ESG Ratings and Carbon Emissions

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First Draft: 5 Feb 2023

Abstract

Despite severe academic criticism ESG has become a buzz-word for investors and companies around the world. Trillions of dollars are invested based on environmental, social and governance (ESG) ratings. In this paper we examine whether ESG investment is associated with desired social outcomes (CO2 emissions) or attractive financial returns using ESG scores from a leading data provider (Refinitiv) for the US sample 2005-2018. We find that investments in portfolios of firms with high ESG or high Environmental scores does not provide higher returns nor lower carbon emissions.

1. Introduction

ESG investment – investment according to environmental, social, and governance criteria – has grown massively in recent years. For example, it is estimated that about 1/3 of all investments in the US are ESG-related (Berg, Fabisik and Sautner 2021). Theoretically ESG investments might lower the cost of capital for sustainable companies, which could help increase their sustainability investments.

ESG investment is often based on ESG ratings, which affect how institutional investors with trillions of dollars in assets under management make investment decisions (Gibson, Glossner, Krueger, Matos, and Steffen 2021; GSIA 2016; USSIF 2020; PRI 2018). Examples of agencies providing ESG ratings include Asset4 (or now Refinitiv), Sustainalytics, FTSE, MSCI, Inrate, and Bloomberg.

While ESG ratings have been used as a tool in asset allocation by environmentally concerned investors, several recent studies have questioned the quality and reliability of the ESG ratings. A number of studies report disagreement among different agencies providing ESG ratings and question their reliability (e.g., Berg, Koelbel, and Rigobon 2020; Brandon, Krueger and Schmidt 2021; Christensen, Serafeim, and Sikochi, 2022). For example, Berg, Fabisik and Sautner (2020) document that the reliability of Refinitiv ESG scores is compromised by changes/adjustments to their past scores. Recently, the integrity of the ESG ratings has also been questioned – for example whether firms with high ESG ratings are actually do what they claim to do by being more social and environmental friendly and having good governance. Bam and van der Kroft (2022) report that investors allocating funds according to good ESG scores may incorrectly invest in firms with poorer sustainable performance. Cohen, Gurun and Nguyen (2020) document that the brownest firms do more to reduce future carbon emission. Relying on firm-level emission futures contracts, Van Binsbergen and Brogger (2022) document that firms with higher E ratings have higher, not

lower, future emissions. In a similar vein, studies suggesting that ESG scores are prone to "cheap talk" include Bingler et al. (2022a, 2022b), Michaely, Ordonez-Calafi and Rubio (2021) and Li, Naaraayanan and Sachdeva (2021).

However, the relationship between ESG ratings and carbon emissions is complex and multifaceted, and there are arguments both in favour of and against the proposition that high ESG ratings result in reduced carbon emissions. On the one hand, proponents of this idea argue that firms with high ESG ratings are more likely to prioritize sustainability and environmental stewardship as such they are more likely to invest in renewable energy, implement environmentally friendly policies, and engage in other initiatives aimed at reducing their carbon footprint. On the other hand, those against the idea argue that no clear causal relationship between ESG ratings and carbon emissions exists. In this line of argument, firms with high ESG ratings produces higher carbon emissions. In addition, there may be other factors at play that influence a firm's carbon emissions, such as industry type, regulatory environment, and technological constraints. This ultimately leads to the on-going debate around whether high ESG ratings lead to lower carbon emissions among academics and stakeholders, leaving them to further explore the complex interplay between sustainability, corporate responsibility, and environmental impact. As such, we contribute to this unresolved controversy by directly exploring whether firms with high ESG or E ratings are less or more polluted.

Based on almost 7,500 firm-year observations of the U.S. firms and our granger causality tests, we find that evidence against the idea that high ESG or E firms emit less carbon. Instead, our findings support "cheap talk" concept, greenwashing hypothesis and legitimacy theory such that ESG or E rating is firm's publicity tool rather than firm' s commitment to do good for the environment. Additionally, our findings may be in line with regulatory capture and technological limitations hypotheses. Similar to greenwashing hypothesis, regulatory capture hypothesis suggests that firms having no real intention to reduce carbon emission lobby

regulators to intervene to set up favourable ESG framework while continue to pollute. Finally, consistent with technological limitations hypothesis, it is possible that firms genuinely committed to ESG still produce high carbon emission as they do not have the most advanced technologies for carbon emissions reductions.

We contribute to the existing literature by challenging the assumption that high ESG or E ratings are always indicative of superior environmental performance, highlighting the need for more comprehensive measures of sustainability, and informing policymakers and regulators in their efforts to promote sustainability and reduce pollution. Our finding is crucial because it implies that companies may be able to manipulate their ESG or E ratings without making meaningful improvements to their environmental performance. Moreover, the study underscores the need for more comprehensive measures of sustainability that go beyond ESG or E ratings, when evaluating its environmental performance. These measures could include carbon footprint assessments, life cycle assessments, and other approaches that provide more detailed insights into a company's environmental impact, including green bonds, sustainability reporting and environmental audits. As such, it is important to consider multiple measures to gain a comprehensive understanding of a company's sustainability practices and environmental impact. We also contribute to the development of ESG rating systems, by highlighting the need for more stringent standards and more thorough evaluation of companies' environmental impact. Additionally, our findings can inform policymakers and regulators in their efforts to reduce pollution and promote sustainability. The study can prompt policymakers to evaluate the effectiveness of current environmental regulations and enforcement mechanisms and consider additional measures, such as stricter regulations or stronger enforcement mechanisms, to address pollution and other environmental concerns.

The reminder of this paper is organised as follows. Section 2 compares theories of ESG investment. Section 3 reviews related empirical literature. Section 34describes data and method. Section 5 presents empirical results. Section 6 concludes.

2. Theories of ESG investment

Universal owners (UN 2011) – very large and globally diversified asset managers – arguably have a special role to play in addressing global challenges such as climate and sustainability (UN 2011). Externalities mean that adverse effects of carbon emissions, biodiversity loss, or social imbalances will reduce the value and expected returns of their assets even if they are cost efficient from the viewpoint of individual firms in their portfolios. Universal owners therefore have strong incentives to address such externalities in order to protect their assets.

Hart and Zingales (2022) develop this argument conceptually. They show by several examples that shareholders have recently voted for proposals that are good for climate and sustainability, but likely to reduce earnings in particular companies. In other words, they no longer maximize shareholder value, but rather another broader value concept, which may be called shareholder welfare.

In a risk management perspective, global environmental risk is systematic and cannot be diversified away (Gordon 2022). Thus, it makes business sense for universal owners to make cost-efficient investments – such as perhaps campaigning, screening and voting – that lower sustainability risks. In fact, given their diversified portfolios – which imply very little exposure to individual firms – it makes much more sense for universal owners to engage in such "systemic stewardship" than in the more traditional investor activism targeting individual firms.

A less positive view is that ESG was invented by an increasingly competitive asset management industry to raise fees by introducing a more complex product (The Economist 2022). The concept was coined in a report ("Who Cares Wins", 2004) by Goldman Sachs and other large financial institutions invited by UN General Secretary Kofi Annan to *"develop guidelines and recommendations to integrate environmental, social and governance issues in asset management, securities brokerage services."*

Macey (2021) suggests that managers use ESG as an excuse for bad performance.

3. Literature review and hypotheses development

2.1. Carbon Emission

Carbon emissions, especially carbon dioxide (CO2) emissions, are viewed as one of the most prominent factors of climate change and are considered the prime cause of current environmental issues (Rehman et al., 2021). Stakeholder and legitimacy theories are often utilized to explain how corporation deals with carbon emissions. According to stakeholder theory, managers should balance all stakeholders' interests to ensure that company gets their supports for long-term success (Roberts, 1992). Given carbon emission leads to climate change and global warming risk, it is therefore in all stakeholders' interests to reduce carbon footprints. Example of papers supporting stakeholder theory in this context includes Huang and Kung (2010), Epstein and Roy (2001) and Pinzone et al. (2015). Liesen et al. (2015). Huang and Kung (2010) suggest that firms utilize social and environmental disclosures as ways in an attempt to balance all stakeholders' interests. In a survey of greenhouse gas emission of 431 European firms, Liesen et al. (2015) document that external stakeholders' pressure significantly affects the greenhouse gas emissions, which eventually influence managers' decision-making and their behaviour in disclosing carbon information. Further studies supporting stakeholder theory suggest that the desire of stakeholders for safeguarding the environment can act as a catalyst for firms taking proactive measures towards environmental protection (Epstein and Roy, 2001, Pinzone et al., 2015). Finally, in line with stakeholder theory, the 2005 and 2008 KPMG international survey of corporate responsibility reporting suggests that firms rely on sustainability disclosure to communicate their actions in response to stakeholders concerns on various sustainable issues.

Another closely related theory is legitimacy theory. Although reduction of carbon footprints is crucial and in best interests of all stakeholders, firms attempt to conform with

stakeholders' expectations by strategically legitimating their policies and conducts. According to the legitimacy theory, the amount and disclosure of carbon emissions are crucial in the stakeholder and public perception. A widely held assumption or conviction that an entity's activities are desirable, acceptable, or appropriate within a socially built system of norms, values, beliefs, and definitions is referred to as legitimacy, according to Suchman (1995); Aouadi & Marsat, (2016); Treepongkaruna et al., (2021a); Treepongkaruna et al., (2021b). As such carbon emission reduction deems to be desirable activities for firm's sustainable development. Carbon emissions are closely linked to multiple factors, including but not limited to, industrial structure, economic growth, research and development investment, urbanization, and the growth rate of energy consumption, with the quantity of released carbon emissions closely correlated to economic growth (Liu at al., 2021). However, according to Matsumura et al., (2014), there is a $212,000 drop in firm value for every thousand more metric tons of carbon emissions. Moreover, Matsumura et al., (2014) discover that the median value of businesses that publicly report their carbon emissions is around $2.3 billion greater than the median value of businesses that do not publicly report. These findings illustrate that while the markets penalize all businesses for their carbon emissions, businesses that fail to declare their emissions are subject to an additional penalty. The findings support the claim that corporate valuations in the capital markets take into account both carbon emissions and the voluntary disclosure of this information, thus supporting the aforementioned legitimacy theory. In addition, investing in carbon emission reduction projects such as prioritizing of the use of capital toward R&D investment in renewable resources and green technologies and energy consumption within the optimal range promote higher future firm value. These findings support the corporate legitimacy theory.

2.2. ESG and carbon emission

According to the OECD's 2021 report titled "ESG Investing and Climate Transition: Market Practices, Issues and Policy Considerations," there is a growing trend of using the

environmental component of ESG ratings to align investments with the low-carbon transition. The report further notes that although ESG rating and investing has the potential to reveal important information about a company's climate risks and opportunities, there are still significant challenges including the existence of divergent approaches, inconsistencies in data, the lack of uniformity in ESG criteria and rating methods, as well as insufficient clarity on how ESG integration impacts asset allocation. Existing literature also documents two opposing views on the relation between ESG and carbon emission. Example of studies supporting stakeholder theory and a positive relation between ESG and carbon emission includes Luo et al. (2012), Clarkson et al. (2013), Li et al. (2017), Plumlee et al. (2015), Schiemann & Sakhel (2019), and Cao & Rees (2020). For example, external stakeholders such as shareholders and debtholders, who are two common sources of funding, tend to favour companies that have superior carbon performance and lower carbon emissions (see Albarrak et al., 2019; Cheng et al., 2014; Choi et al.,2021; Choi & Luo, 2021; Clarkson et al., 2015; Griffin et al., 2017; Jung et al., 2018; Matsumura et al.,2014; and Shen et al.,2022).

On contrary, another strand of research finds an insignificant or negative relation between ESG and carbon emission and support legitimacy theory, along with "cheap talk" or "greenwashing" hypotheses. These include Diouf & Boiral (2017), Wedari et al. (2021), Christensen et al. (2021), Khan et al. (2022), Adu et al. (2022), Van Binsbergen and Brogger (2022) and Rughunandan and Rajgopal (2022). According to Diouf and Boiral (2017), managers may choose to engage in symbolic ESG reporting or selectively disclose only those ESG metrics that present the company in a positive light in order to justify their corporate decisions. The effectiveness of benchmarking through ESG reporting is dependent on the importance, credibility, significance, and comparability of the reported information. However, Adu et al. (2022) argue that the use of symbolic ESG reporting can reduce transparency and hinder stakeholders from utilizing it for efficient benchmarking. As a result, it may not be possible for ESG reporting to have a tangible impact on carbon mitigation. Additionally,

Rughunandan and Rajgopal (2022) examines whether ESG mutual funds actually invest in firms with stakeholder-friendly track records, however they report that ESG scores actually indicates the quantity of voluntary ESG-related disclosures rather than compliance records or actual levels of carbon emissions by firms. Hence, it appears that socially responsible funds, advocating to do more for stakeholders' concerns do not actually do so.

3.3. Hypotheses development

As previously noted, two contrasting evidence on the relation between ESG and carbon emission exists. We therefore develop the following hypotheses consistent with both positive and negative view of the effect of ESG on carbon emissions. First, *consistent with legitimacy theory,* we refer to "*cheap talk" or "greenwashing" hypothesis*. This hypothesis suggests that companies may engage in deceptive practices by presenting themselves as more environmentally friendly than they actually are. This is done to attract consumers who are becoming more environmentally conscious and to improve their public image. "Greenwashing" or "cheap talk" involves promoting a company's environmental initiatives through advertising or other public relations efforts without actually making significant changes to reduce their environmental impact. This practice has become more prevalent as companies face increasing pressure to appear environmentally responsible. However, critics argue that such practice is a form of deception that can mislead consumers, and it undermines the efforts of companies that are genuinely committed to sustainability. Another hypothesis predicting a negative relation between ESG and carbon emission is "*technological limitation"* hypothesis. Under this hypothesis, companies may genuinely have intentional to reduce carbon footprints but do not have sufficient fund or know-how to do so.

As opposed to the first line of hypothesis, we refer to *"shared valued"* hypothesis, predicting a positive relation between ESG and carbon emission. Consistent with stakeholder theory, it is best interests to all stakeholders to reduce carbon emission which in turns leads to long-run corporate sustainability. The *"shared value"* hypothesis suggests that companies that prioritize

ESG factors, including environmental sustainability, can also generate long-term value for their shareholders. This value creation can occur through improved efficiency, cost savings, and increased brand reputation, among other benefits. According to this hypothesis, companies that manage their environmental impact more effectively will be more likely to succeed in the long run. In the case of carbon emissions, companies that reduce their emissions may also benefit from increased efficiency and reduced costs. For example, companies that actively address climate change and reduce their carbon footprint may attract customers who prioritize sustainability and may benefit from increased brand loyalty and reputation. As such, this hypothesis suggests that companies that focus on environmental sustainability are not only benefiting the environment, but also creating value for their shareholders and stakeholders.

4. Data and Method

We obtain the data from several sources. Following Bolton and Kacperczyk (2021), we collect the data on carbon emissions of companies from S&P Trucost. The Center for Research in Security Prices (CRSP) provides data on stock returns and market capitalization. We collect monthly holding period return (RET) for each stock and value-weighted market return from CSRP). Compustat provides accounting data for estimating firm-level control variables, whilst Refinitiv supplies ESG and Environmental scores. The sample period of our study covers from 2005 to 2018. To examine the relation between carbon emission intensity and ESG performance, we employ the following granger causality models:

$$Carbon_{it} = \alpha_0 + \alpha_1 ESG_{it-1} + \alpha_2 Carbon_{it-1} + \sum b_j \, Control_{it} + \sum FE + \varepsilon_t \quad (1)$$

$$ESG_{it} = \alpha_0 + \alpha_1 Carbon_{it-1} + \alpha_2 ESG_{it-1} + \sum b_j \, Control_{it} + \sum FE + \varepsilon_t \quad (2)$$

We also replace the Refinitiv' s ESG score in equations 1 and 2 with the Refinitiv's Environmental score. Our carbon emission (Carbon) variable is the natural logarithm of carbon intensity. Specifically, it is the amount of carbon emissions (measured in units of tons of CO2 and CO2 equivalent, and scaled by revenues and normalized using the natural

logaritmic scale by company *i* in year *t*. The Greenhouse Gas (GHG) Protocol Corporate Standard categorizes a company's carbon emissions into one of the following "scopes": direct emissions from owned or controlled sources (Scope 1), indirect emissions from the generation of purchased energy such as heat, steam and electricity (Scope 2), and other indirect emissions caused by the operations and productions of the company, but occur from sources not owned or controlled by the company, including the production of purchased materials, product use, and waste disposal (Scope 3). Because we focus on analyzing the relation between ESG or E performance and company's carbon emissions, we employ only Scope 1, scaled by company revenues.

In addition, we also include the following control variables that may be related to carbon emissions. A number of firm-specific attributes such firm size (natural logarithm of total assets), profitability (earnings before interests and taxes scaled by total assets), leverage (total debt divided by total assets), investments (capital expenditures divided by total assets), intangible assets (research and development divided by total assets and advertising expense divided by total assets), discretionary spending (SG&A expense divided by total assets), cash holdings (cash holding divided by total assets), and dividend payouts (total dividends divided by total assets) are included. Further, we account for corporate governance by including two popular proxies of board quality being proportion of board independence and natural log of board size (Rosenstein and Wyatt, 1990; Cotter, Shivdasani, and Zenner, 1997; Nguyen and Nielsen, 2010; Yermack, 1996; Adams & Ferreira, 2009; Arun et al., 2015; Campbell & Mínguez-Vera, 2008; Tanthanongsakkun, Treepongkaruna and Jiraporn, 2022).

Table 1 reports descriptive statistics for all variables included in this study. On average, firms in our sample emit carbon dioxide (CO2) about 26 tons per a million dollars of revenues with average ESG score of 45.6 and Environment score of 35.6. We further split sample into 2 subsamples: firms with ESG (or Environment) scores above median (Hi-score sample) and firms with ESG (or Environment) scores below median (Low-score sample). Hi-score (Low-

score) sample, on average, emits carbon dioxide (CO2) about 28 (25) tons per a million dollars of revenues. The Refinitiv's ESG (Environment) scores are 61 and 59 in Hi-score sample and 30 and 12 for Low-score sample, respectively. Firms in our sample use leverage only 25%, have low intangible assets, hardly spend on capital investments, hold low cashes and pay little dividends. Interestingly, 80% of boards are independent directors.

[Table 1 About Here]

5. Results

a. Preliminary analysis

Our main research question is to explore whether ESG rating influences firms to do more for environment or to be more specific whether firms awarded with high ESG rating actually do what they proclaimed to do. Hence, we focus on two Refinitiv scores being ESG and Environment scores. We initially explore how the Refinitiv's ESG (or Environment) score relates to firms' carbon and return performance and risk by using visual inspection as shown in Figures 1 and 2. First, we construct 4 portfolios, quarterly sorting by the Refinitiv's ESG (or Environment) score. Two ways of forming portfolio are employed as follows. First, we form static portfolio at the beginning of our sample period, which is year 2005 and leave constituents of the portfolio unchanged over the sample period. Second, we form dynamic portfolio by rebalancing portfolio at the beginning of each year. For each portfolio, we compute the following 4 measures: annualised holding period return, CAPM (or market model) based return, CAPM beta and carbon intensity, respectively. First, the monthly holding period return (HRP) for each stock is directly taken from CRSP, which defines HRP as follows:

$$HRP_{it} = \left[\frac{p_{it} \times f_{it} + d_{it}}{p_{it-1}}\right] - 1$$

where p_{it} is price of stock *i* at time *t*, f_{it} is price adjustment factor for time *t*, d_{it} is cash adjustment at time *t*. Next, to construct the CAPM based return, for each stock, we first estimate the following regression model:

$$HRP_{it} = \alpha + \beta MKT_t + \varepsilon_{it}$$

where MKT_t is market index at time *t*. Based on the estimated parameters, we obtain the CAPM based return and beta.

Figure 1 (2) plots return, carbon emission performances and beta of two ESG (Environment) based portfolios: top vs. bottom quartile ESG (Environment) portfolios. Overall, both figures indicate that return performance is not significantly different between firms with hi and low ESG (or Environment) scores while low ESG (or Environment) portfolio are riskier than hi ESG (or Environment) portfolio. More interestingly, carbon emission reduces over the year but firms with hi ESG(Environment) score tends to have higher carbon emission than the rest of the firms. Next, Table 2 reports the average annualised holding period return, CAPM (or market model) based return, CAPM beta and carbon intensity for each quartile portfolio. For these four measures, we also compute the difference between top and bottom quartile portfolios, along with t-statistics. Table 2 confirms findings from Figures 1 and 2. Overall, our preliminary analysis provides evidence supporting ESG as a cheap talk as firms with high ESG (or Environment) score are actually more polluted.

[Figures 1 & 2 and Table 2 About Here]

b. *Granger Causality analysis*

As our preliminary results point towards potential relation between carbon emission and the ESG (or Environment) score, we conduct the following formal analyses. Specifically, we conduct Dumitrescu & Hurlin (2012) Granger non-causality test for our panel sample and reject the null hypothesis, suggesting that ESG (or Environment) score does Granger-cause carbon intensity for at least one panel. Table 3 reports granger causality between carbon emission and ESG score. The coefficient of lagged ESG score on carbon intensity is not significant for full and low-ESG samples, but positively significant for the hi-ESG sample. Given the standard deviation of the natural logarithm of carbon emission is 2.29 in the hi-ESG sample, an increase in an ESG score increases carbon emission by 0.001 divided by 2.29, which

is 0.04% or approximately 0.01 tonnes per millions of revenues. Controlling for firm characteristics and corporate governance, the coefficient of lagged ESG score on carbon intensity is not significant for all samples. These findings indicate that ESG rating hardly has any impact on carbon emission and even worse than that hi-ESG firms actually increase carbon emission.

Turning to the effect of Environment score on carbon emission reported in Table 4, we also find the coefficient of lagged Environment (ENV) is not significant for full and low-ENV samples, but positively significant for the hi-ENV sample. This implies that firms in hi-ENV sample increase carbon emission by approximately 0.04% or 0.01 tonnes per millions of revenue for one standard deviation increase in ENV score. Controlling for firm characteristics and corporate governance, the coefficient of lagged ENV score on carbon intensity is not significant for hi-ENV sample, negatively significant at 10% and 1% level for the full and low-ENV samples, respectively. This implies that firms in low-ENV sample decrease carbon emission by approximately 0.21% or 0.05 tonnes per millions of revenue for one standard deviation increase in ENV score. It appears that firms with high ENV score emit more carbon dioxide while firms with low ENV score do more for environment by lowing carbon emission.

6. Conclusion

Climate change is a real threat to humankinds and a pressing global concerns needing urgent action to mitigate its effects. Fossil fuels are traditional energy sources that are relatively cheap but emit carbon, creating pollutions and climate changes. Carbon emissions reduction is critical to achieving global climate goals. While governments around the world collectively work towards meeting the goals of the Paris Agreement and the United Nation's Sustainable Development Goals (SDGs), social and environmental concerned investors are also increasingly using ESG for climate transition when making investment decisions. This makes ESG investing a popular form of sustainable finance and in line with long-term value and societal values. However, recent studies raised some doubt on investing in ESG friendly firms

or funds whether these firms or funds genuinely reduce carbon footprints. It is therefore important to study the relationship between ESG and carbon emissions. Understanding the relationship between ESG and carbon emissions helps us identify the most effective strategies in response to climate changes, make an informed decision in investments and finally assist regulators to develop policies and regulations supporting sustainable development and emissions reduction.

Our findings are consistent with the legitimacy theory as they indicate that investing in high ESG or E pillar of the ESG scores does not provide a better return nor lower carbon emission. Two implications from our findings are as follows. First, scores provided by the Refinitiv may not be a good tool in ranking firms based on environmental concerns. As noted in the OECD's 2021 report titled "ESG Investing and Climate Transition: Market Practices, Issues and Policy Considerations," there are inconsistent among ESG ratings provided by leading rating providers. Boffo (2020) also argue that in an absence of a universally accepted global set of principles and guidelines for consistent and meaningful reporting, it becomes difficult to effectively compare and integrate sustainability-related factors into the investment decision procedures. Based on our findings, more work needs to ensure ESG ratings representing what they are supposed to do.

Alternative implication of our findings lies on the assumption that ESG rating is reliable and a negative relation between ESG or E pillar of ESG scores and carbon emission is evidence of "cheap talk." Firms with high ESG or E scores do not have incentives to do more to be less polluted. Based on our findings, smart and environmental concerned investors can avoid falling victim to greenwashing behaviours of the firms and carefully choose to invest in firms that provide evidence of concrete actions taken to reduce their carbon footprints. Our findings also affect how regulators set their policies towards green economy. Regulators may wish to impose fine to discourage firms from "greenwashing" behaviours. Further, regulators

may also introduce policies such as tax reduction to encourage firms with limited technologies to do more to reduce carbon footprints.

References

Adu, D. A., Flynn, A., & Grey, C. (2022). Carbon performance, financial performance and market value: The moderating effect of pay incentives. Business Strategy and the Environment. https://doi.org/10.1002/bse.3239

Albarrak, M. S., Elnahass, M., & Salama, A. (2019). The effect of carbon dissemination on cost of equity. Business Strategy and the Environment, 28(6), 1179–1198. https://doi.org/10.1002/bse.2310

Cao, Z., & Rees, W. (2020). Do employee-friendly firms invest more efficiently? Evidence from labor investment efficiency. Journal of Corporate Finance, 65, 101744. https://doi.org/10.1016/j.jcorpfin.2020.101744

Cheng, B., Ioannou, I., & Serafeim, G. (2014). Corporate social responsibility and access to finance. Strategic Management Journal, 35(1), 1–23. https://doi.org/10.1002/smj.2131

Choi, B., Luo, L., & Shrestha, P. (2021). The value relevance of carbon emissions information from Australian-listed companies. Australian Journal of Management, 46(1), 3–23. https://doi.org/10.1177/0312896220918642

Choi, B., & Luo, L. (2021). Does the market value greenhouse gas emissions? Evidence from multi-country firm data. The British Accounting Review, 53(1), 1–24. https://doi.org/10.1016/j.bar.2020.100909

Christensen, H. B., Hail, L., & Leuz, C. (2021). Mandatory CSR and sustainability reporting: Economic analysis and literature review. Review of Accounting Studies, 26(3), 1176–1248. https://doi.org/10.1007/s11142-021-09609-5

Clarkson, P. M., Fang, X., Li, Y., & Richardson, G. (2013). The relevance of environmental disclosures: Are such disclosures incrementally informative? Journal of Accounting and Public Policy, 32(5), 410–431. https://doi.org/10.1016/j.jaccpubpol.2013.06.0

Diouf, D., & Boiral, O. (2017). The quality of sustainability reports and impression management. Accounting, Auditing & Accountability Journal, 30(3), 643–667. https://doi.org/10.1108/AAAJ-04-2015-2044

Epstein, M.J. & Roy, M.J. (2001). Sustainability in action: identifying and measuring the key performance drivers. Long Range Planning, 34 (5), 585-604

Griffin, P. A., Lont, D. H., & Sun, E. Y. (2017). The relevance to investors of greenhouse gas emission disclosures. Contemporary Accounting Research, 34(2), 1265–1297. https://doi.org/10.1111/1911-3846.12298

Huang, C.L., & Kung, F.-H. (2010). Drivers of environmental disclosure and stakeholder expectation: Evidence from Taiwan. Journal of Business Ethics, 96(3), 435–451.

Jung, J., Herbohn, K., & Clarkson, P. (2018). Carbon risk, carbon risk awareness and the cost of debt financing. Journal of Business Ethics, 150(4), 1151–1171. https://doi.org/10.1007/s10551-016-3207-6

Khan, H. Z., Houqe, M. N., & Ielemia, I. K. (2022). Organic versus cosmetic efforts of the quality of carbon reporting by top New Zealand firms. Does market reward or penalise? Business Strategy and the Environment, 1–18. https://doi.org/10.1002/bse.3169

KPMG. (2005). KPMG international survey of corporate responsibility reporting 2005. Amsterdam: KPMG.

KPMG. (2008). KPMG international survey of corporate responsibility reporting 2008. Amsterdam: KPMG.

Li, Y., Gong, M., Zhang, X.-Y., & Koh, L. (2017). The impact of environmental, social, and governance disclosure on firm value: The role of CEO power. The British Accounting Review, 50, 60–75. https://doi.org/10.1016/j.bar.2017.09.007

Liesen A, Hoepner AG, Patten DM, and Figge, F. (2015). Does stakeholder pressure influence corporate GHG emissions reporting? Empirical evidence from Europe. Accounting Auditing & Accountability Journal, 28(7), 1047–1074. doi:10.1108/AAAJ-12-2013-1547.

Luo, L., Lan, Y. C., & Tang, Q. (2012). Corporate incentives to disclose carbon information: Evidence from the CDP global 500 report. Journal of International Financial Management & Accounting, 23(2), 93–120. https://doi.org/10.1111/j.1467-646X.2012.01055.x

Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2014). Firm-value effects of carbon emissions and carbon disclosures. The Accounting Review, 89(2), 695–724. https://doi.org/10.2308/accr-50629

OECD (2021), ESG Investing and Climate Transition: Market Practices, Issues and Policy Considerations, OECD Paris, https://www.oecd.org/finance/ESG-investing-and-climatetransition-Market-practices-issues-and-policy-considerations.pdf.

Pinzone, M., Lettieri, E. & Masella, C. (2015). Proactive environmental strategies in healthcare organisations: drivers and barriers in Italy. Journal of Business Ethics, 131, 183-197.

Plumlee, M., Brown, D., Hayes, R. M., & Marshall, R. S. (2015). Voluntary environmental disclosure quality and firm value: Further evidence. Journal of Accounting and Public Policy, 34(4), 336–361. https://doi.org/10.1016/j.jaccpubpol.2015.04.00

Roberts, R. (1992). Determinants of corporate social responsibility disclosure: An application of stakeholder theory. Accounting, Organizations and Society, 17(6), 595–612.

Schiemann, F., & Sakhel, A. (2019). Carbon disclosure, contextual factors, and information asymmetry: The case of physical risk reporting. The European Accounting Review, 28(4), 791–818. https://doi.org/10.1080/09638180.2018.153460

Shen, H., Yang, Q., Luo, L., & Huang, N. (2022). Market reactions to a cross-border carbon policy: Evidence from listed Chinese companies. The British Accounting Review, 101116. https://doi.org/10.1016/j.bar.2022.101116

Wedari, L. K., Jubb, C., & Moradi-Motlagh, A. (2021). Corporate climate-related voluntary disclosures: Does potential greenwash exist among Australian high emitters reports? Business Strategy and the Environment, 30(8), 3721–3739. https://doi.org/10.1002/bse.2836

Table 1. Summary Statistics

This table reports descriptive statistics for all variables. Carbon is the natural logarithm of carbon intensity (Scpoe1), which is direct measure of carbon emission, scaled by firm's revenue. ESG and Environment are the Refinitiv scores. Control variables include firm size (Ln of total assets), profitability (EBIT/total assets), leverage (total debt/total assets), investments (capital expenditures/total assets), intangible assets (research and development/total assets and advertising expense/total assets), discretionary spending (SG&A expense/total assets), cash holdings (cash holdings/total assets), dividend payouts (total dividends/total assets), proportion of board independence and natural log of board size.

Panel A: Key variables of interests

	N	Mean	SD	p50	p25	p75
Full Sample						
Carbon	7463	3.275504	2.102561	2.985906	2.033255	4.228223
ESG	7468	45.63837	19.79361	44.22	29.96	61.035
Environment	7464	35.59833	28.44181	33.45	7.715	59.92
High Score						
Carbon	3825	3.336739	2.297373	2.934115	1.857906	4.678478
ESG	3827	60.95562	13.28604	60.54	50.85	70.62
Environment	3819	58.53617	18.78613	59.38	45.52	73.24
Low Score						
Carbon	3638	3.211122	1.874208	3.035141	2.116898	3.954602
ESG	3641	29.53865	10.59337	29.66	22.09	36.69
Environment	3645	11.56552	12.562	7.62	0	20.56

Panel B: Control Variables

	N	Mean	SD	p50	p25	p75
size	5170	8.979407	1.216066	8.834919	8.075	9.780076
leverage	5170	0.2465238	0.1617944	0.2386899	0.1319929	0.3432955
Profitability	5170	0.1133252	0.1044071	0.1043571	0.0662328	0.1538474
Capital Investment	5170	0.0522085	0.0511577	0.0375131	0.0205534	0.0656311
R&D Intensity	5170	0.0242038	0.0469659	0	0	0.0278399
Advertising Intensity	5170	0.0135959	0.0343863	0	0	0.0117847
Dividends	5170	0.0196872	0.0272191	0.0136504	0	0.0271259
Cash Holdings	5170	0.1311799	0.1339476	0.0865021	0.0314319	0.1880302
Discretionary Spending	5170	0.1885897	0.1776072	0.145811	0.0523552	0.2730442
% Ind Director	5170	80.07027	11.03733	81.81818	75	88.88889
Bsize	5170	2.394636	0.1793198	2.397895	2.302585	2.484907

Table 2. Portfolio performance

This table reports average holding period return, market model return, natural logarithm of carbon intensity (scope 1) and CAPM beta of dynamic portfolios with annual rebalance, sorting by ESG or Environment scores into quartile.

ESG	HRP	Return	Carbon	Beta
Q1	12.85%	12.80%	3.26	1.27
Q2	11.97%	12.08%	3.27	1.26
Q3	12.53%	12.55%	3.28	1.17
Q4	10.33%	10.35%	3.47	1.01
Q4-Q1	-2.52%	-2.45%	0.22**	-0.26***

Environment	HRP	Return	Carbon	Beta
Q1	12.15%	12.80%	2.84	1.26
Q2	14.40%	12.08%	3.43	1.23
Q3	12.03%	12.55%	3.55	1.16
Q4	10.26%	10.35%	3.54	1.00
Q4-Q1	-1.90%	-2.45%	0.71***	-0.26***

Table 3. Granger Causality between carbon emission and ESG score

The Granger causality framework is employed to explore the causal relationship between carbon emission and the Refinitiv's environmental score (*Environment*). The following models are estimated with and without controls.

$$Carbon_{it} = \alpha_0 + \alpha_1 ESG_{it-1} + \alpha_2 Carbon_{it-1} + \sum b_j \, Control_{it} + \sum FE + \varepsilon_t \quad (1)$$

$$ESG_{it} = \alpha_0 + \alpha_1 Carbon_{it-1} + \alpha_2 ESG_{it-1} + \sum b_j \, Control_{it} + \sum FE + \varepsilon_t \quad (2)$$

The sample period covers 2005-2018. A firm is classified as high (low) environment if the firm's environmental score is above (below) yearly median environmental score. Standard errors clustered by firm are reported in parentheses. *, ** and *** represent statistical significance at 10%, 5% and 1%, respectively.

	Full Sample		Hi ESG Score		Lo ESG Score		Full Sample		Hi ESG Score		Lo ESG Score	
	Carbon	ESG	Carbon	ESG	Carbon	ESG	Carbon	ESG	Carbon	ESG	Carbon	ESG
ESG[-1]	-0.000	0.925***	0.001**	0.718***	-0.001	0.796***	-0.00001	-0.002	0.00001	0.003	-0.00001	0.003
	(-1.400)	(216.883)	(2.228)	(98.877)	(-0.775)	(92.730)	(-0.003)	(-0.236)	(0.211)	(0.426)	(-1.007)	(0.434)
Carbon[-1]	0.990***	0.063	0.996***	-0.030	0.981***	0.053	0.489***	-0.245	0.545***	-0.319	0.360***	0.063
	(396.876)	(1.544)	(307.886)	(-0.593)	(249.403)	(1.034)	(38.499)	(-0.967)	(28.990)	(-1.013)	(20.269)	(0.230)
size							-0.099***	3.840***	-0.241***	3.281***	-0.005	2.433***
							(-3.108)	(6.005)	(-4.556)	(3.694)	(-0.129)	(3.718)
leverage							0.052	3.214*	-0.218	9.156***	0.131	0.382
							(0.538)	(1.672)	(-1.238)	(3.106)	(1.193)	(0.220)
Profitability							-0.172**	2.485	-0.100	6.256***	-0.238**	-0.484
							(-2.023)	(1.458)	(-0.724)	(2.695)	(-2.341)	(-0.300)
Capital Investment							-1.100***	1.922	-1.382**	6.838	-0.510	-0.524
							(-3.412)	(0.297)	(-2.123)	(0.627)	(-1.449)	(-0.094)
R&D Intensity							1.409***	11.191	0.625	8.417	2.559***	-4.824
							(3.250)	(1.286)	(1.001)	(0.804)	(4.094)	(-0.487)
Advertising Intensity							1.552**	15.878	5.053***	29.214	0.433	3.793
							(1.968)	(1.002)	(3.000)	(1.034)	(0.525)	(0.290)
Dividends							-0.869**	14.271*	-1.673***	22.789**	0.466	-0.050
							(-2.041)	(1.669)	(-2.870)	(2.331)	(0.733)	(-0.005)
Cash Holdings							-0.188	5.990**	-0.362*	4.006	0.010	2.650
							(-1.458)	(2.314)	(-1.763)	(1.163)	(0.061)	(1.020)
Discretionary Spending							-0.257	-1.669	-0.880**	-9.398	-0.198	4.526
							(-1.156)	(-0.374)	(-2.483)	(-1.581)	(-0.688)	(0.994)
% Ind Director							0.001	0.054**	-0.000	0.081**	0.001	0.028
							(0.736)	(2.214)	(-0.167)	(2.512)	(0.784)	(1.141)
Bsize							-0.090	-3.079**	-0.029	-3.309*	0.005	-3.485**
							(-1.205)	(-2.059)	(-0.264)	(-1.803)	(0.045)	(-2.173)

Constant	0.000	5.173***	-0.112***	19.705***	0.044*	6.496***	5.611***	30.509***	6.985***	25.824**	0.516	-0.111
	(0.003)	(21.264)	(-3.739)	(42.147)	(1.815)	(20.523)	(14.420)	(3.909)	(11.202)	(2.469)	(1.118)	(-0.015)
Observations	7,463	7,468	3,825	3,827	3,638	3,641	3,896	3,899	2,132	2,133	1,764	1,766
R-squared	0.955	0.863	0.961	0.719	0.945	0.703	0.973	0.876	0.977	0.815	0.977	0.755
Firm FE	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Adj R-squared	0.955	0.863	0.961	0.719	0.945	0.703	0.968	0.853	0.971	0.769	0.970	0.675

Table 4. Granger Causality between carbon emission and environmental score

The Granger causality framework is employed to explore the causal relationship between carbon emission and the Refinitiv's environmental score (*Environment*). The following models are estimated with and without controls.

$$Carbon_{it} = \alpha_0 + \alpha_1 Environment_{it-1} + \alpha_2 Carbon_{it-1} + \sum b_j\, Control_{it} + \sum FE + \varepsilon_t \quad (3)$$

$$Environment_{it} = \alpha_0 + \alpha_1 Carbon_{it-1} + \alpha_2 Environment_{it-1} + \sum b_j\, Control_{it} + \sum FE + \varepsilon_t \quad (4)$$

The sample period covers 2005-2018. A firm is classified as high (low) environment if the firm's environmental score is above (below) yearly median environmental score. Standard errors clustered by firm are reported in parentheses. *, ** and *** represent statistical significance at 10%, 5% and 1%, respectively.

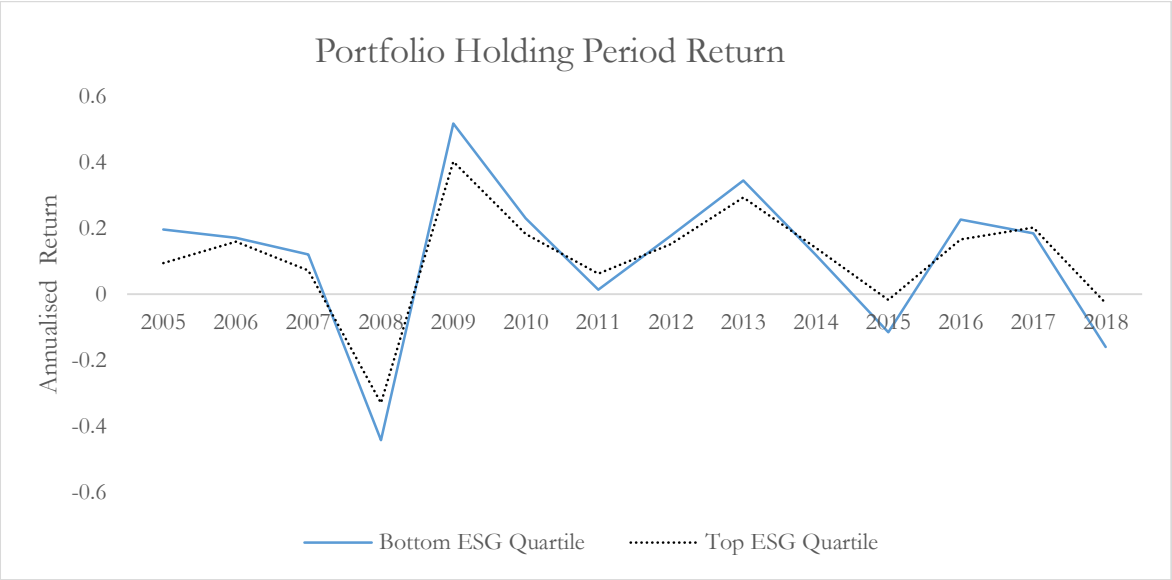
	Full Sample		Hi Environment Score		Lo Environment Score		Full Sample		Hi Environment Score		Lo Environment Sc	
	Carbon	Environment	Carbon	Environment	Carbon	Environment	Carbon	Environment	Carbon	Environment	Carbon	Environ
Environment[-1]	-0.00001	0.941***	0.001***	0.704***	0.00001	0.847***	-0.001*	0.543***	0.001	0.375***	-0.004***	0.461*
	(-0.381)	(237.058)	(3.987)	(97.767)	(0.296)	(111.026)	(-1.661)	(46.030)	(1.321)	(24.807)	(-3.706)	(27.1
Carbon[-1]	0.990***	0.145***	0.998***	-0.145**	0.979***	0.121**	0.483***	-0.160	0.550***	0.136	0.291***	-0.06
	(400.113)	(2.680)	(317.974)	(-2.071)	(239.793)	(2.157)	(43.114)	(-0.626)	(33.318)	(0.372)	(18.675)	(-0.28
size							-0.086***	2.940***	-0.254***	1.742*	-0.018	1.819*
							(-3.119)	(4.631)	(-5.571)	(1.726)	(-0.510)	(3.52
leverage							0.009	-0.550	-0.164	2.007	-0.043	-0.55
							(0.112)	(-0.283)	(-1.157)	(0.640)	(-0.431)	(-0.37
Profitability							-0.242***	2.482	-0.237**	2.015	-0.229**	1.80
							(-2.998)	(1.341)	(-2.008)	(0.772)	(-2.199)	(1.18
Capital Investment							-0.808***	7.381	-1.576***	11.471	0.070	5.32
							(-2.821)	(1.125)	(-2.959)	(0.974)	(0.214)	(1.12
R&D Intensity							1.566***	2.484	2.930***	23.115	1.632***	-8.17
							(3.799)	(0.263)	(2.841)	(1.013)	(4.005)	(-1.37
Advertising Intensity							1.788**	1.919	4.107***	-10.336	0.021	-1.53
							(2.400)	(0.112)	(3.081)	(-0.350)	(0.025)	(-0.12
Dividends							-1.027***	12.649	-1.253**	21.736**	-0.274	3.60
							(-2.897)	(1.556)	(-2.561)	(2.007)	(-0.554)	(0.49
Cash Holdings							-0.149	-0.029	-0.188	2.807	-0.146	5.161
							(-1.277)	(-0.011)	(-1.004)	(0.676)	(-1.028)	(2.48
Discretionary Spending							-0.138	4.157	-0.817**	-5.153	0.093	2.65
							(-0.684)	(0.900)	(-2.351)	(-0.670)	(0.388)	(0.76
% Ind Director							0.001	-0.040	0.001	0.006	-0.001	-0.02
							(0.859)	(-1.615)	(0.515)	(0.168)	(-0.359)	(-0.97
Bsize							-0.052	-1.359	-0.055	-1.180	-0.024	-3.341
							(-0.768)	(-0.868)	(-0.557)	(-0.544)	(-0.255)	(-2.45

Constant	-0.015	4.339***	-0.131***	21.184***	0.033**	2.149***	5.442***	-0.144	6.621***	11.873	0.774**	-19.342
	(-1.367)	(17.957)	(-5.918)	(42.762)	(2.144)	(10.226)	(16.052)	(-0.019)	(11.948)	(0.968)	(1.969)	(-3.36
Observations	7,458	7,463	3,816	3,818	3,642	3,645	4,684	4,687	2,537	2,538	2,147	2,14
R-squared	0.956	0.884	0.964	0.716	0.941	0.774	0.970	0.914	0.976	0.829	0.969	0.82
Firm FE	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Adj R-squared	0.956	0.884	0.964	0.715	0.941	0.774	0.966	0.901	0.972	0.797	0.961	0.78

Figure 1a: Holding Period Return Performance of ESG based portfolio

This figure plots holding period return performance of two ESG based portfolios: top vs. bottom quartile ESG portfolio. Two ways of forming portfolio are employed as follows. First, we form static portfolio at the beginning of our sample period, which is year 2005 and leave constituents of the portfolio unchanged over the sample period. Second, we form dynamic portfolio by rebalancing portfolio at the beginning of each year.

Panel A: Static Portfolio



Panel B: Dynamic Portfolio

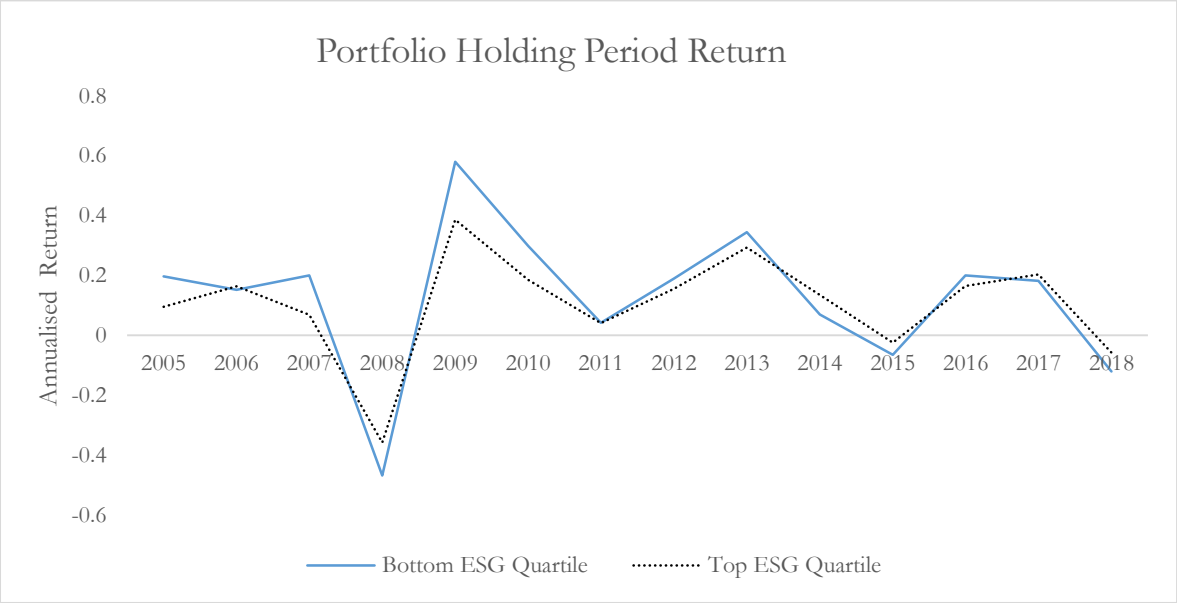
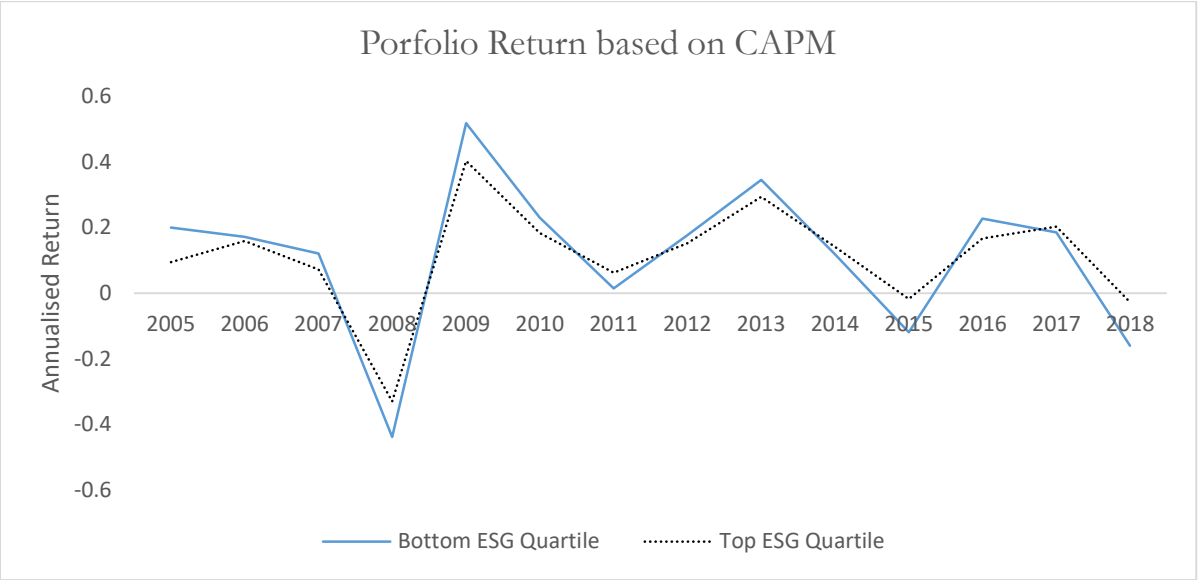


Figure 1b: CAPM Return Performance of ESG based portfolio

This figure plots CAPM return performance of two ESG based portfolios: top vs. bottom quartile ESG portfolio. Two ways of forming portfolio are employed as follows. First, we form static portfolio at the beginning of our sample period, which is year 2005 and leave constituents of the portfolio unchanged over the sample period. Second, we form dynamic portfolio by rebalancing portfolio at the beginning of each year.

Panel A: Static Portfolio



Panel B: Dynamic Portfolio

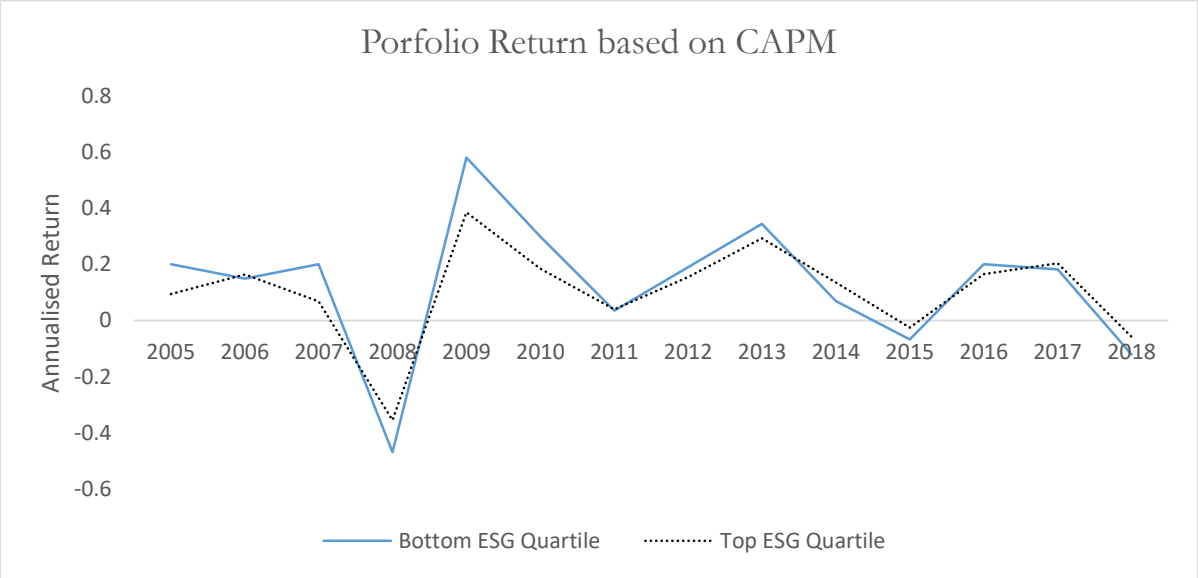
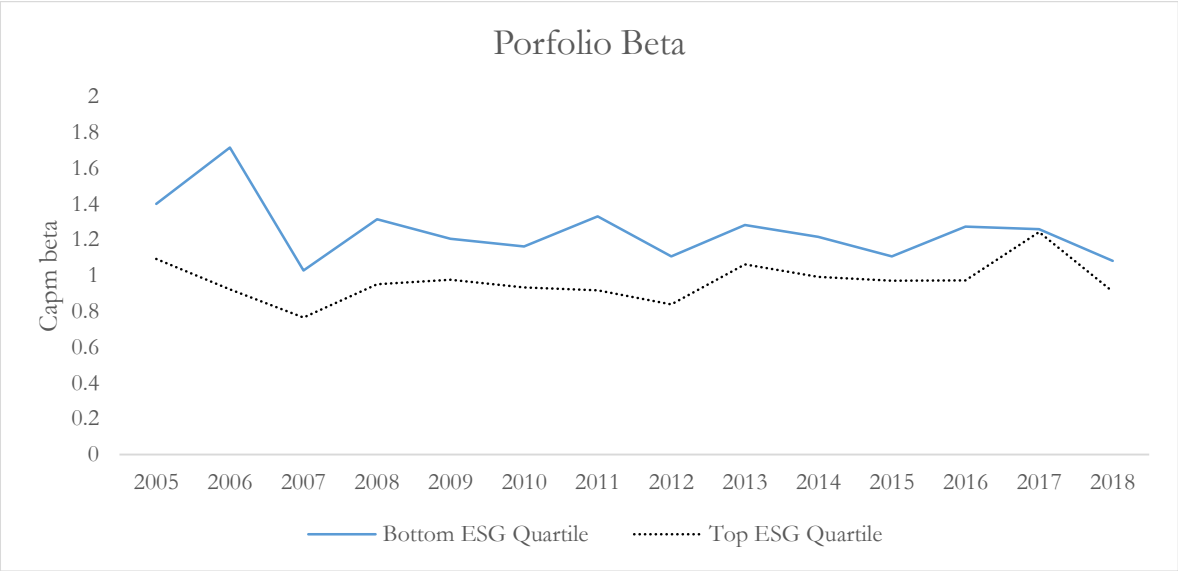


Figure 1c: CAPM Beta of ESG based portfolio

This figure plots CAPM beta of two ESG based portfolios: top vs. bottom quartile ESG portfolios. Two ways of forming portfolio are employed as follows. First, we form static portfolio at the beginning of our sample period, which is year 2005 and leave constituents of the portfolio unchanged over the sample period. Second, we form dynamic portfolio by rebalancing portfolio at the beginning of each year.

Panel A: Static Portfolio



Panel B: Dynamic Portfolio

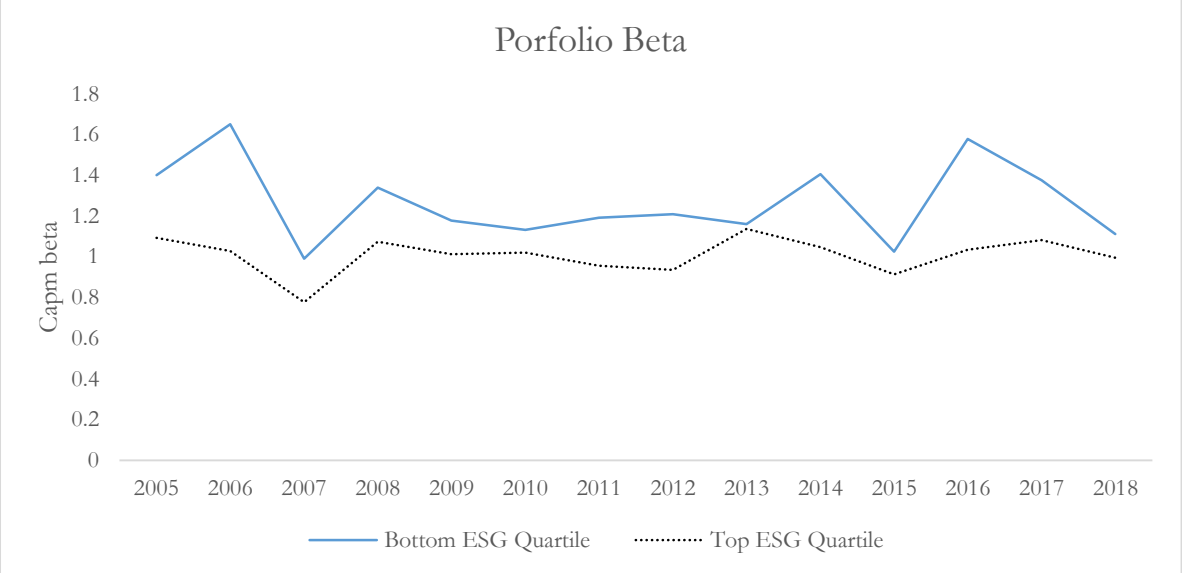
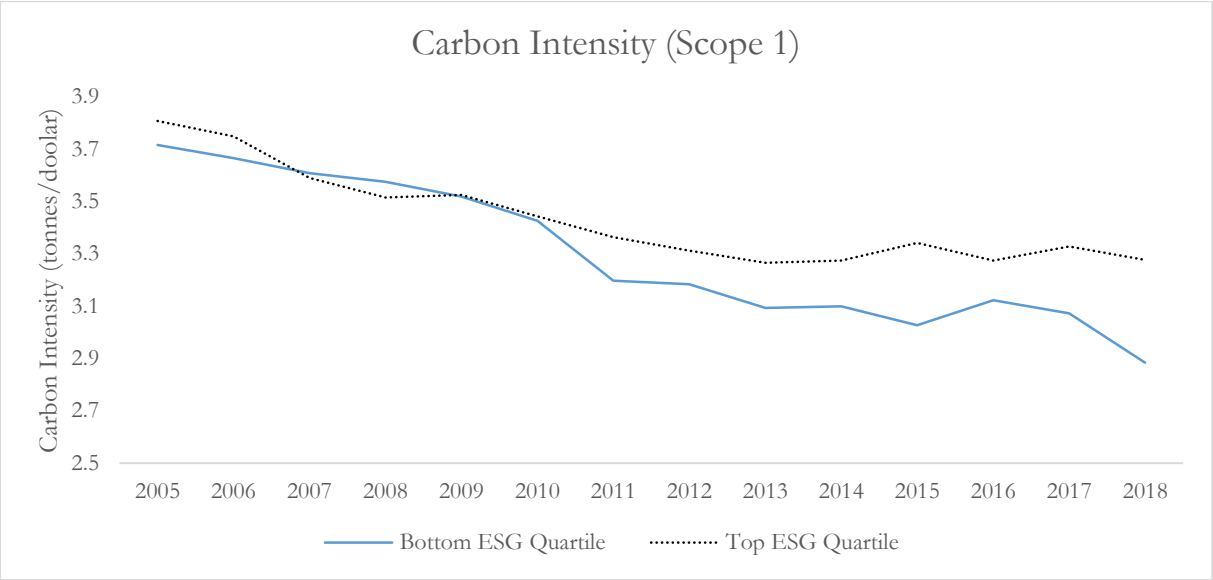


Figure 1d: Carbon Performance of ESG based portfolio

This figure plots emission performance of two ESG based portfolios: top vs. bottom quartile ESG portfolio. Two ways of forming portfolio are employed as follows. First, we form static portfolio at the beginning of our sample period, which is year 2005 and leave constituents of the portfolio unchanged over the sample period. Second, we form dynamic portfolio by rebalancing portfolio at the beginning of each year.

Panel A: Static Portfolio



Panel B: Dynamic Portfolio

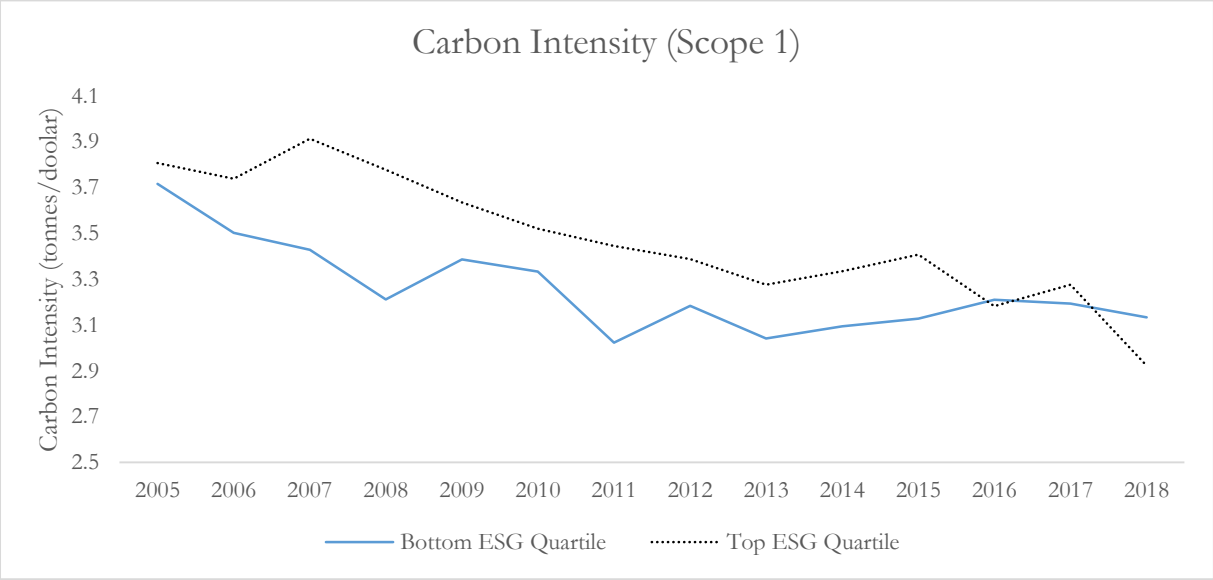
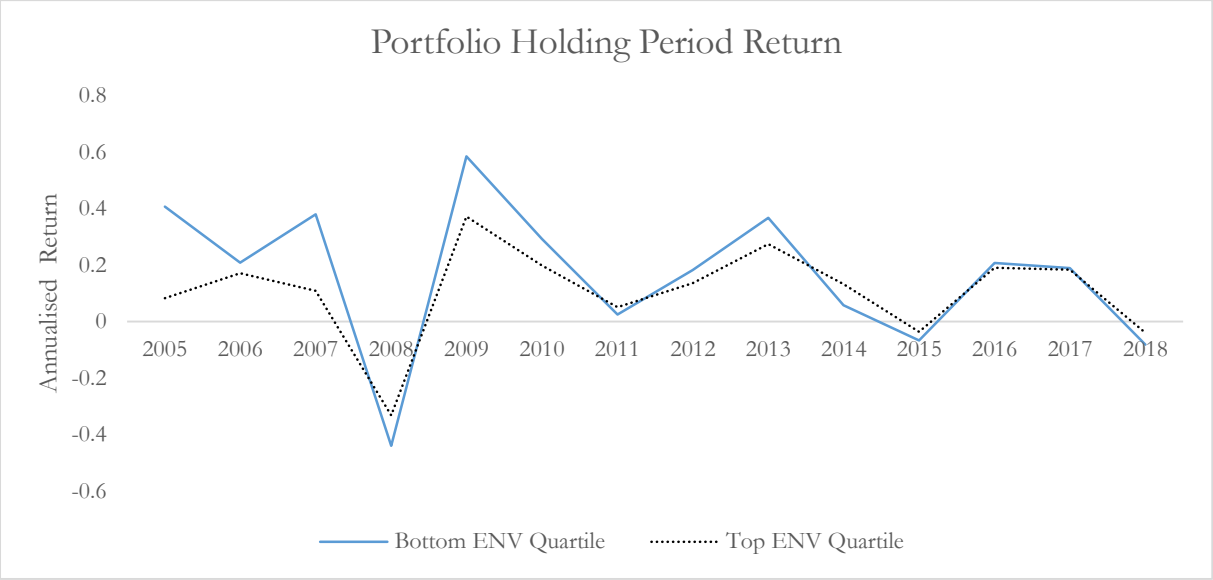


Figure 2a: Holding Period Return Performance of Environment Score based portfolio

This figure plots holding period return performance of two Environment (ENV) score based portfolios: top vs. bottom quartile ENV portfolio. Two ways of forming portfolio are employed as follows. First, we form static portfolio at the beginning of our sample period, which is year 2005 and leave constituents of the portfolio unchanged over the sample period. Second, we form dynamic portfolio by rebalancing portfolio at the beginning of each year.

Panel A: Static Portfolio



Panel B: Dynamic Portfolio

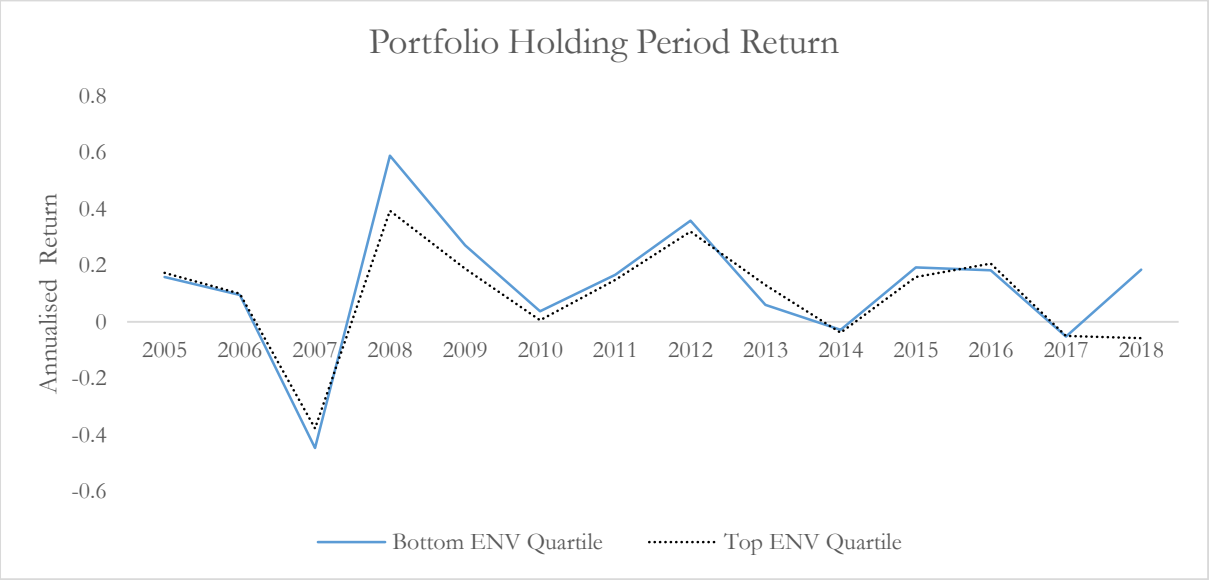
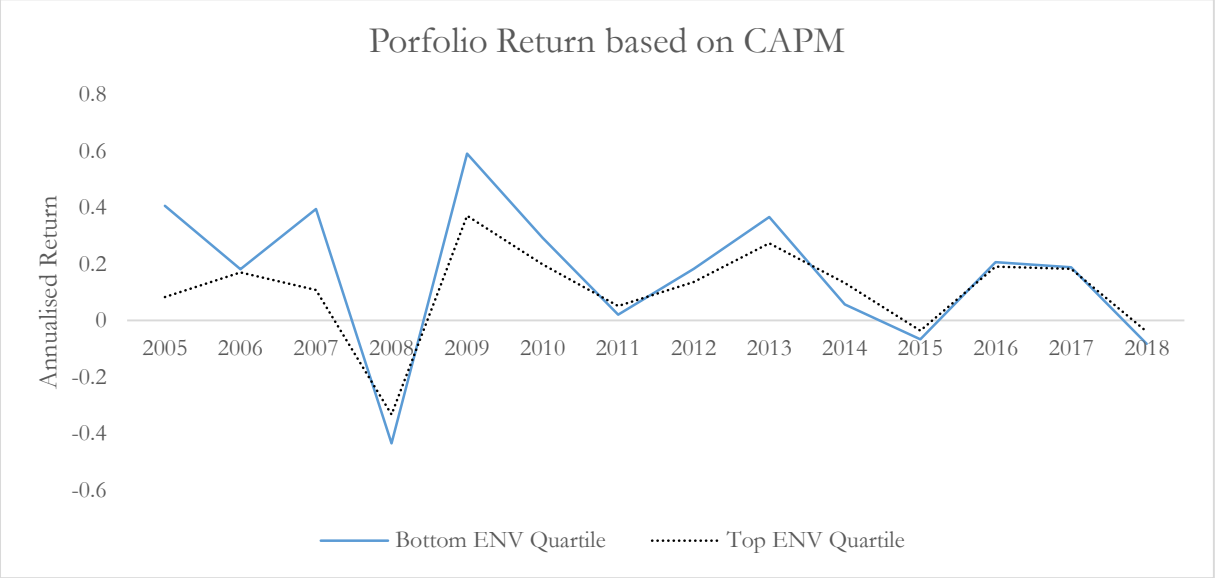


Figure 1b: CAPM Return Performance of Environment Score based portfolio

This figure plots CA{M return performance of two Environment (ENV) score based portfolios: top vs. bottom quartile ENV portfolio. Two ways of forming portfolio are employed as follows. First, we form static portfolio at the beginning of our sample period, which is year 2005 and leave constituents of the portfolio unchanged over the sample period. Second, we form dynamic portfolio by rebalancing portfolio at the beginning of each year.

Panel A: Static Portfolio



Panel B: Dynamic Portfolio

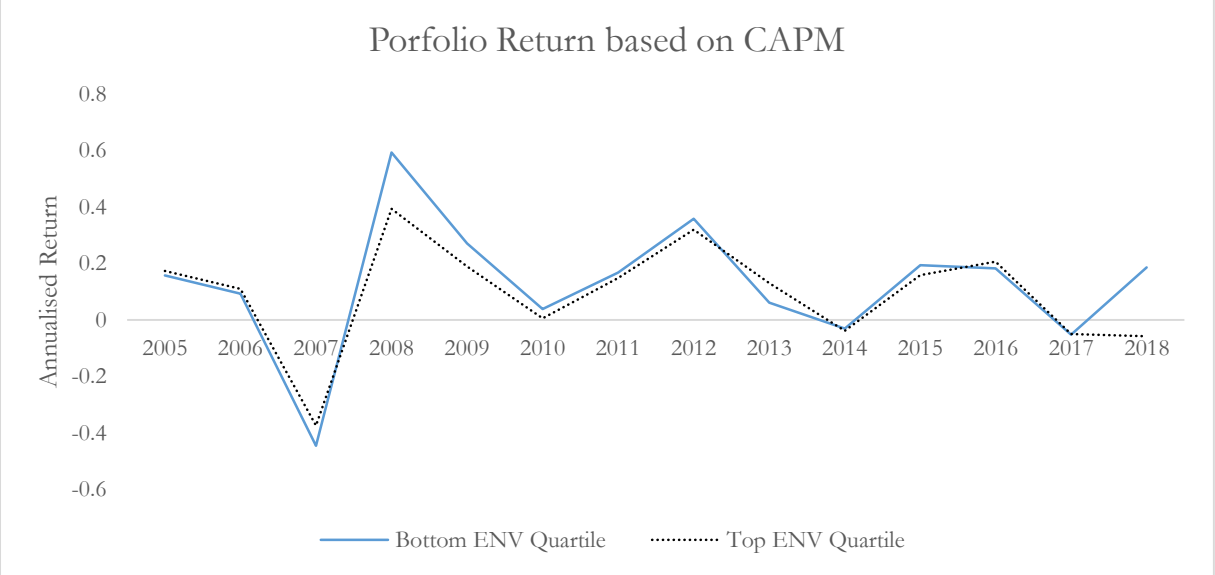
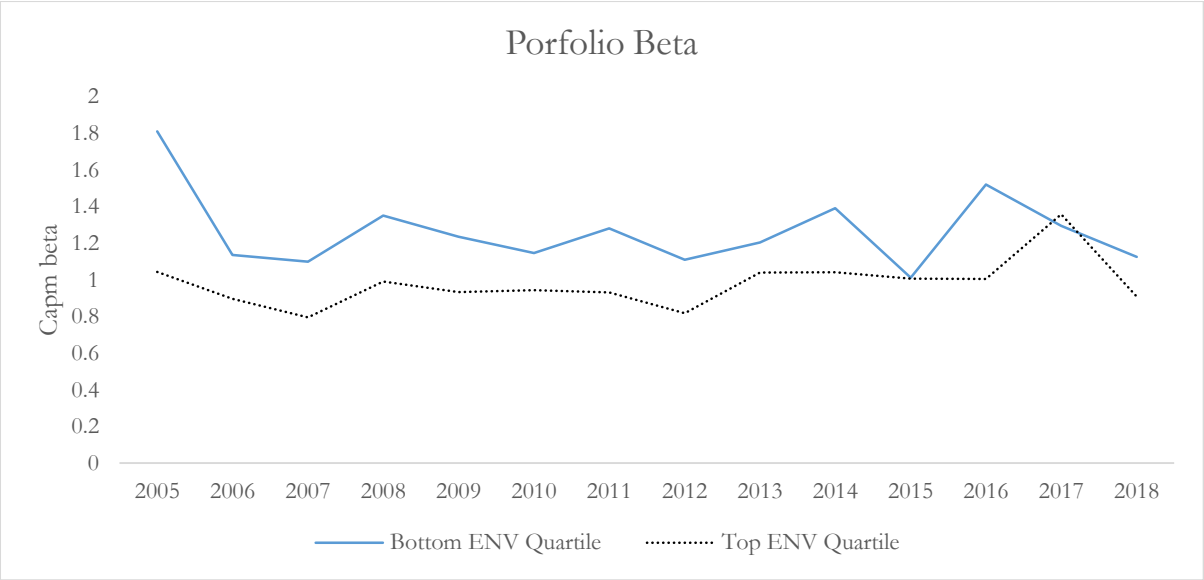


Figure 1c: CAPM Beta of Environment Score based portfolio

This figure plots CA{M beta of two Environment (ENV) score based portfolios: top vs. bottom quartile ENV portfolio. Two ways of forming portfolio are employed as follows. First, we form static portfolio at the beginning of our sample period, which is year 2005 and leave constituents of the portfolio unchanged over the sample period. Second, we form dynamic portfolio by rebalancing portfolio at the beginning of each year.

Panel A: Static Portfolio



Panel B: Dynamic Portfolio

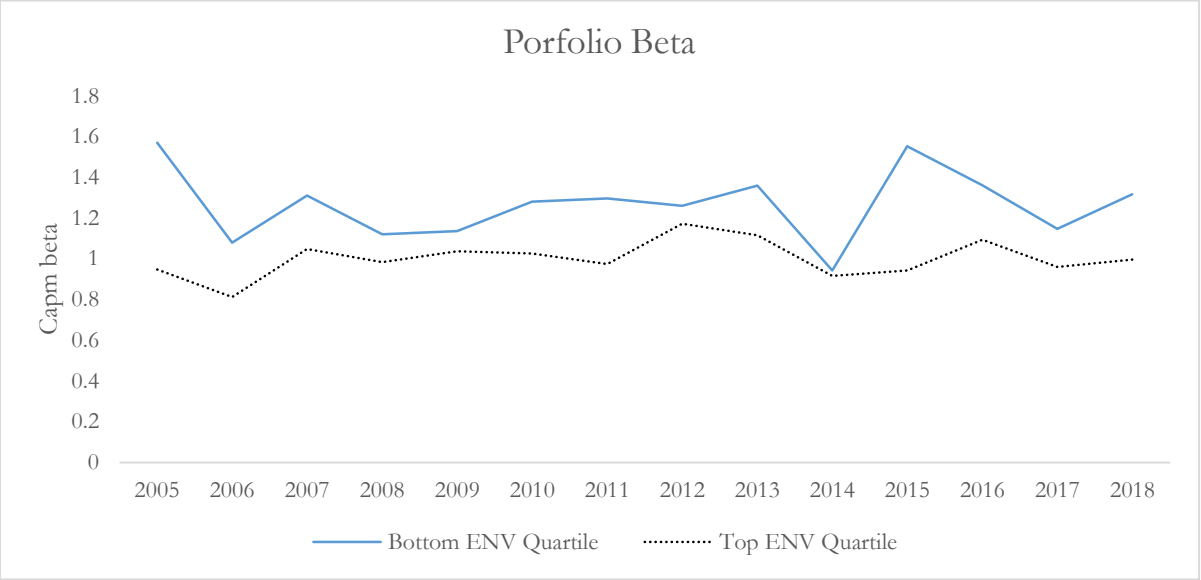
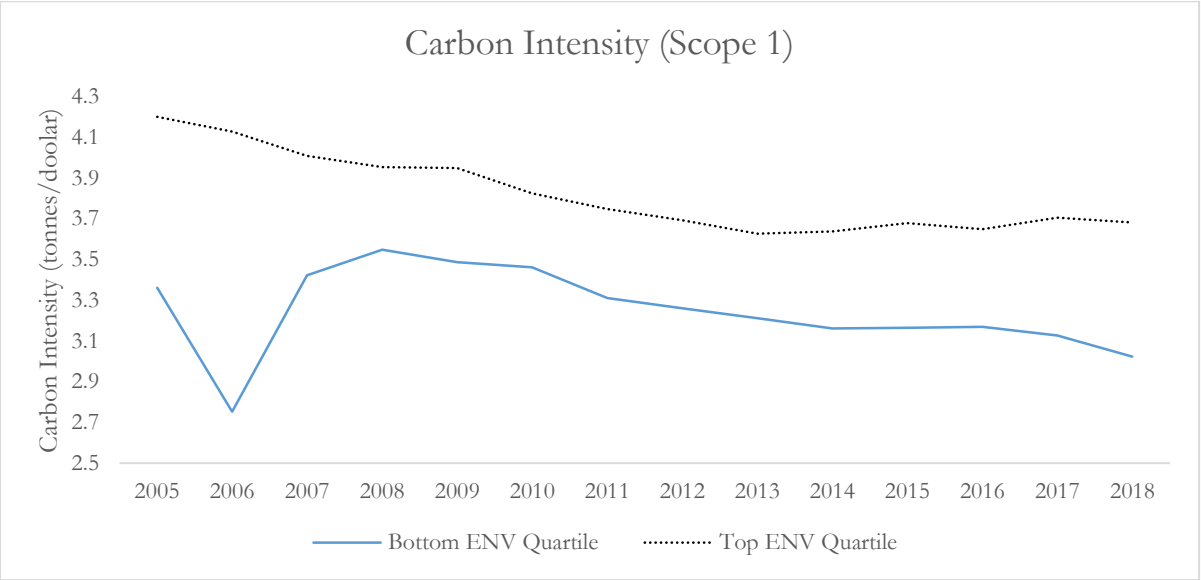


Figure 1d: Carbon Performance of Environment Score based portfolio

This figure plots emission performance of two Environment (ENV) score based portfolios: top vs. bottom quartile ENV portfolio. Two ways of forming portfolio are employed as follows. First, we form static portfolio at the beginning of our sample period, which is year 2005 and leave constituents of the portfolio unchanged over the sample period. Second, we form dynamic portfolio by rebalancing portfolio at the beginning of each year.

Panel A: Static Portfolio



Panel B: Dynamic Portfolio