Funds						
Emissions	506	86.9759	270.4403	0.0005	4.3662	1859.2316
Pollution/TNA	506	28.0944	104.2656	0.0003	1.2320	884.4234
Conventional Funds						
Emissions	2124	3047.5074	595,988.6296	0.0105	612.5388	45,444.9769
Pollution/TNA	2124	9.3525	46.4700	0.0002	0.4472	999.9630

Appendix F

Average Pollution versus Percentage of Portfolio Total Net Assets per Industry

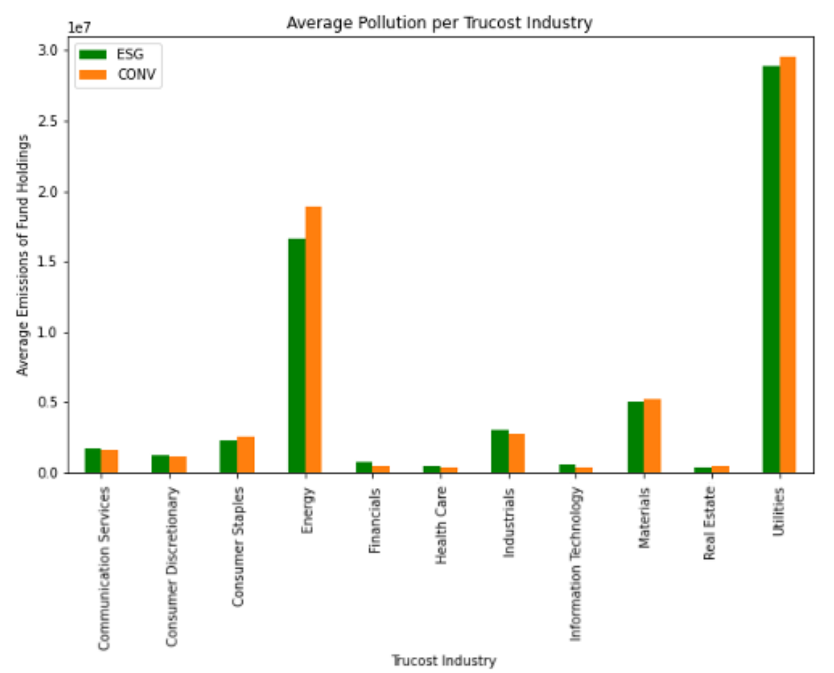
This figure shows the average pollution of each Trucost industry invested in by the mutual funds under study compared to its percentage of portfolio total net assets. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that self-declare as ESG in their fund names and those that do not. Pollution is represented by greenhouse gas (GHG) emissions in tonnes of carbon dioxide equivalent (tCO_2e). The industries used are according to Trucost's classification of business activities. Panel A shows the average percentage of total net assets invested per industry of ESG name fund portfolios compared to conventional fund portfolios. Panel B shows the average pollution per industry of ESG name fund portfolios compared to conventional fund portfolios. The sample period is 2006 to 2020.

Panel A



Appendix F (cont'd)

Panel B



Appendix G

Differences in Percentage of Total Net Assets Invested in Each Industry

This table presents a comparison of the percentage of total net assets invested in each Trucost industry by ESG name and conventional fund portfolios. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that self-declare as ESG in their fund names and those that do not. "Mean %TNA" is defined as the percentage of portfolio total net assets invested in each industry. The industries used are according to Trucost's classification of business activities. "Difference" represents the difference in percentage of total net assets between ESG name and non-ESG fund portfolios. Significance is tested using *t* tests and *t* statistics are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The sample period is 2006 to 2020.

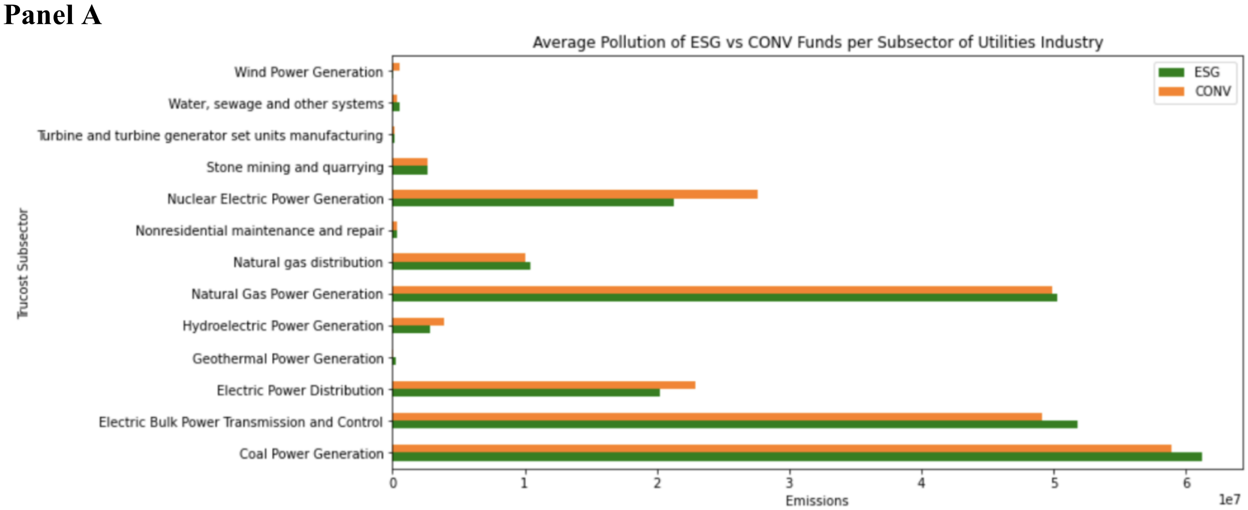
Industry	CONV Mean %TNA	ESG Mean %TNA	Difference
Communication Services	0.1085	0.0741	0.0344***
			(3.3929)
Consumer Discretionary	0.0741	0.0821	-0.008
			(-0.6491)
Consumer Staples	0.0801	0.0802	-0.0001
			(-0.0036)
Energy	0.1177	0.0539	0.0639***
			(4.5951)
Financials	0.0245	0.1340	-0.1095***
			(-6.4639)
Health Care	0.1784	0.1871	-0.0087
			(-0.3101)
Industrials	0.1645	0.1243	0.0402***
			(2.9721)
Information Technology	0.1475	0.2541	-0.1067*
			(-2.0176)
Materials	0.0393	0.0349	0.0044
			(1.0521)
Real Estate	0.0155	0.0235	-0.008
			(-1.6527)
Utilities	0.0500	0.0177	0.0323***
			(7.1414)

Appendix H

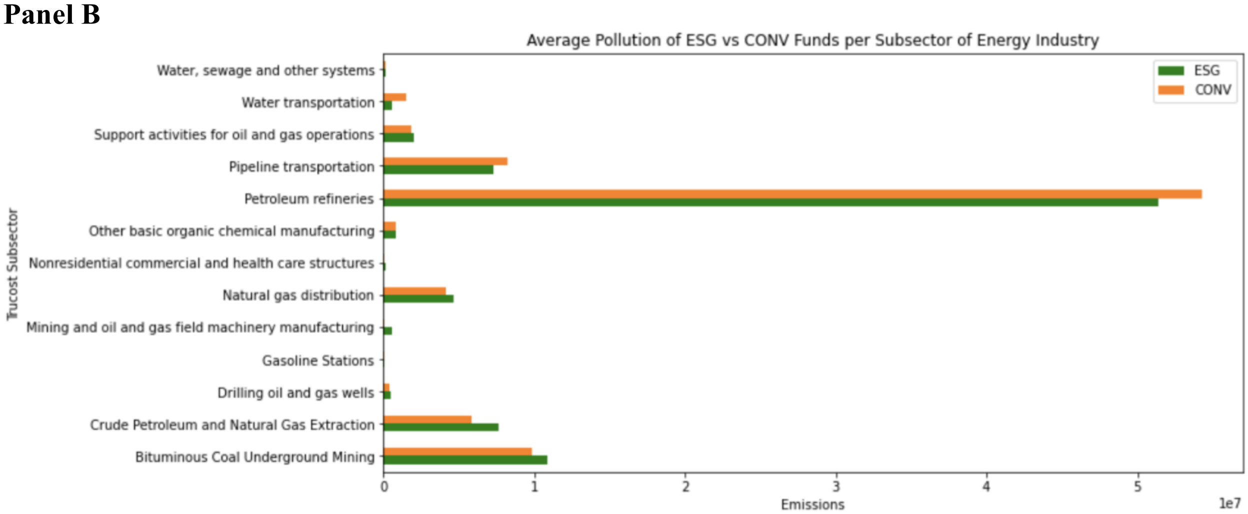
ESG Name Funds: Average Pollution of Utilities and Energy Industries

This figure shows the average pollution of the Trucost subsectors of the utilities and energy industries. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that self-declare as ESG in their fund names and those that do not. Pollution is represented by greenhouse gas (GHG) emissions in tonnes of carbon dioxide equivalent (tCO_2e). The industries used are according to Trucost's classification of business activities. Panel A shows the average pollution per subsector of the utilities industry for ESG name fund portfolios compared to conventional fund portfolios. Panel B shows the average pollution per subsector of the energy industry for ESG fund portfolios compared to conventional fund portfolios. The sample period is 2006 to 2020.

Panel A



Panel B

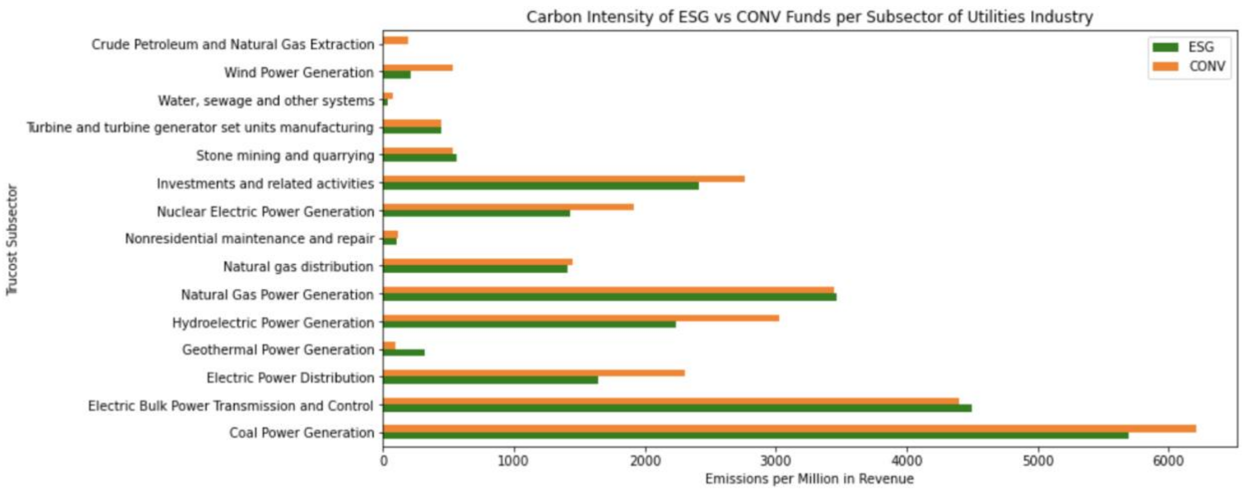


Appendix I

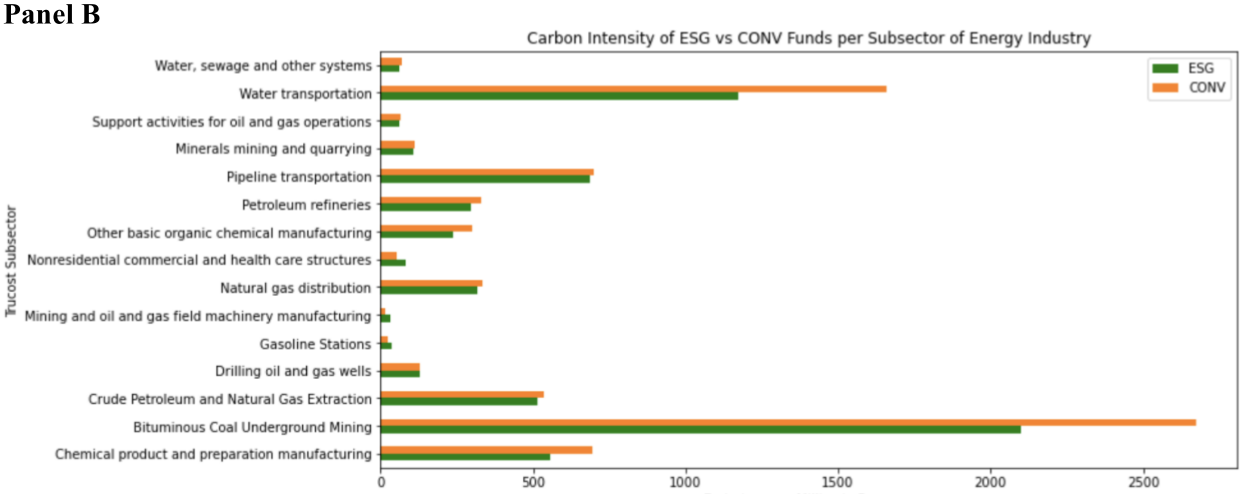
ESG Name Funds: Average Carbon Intensity of Utilities and Energy Industries

This figure shows the average carbon intensity of portfolio holdings in the Trucost subsectors of the utilities and energy industries. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that self-declare as ESG in their fund names and those that do not. Carbon intensity is represented by greenhouse gas (GHG) emissions in tonnes of carbon dioxide equivalent (tCO_2e) per million dollars in revenue. The industries used are according to Trucost's classification of business activities. Panel A shows the average carbon intensity of portfolio holdings per subsector of the utilities industry for ESG name fund portfolios compared to conventional fund portfolios. Panel B shows the average carbon intensity of portfolio holdings per subsector of the energy industry for ESG name fund portfolios compared to conventional fund portfolios. The sample period is 2006 to 2020.

Panel A



Panel B



Appendix J

Descriptive Statistics – Utilities and Energy Industry Pollution

This table presents descriptive statistics on industry pollution of PRI, ESG name, and conventional funds for the utilities and energy industries. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. Pollution is represented by greenhouse gas (GHG) emissions in millions of tonnes of carbon dioxide equivalent (tCO_2e). Carbon intensity is the ratio of GHG emissions to a company's annual revenue in millions of dollars. The industries used are according to Trucost's classification of business activities. The sample period is 2006 to 2020.

Panel A: Utilities Industry Pollution

	Obs	Mean	Std Dev	Min	Median	Max
PRI Funds						
Emissions	4509	28.3506	33.8472	0.1984	15.0372	147.5374
Carbon Intensity	4509	2919.5334	2632.9421	2.7001	2796.7478	15,192.5809
ESG Name Funds						
Emissions	1005	27.1240	32.0627	0.4462	16.3773	134.0327
Carbon Intensity	1005	2696.8903	2603.8445	2.7004	2592.0892	14,133.5827
Conventional Funds						
Emissions	5416	29.0235	33.4876	0.2018	16.5975	157.02763
Carbon Intensity	5416	3045.5289	2732.5311	5.7933	2890.7945	18,040.8665

Panel B: Energy Industry Pollution

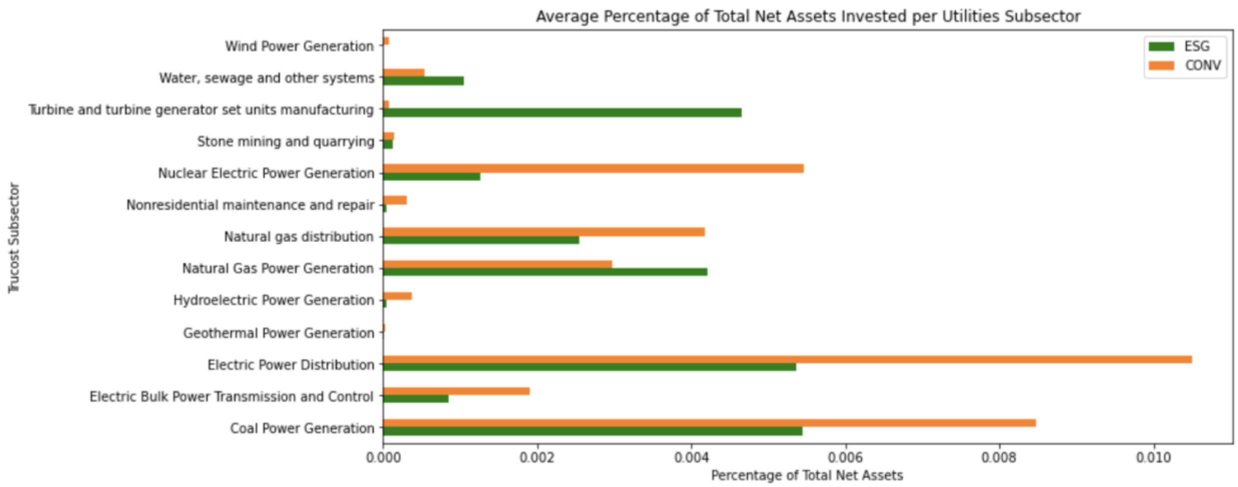
	Obs	Mean	Std Dev	Min	Median	Max
PRI Funds						
Emissions	6789	16.5993	32.2613	0.5300	2.8547	160.2098
Carbon Intensity	6789	432.4899	571.8747	0.7590	278.2857	8688.3745
ESG Name Funds						
Emissions	1221	16.6620	31.1155	0.1003	3.4968	160.2098
Carbon Intensity	1221	368.9876	396.5732	10.7422	274.3349	4682.4634
Conventional Funds						
Emissions	7438	17.82189	33.7099	0.1497	2.9430	160.20983
Carbon Intensity	7438	428.0010	537.5789	6.1080	278.6777	8688.3723

Appendix K

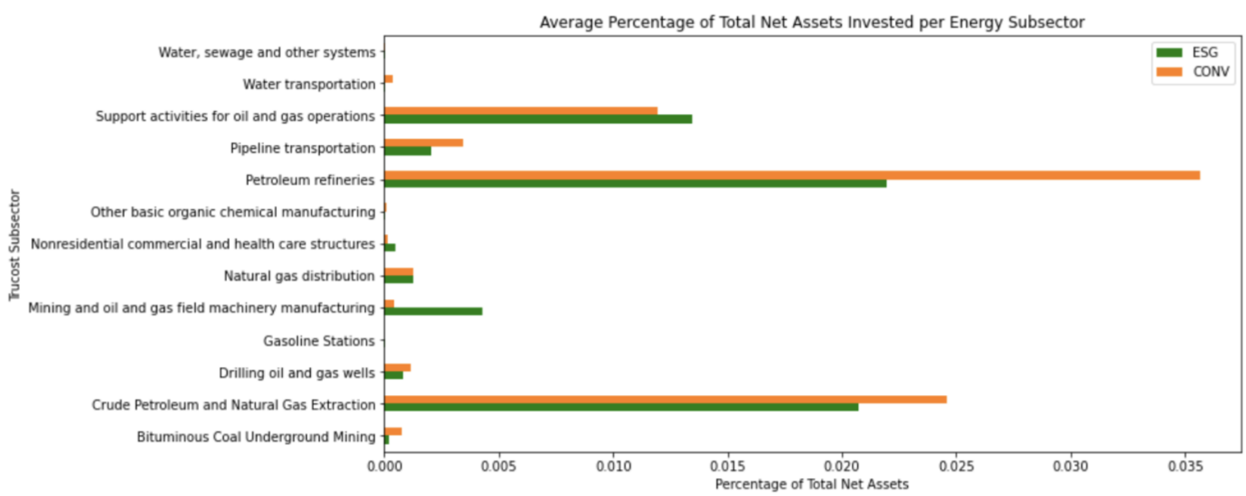
ESG Name Funds: Average Percentage of Portfolio Total Net Assets of Utilities and Energy Industries

This figure shows the average percentage of portfolio total net assets invested in each Trucost subsector of the utilities and energy industries. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that self-declare as ESG in their fund names and those that do not. The industries used are according to Trucost's classification of business activities. Panel A shows the percentage of portfolio total net assets invested per subsector of the utilities industry for ESG name fund portfolios compared to conventional fund portfolios. Panel B shows the percentage of portfolio total net assets invested per subsector of the energy industry for ESG name fund portfolios compared to conventional fund portfolios. The sample period is 2006 to 2020.

Panel A



Panel B

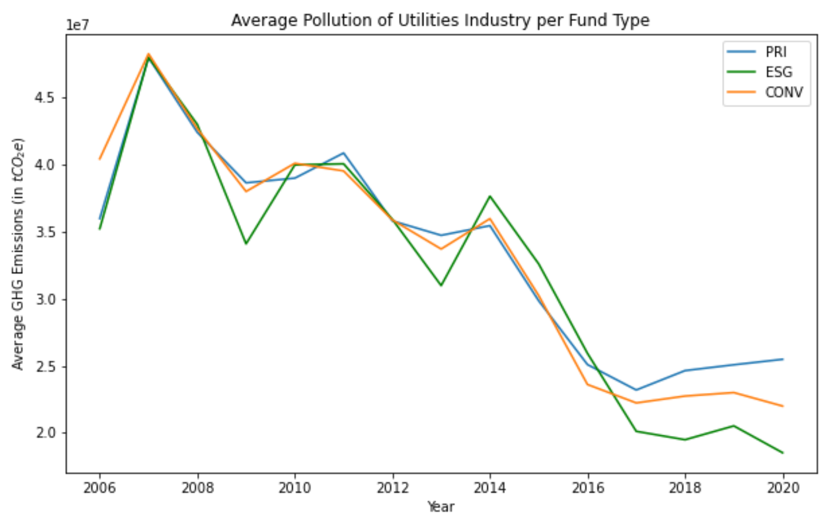


Appendix L

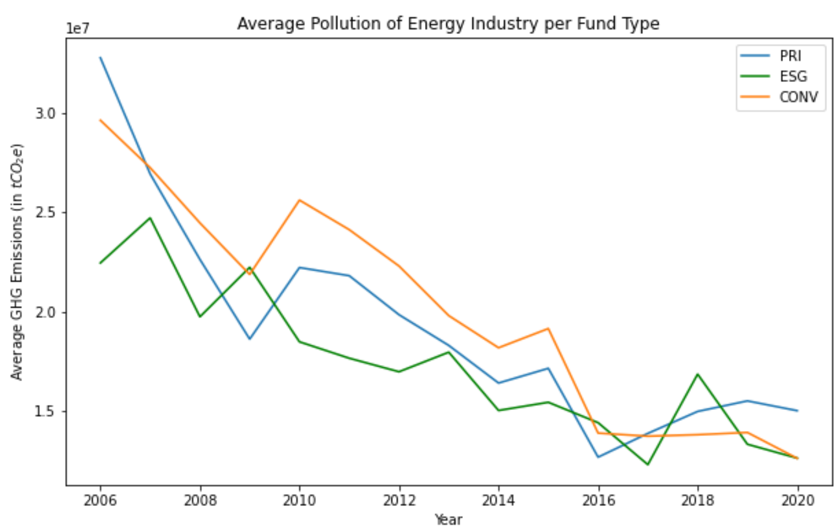
Average Pollution of Utilities and Energy Industries Over Time

This figure shows the average pollution of the utilities and energy industries over time by fund type. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into three types: those that are signatories of the Principles of Responsible Investment (PRI), those that have an ESG fund name, and those that are conventional non-ESG funds. PRI fund data is taken as of the PRI signature date. Pollution is represented by greenhouse gas (GHG) emissions in tonnes of carbon dioxide equivalent (tCO_2e). The industries used are according to Trucost's classification of business activities. Panel A shows the average pollution of the utilities industry for PRI and ESG name fund portfolios compared to conventional non-ESG fund portfolios. Panel B shows the average pollution of the energy industry for PRI and ESG name fund portfolios compared to conventional non-ESG fund portfolios. The sample period is 2006 to 2020.

Panel A



Panel B

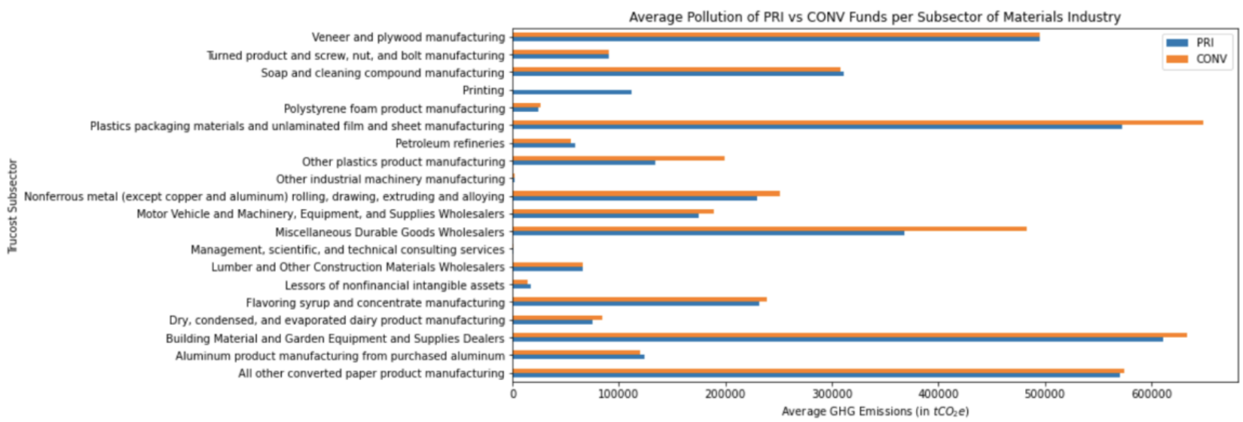


Appendix M

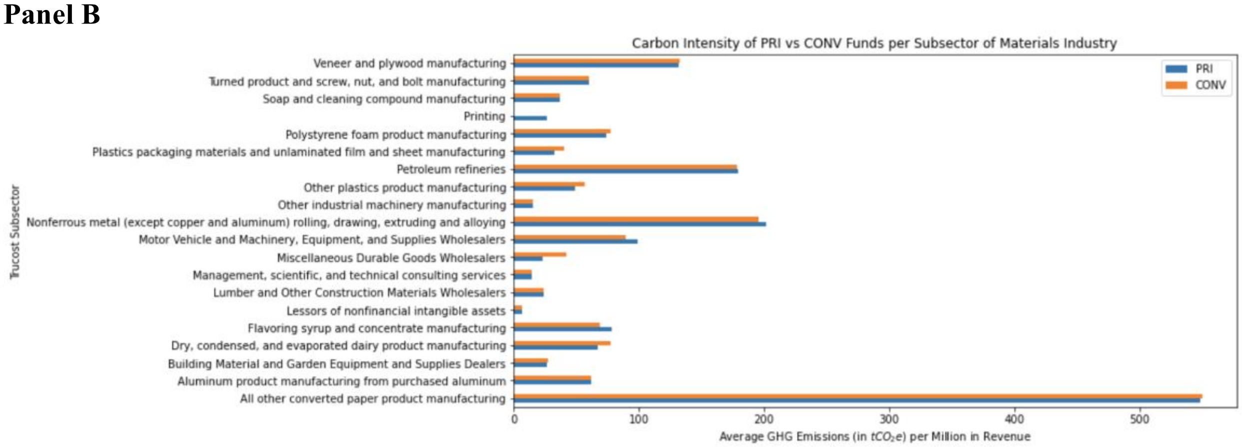
Average Pollution, Carbon Intensity, and Percentage of Portfolio Total Net Assets of Materials Industry

This figure shows the characteristics of each Trucost subsector in the materials industry. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that are signatories of the Principles of Responsible Investment (PRI) and those that are not. PRI fund data is taken as of the PRI signature date. The industries used are according to Trucost's classification of business activities. Panel A shows average pollution per subsector of the materials industry for PRI fund portfolios compared to conventional non-PRI fund portfolios. Panel B shows average carbon intensity per subsector of the materials industry for PRI fund portfolios compared to conventional non-PRI fund portfolios. Panel C shows the percentage of portfolio total net assets invested per subsector of the materials industry for PRI fund portfolios compared to conventional non-PRI fund portfolios. The sample period is 2006 to 2020.

Panel A

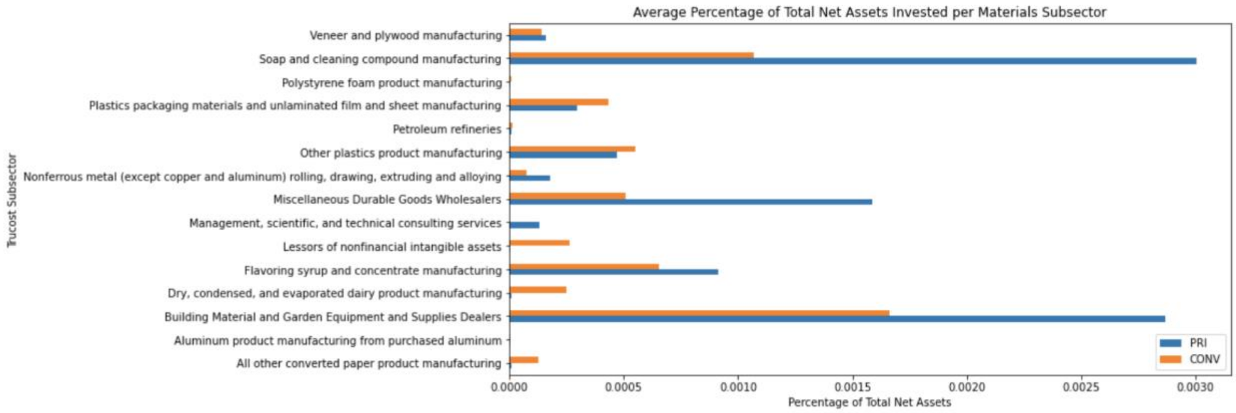


Panel B



Appendix M (cont'd)

Panel C

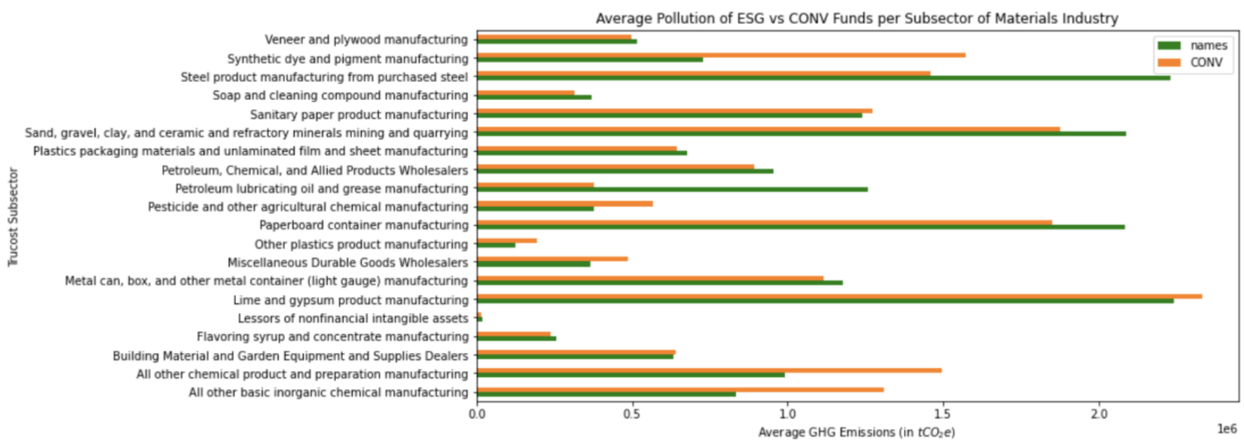


Appendix N

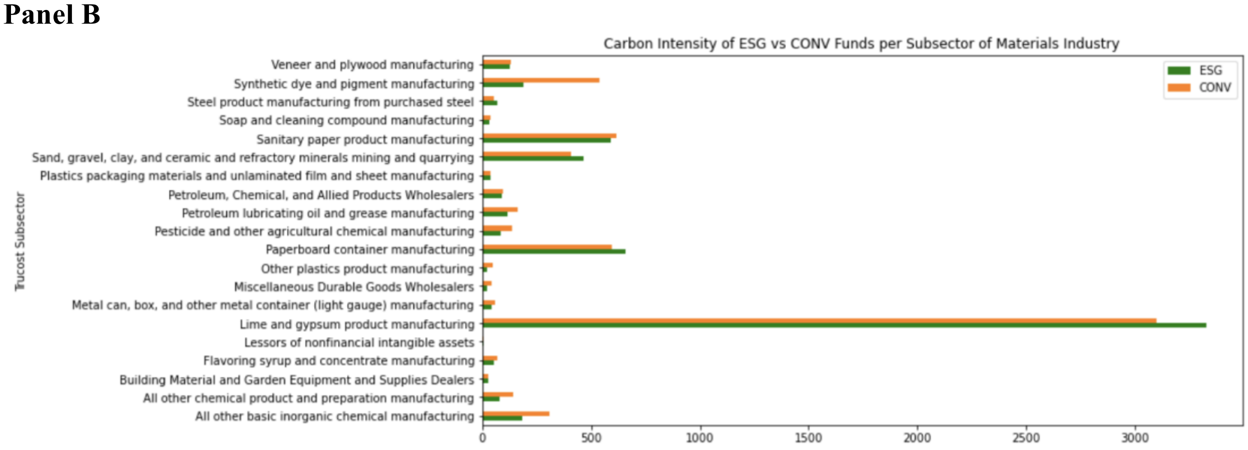
ESG Name Funds: Average Pollution, Carbon Intensity, and Percentage of Portfolio Total Net Assets of Materials Industry

This figure shows the characteristics of each Trucost subsector in the materials industry. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. This figure shows the average pollution of each Trucost industry invested in by the mutual funds under study. The sample is US domestic equity mutual funds from the CRSP Mutual Funds database. Funds are categorized into two types: those that self-declare as ESG in their fund names and those that do not. The industries used are according to Trucost's classification of business activities. Panel A shows average pollution per subsector of the materials industry for ESG name fund portfolios compared to conventional non-ESG fund portfolios. Panel B shows average carbon intensity per subsector of the materials industry for ESG name fund portfolios compared to conventional non-ESG fund portfolios. Panel C shows the percentage of portfolio total net assets invested per subsector of the materials industry for ESG name fund portfolios compared to conventional non-ESG fund portfolios. The sample period is 2006 to 2020.

Panel A



Panel B



Appendix N (cont'd)

Panel C