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# PRIVATE EQUITY AND CARBON EMISSIONS: AN EMPIRICAL EXAMINATION

Author: Roberto Expósito - 7998589 - r.expositoraspeno@students.uu.nl

Supervisor: Dr. Benjamin Hammer

Internship organization: Guidehouse / Contact: Evan Bruner: ebruner@guidehouse.com

**Abstract**

Extensive literature documents a negative relationship between the level of carbon emissions and the market value of public firms. This paper examines the relationship between carbon emissions and the private equity (PE) industry. Using the exit multiple of PE deals and leveraging the PCAF emission factor database to estimate the carbon emissions of portfolio companies, we find a carbon premium for lower unscaled Scope 2 emissions of portfolio companies. This premium is not influenced by the size of the PE firm or the institutional pressure on the PE's home country, but significantly increases when the PE firm is an ESG Investor, defined as a UN PRI signatory. Furthermore, we find that larger PE are more likely to invest in lower carbon intensity companies. Greater institutional pressure in PE’s home country is associated with higher carbon emissions. We find no evidence that PE ESG investors hold portfolio companies with better carbon emissions performance. By providing evidence of a carbon exit premium, our results highlight the importance for PE investors to reduce the carbon footprint of their portfolios and commit to sustainable investing. We also raise concerns about the effectiveness of regulation and environmental initiatives, emphasizing the need for robust evaluation mechanisms to ensure the alignment of PE actions with sustainability commitments, mitigating the risk of greenwashing.

**JEL codes:** G11, G23, G32, G34, M14

**Keywords:** Private Equity, Carbon Emissions, ESG investors, Carbon Premium, PCAF

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# 1. INTRODUCTION

Climate change and environmental sustainability have become pressing global concerns, prompting increased scrutiny of various industries' carbon emissions and their impact on the economy. The private equity (PE) industry, which controls around $12 trillion assets globally, play a significant role in shaping the environmental performance of their portfolio companies and, consequently, the overall economy. Investors are increasingly recognizing the need to consider environmental factors in their decision-making processes. This paper evaluates whether lower portfolio companies' carbon emissions are associated with a higher exit multiple for PE funds, shedding light on the existence of a carbon premium and encouraging PE to drive decarbonization efforts. We investigate the influence of key characteristics of PE funds, such as fund size, institutional pressure in their HQ country, and ESG investor status on the carbon premium. Furthermore, we examine how the previous characteristics of PE funds affect the carbon footprint of their portfolios, providing insight on the effectiveness of regulatory frameworks and environmental initiatives in promoting sustainability within the private equity industry.

Extensive research has been conducted on the effect of carbon emissions on public companies' value, risk, and returns, concluding that investors price firms' GHG emissions as a negative component of equity value (Saka & Oshika, 2014) (Zhao-Yong Sun et al., 2022) (Griffin et al., 2017a), GHG emission intensity leads to higher cost of equity capital (Bui et al., 2020a), and increased carbon risk increases the cost of debt (Jung et al., 2018). (Matsumura et al., 2014) show that, on average, for every additional thousand metric tons of carbon emissions, the firm value decreases by $212,000. This market penalization arises from looming regulatory and transition risks (Basse Mama & Mandaroux, 2022).

Another stream of literature have researched how ESG funds in public markets fulfill their stated objectives, finding that ESG funds hold stocks with higher carbon intensity and are less likely to pick firms with better ESG scores (Aneesh Raghunandan & Shiva Rajgopal, 2022) (Rajna Gibson et al., 2022). Institutional investors play a crucial role in providing capital to private equity funds. Their influence on private equity decision-making is significant, and their concerns about climate-related impacts and carbon emissions reduction initiatives are growing (Labatt & White, 2011; Safiullah et al., 2022). Moreover, institutional investors value climate risk disclosures and engage in divestment based on carbon emissions (Emirhan Ilhan et al., 2019; Patrick Bolton & Marcin T. Kacperczyk, 2020). Despite the substantial growth and relevance of PE firms, limited knowledge exists about how these relationships manifest within the private equity industry. This paper aims to address this research gap by investigating the dynamics between private equity funds and their portfolio companies' carbon emissions, contributing to a more comprehensive understanding of sustainable practices and their financial implications within the private equity industry.

We use a sample of 191 deals from FactSet in which a PE fund fully exited its position, in which the exit multiple, measured as EV/Revenue, was disclosed providing an official price for the transaction. Provided that the median general partner (GP) discloses only 8% of the available ESG indicators (Pascal Böni et al., 2022), portfolio firms' carbon emissions are estimated using the PCAF economic emission factor database, which provides a reliable and rigorous method to obtain the carbon emissions of the acquired companies. The approach is further explained in section 3.2.2. We employ both unscaled emissions and carbon intensity (emissions scaled by revenue) to study how they affect the exit multiple of PE funds. Furthermore, carbon emissions are grouped into 3 categories: direct emissions from production (scope 1), indirect emissions from consumption of purchased energy (scope 2), and other indirect emissions that occur as a result of an organization's activities but are outside the organization's operational control or ownership (scope 3).

We find a negative relationship between the portfolio company's unscaled carbon emissions and the exit multiple (EV/Revenue) of the PE when controlling for industry, country, and year fixed effects, but this relationship becomes insignificant when including the control variables. We observe a significant carbon premium for portfolio companies with lower unscaled Scope 2 carbon emissions. A 1% decrease in the Scope 2 emissions of the portfolio company leads to an increase in the exit multiple for PE of between 0.033%-0.057%. We argue that, since switching to renewable energy usually implies an important capital expenditure for companies, private investors are willing to pay a higher multiple for lower Scope 2 emitters. This premium is not affected by the size of the PE selling the company or the institutional pressure on the PE's home country. However, we find that this premium differs depending on whether the PE fund is classified as an ESG investor or not. If the PE selling the company is an ESG Investor, defined as UN PRI signatory, a 1% decrease in the unscaled Scope 2 emissions of the portfolio company leads to an increase in the exit multiple of 0.088%, compared to a 0.033%-0.057% increase for non-ESG private equity firms. Signing the UN Principles for Responsible Investment (PRI) implies a public statement to commit to responsible investment, which instills market confidence in the PE firm's efforts to reduce carbon emissions. Consequently, investors place greater reliance on the decarbonization initiatives undertaken by these PE funds, leading to a higher exit premium. Scope 3 unscaled emissions have a negative relationship to the exit multiple when accounting for fixed effects but become statistically insignificant when including control variables. When using carbon intensity, which captures the relative carbon efficiency of a firm, we find no evidence of such exit multiple premium for PE funds, neither in total carbon intensity nor in any of the different Scope emissions. Investors in the private capital industry are willing to pay a premium for overall lower emitter companies as they look into reducing their portfolio carbon footprint, rather than focusing on more carbon-efficient companies. We provide PE firms with empirical evidence of the existence of a carbon premium when investing in companies with lower indirect carbon emissions. These results should encourage PE to actively engage in decarbonization practices on their portfolio, particularly focusing on reducing Scope 2 emissions.

On the second part of our study, we find that PE funds operating in countries with stewardship codes in place are associated with higher levels of carbon emissions across both unscaled and intensity carbon measures. These results confront (Bonacchi et al., 2022) findings in the effectiveness of institutional investor engagement on the ESG performance of public companies, as they find that the introduction of the tiering system in the UK was associated with increases in ESG performances in investee companies. We provide evidence that larger PE funds are more likely to hold lower carbon intensity firms in general, and those that have lower Scope 3 carbon intensities in particular with respect to non-large PE funds. This result is consistent with our hypothesis that larger PE firms have greater visibility and receive greater institutional and public pressure to engage in sustainable investing strategies. Lastly, and consistent with (Aneesh Raghunandan & Shiva Rajgopal, 2022), we find no evidence that PE ESG investors hold portfolio companies with better carbon emissions performance. We reveal a potential discrepancy between PE's goals and investment choices, which could represent a sign of greenwashing. Transparent mechanisms should be implemented to measure ESG investors' efforts in incorporating ESG issues into investment analysis and decision-making.

This research constitutes a significant contribution to society's collective effort to combat climate change. By examining the carbon exit premium for private equity investors, we empirically encourage PE firms to reduce the carbon footprint of their portfolios, leading to considerable reduction in the carbon footprint of the private equity industry and, consequently, contributing to the broader society objective of reducing global carbon emissions and achieving The Paris Agreement goals. Our study contributes to the literature that studies how carbon emissions affect companies' valuation. Several papers have documented a negative relationship between the level of carbon emissions and the market value of public firms (Saka & Oshika, 2014) (Zhao-Yong Sun et al., 2022) (Griffin et al., 2017a) (Bui et al., 2020a) (Matsumura et al., 2014). However, and to the best of our knowledge, we are the first to empirically examine the effect of carbon emissions on private equity valuations and to provide evidence of a carbon premium in PE exits. Furthermore, a body of research is emerging to examine the influence of institutional investors on companies' decision-making processes concerning climate change. There is a lack of consensus among existing papers, as (Safiullah et al., 2022) find that institutional investors help reduce carbon emissions and (Patrick Bolton & Marcin T. Kacperczyk, 2020) documents a widespread divestment based on carbon emissions by institutional investors, while the working paper (Tim Kievid et al., 2021), that uses a broad sample of 68 countries for the period 2007-2018, show that institutional investment does not appear to lead to a carbon footprint reduction. We also believe that we are the first to empirically examine how institutional investors are influencing private capital markets carbon footprint, finding that institutional pressure is not leading to a carbon emissions reduction in the private equity industry. Lastly, our study complements literature focused on studying if ESG investors are following their commitment to incorporate ESG factors into their investment decisions. (Aneesh Raghunandan & Shiva

Rajgopal, 2022), (Rajna Gibson et al., 2022) and (Kim et al., 2015a) show that ESG investors in public markets, defined as UN PRI signatories, are not “walking the talk”, as they are less likely to pick firms with better ESG scores and more likely to hold stocks with higher carbon intensity. Reiteratively, we study this relationship in the PE market, finding similar results to those in public equity markets.

The remaining parts of the paper proceed as follows. Section 2 reviews the theoretical framework and literature review to develop our hypotheses. Section 3 presents the research methodology, data analysis, and empirical strategy to examine our research. Section 4 discusses our empirical results and robustness tests. Section 5 concludes.

## 2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

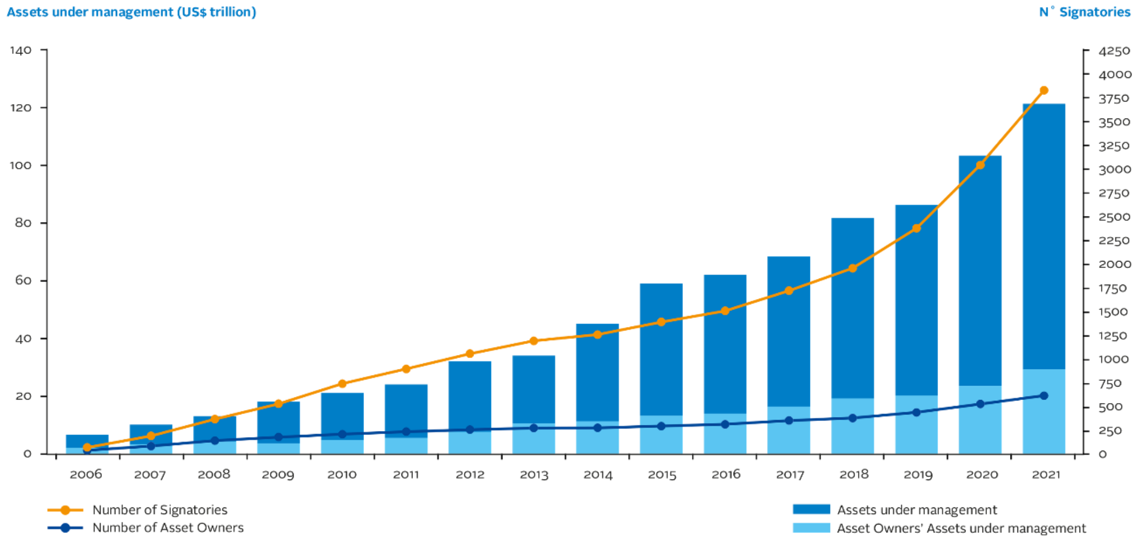
### 2.1. Private Equity industry

The private equity industry is continuing to grow at a rapid pace. Total private markets assets under management (AUM) reached $11.7 trillion as of June 30, 2022, and AUM has now grown at an annual rate of nearly 20 percent since 2017 (McKinsey Global Private Markets Review 2023: Private markets turn down the volume | McKinsey.) Since 2009, companies have raised more external capital in private markets than in public capital markets (Michael J. Mauboussin & Dan Callahan, 2020). (Joseph A. McCahery & Paolo Giudici, 2022) concludes that institutional investors are increasingly shifting their portfolio allocations to various alternative asset classes. The increased relevance of private equity firms implies that their efforts on reducing global carbon emissions are crucial for society to succeed in the climate change challenge. Research shows that private equity have become an increasingly important governance mechanism to rapidly and radically restructure organizations (Wright et al., 2009). As a result, private equity firms are placed in a unique position to drive the decarbonization journey and catalyze the low-carbon transition by investing in sustainable businesses and restructuring their high-carbon portfolio companies.

### 2.2. Private Equity's Role in Decarbonization: Current Progress

The United Nations Principles for Responsible Investment (UN PRI) is one of the world's largest initiatives to promote ESG investing in the asset management industry. They offer a menu of actions for incorporating ESG issues into investment analysis and decision-making, as well as seeking appropriate disclosure on ESG issues of their investees. (What are the Principles for Responsible Investment?). Signing the UN PRI entails investors' commitment to integrating ESG considerations into their investment analysis and decision-making. As shown in Figure 1, the growth in ESG committed investors has been steadily increasing over the years.

**Figure 1 – PRI signatories' growth from 2006-2021**




(Data source: What are the principles for responsible investment? | 2023).

In September 2021, Apex Research surveyed 358 Private Equity executives on their approach to climate change (APEX RESEARCH, 2021). 81% of Private Equity leaders said their company and their portfolio companies should be taking greater responsibility for their carbon footprint. However, less than half of all Private Equity firms currently measure their own carbon footprint (44%), or that of their suppliers (48%), and only 50 percent measure the carbon footprint of their investments. Furthermore, (The Boston Consulting Group, UK LLP. 2023,) survey reveals that 70% of private markets leadership and CEOs have high or very high expectations of getting paid a premium at exit for proactive decarbonization of portfolio companies. The success of a private equity firm relies heavily on its ability to secure future investments and maintain a positive reputation. Limited partners (LPs) are increasingly requiring PE funds to incorporate ESG metrics into their investment decision. Hence, PE firms' ability to raise larger funds and earn management fees and carried interest depends on aligning with the ESG preferences and priorities of LPs. In that regard, (Marco Ceccarelli et al., 2023) proves that mutual funds labeled as "low carbon" experienced a significant increase in investor demand, and (Florin P. Vasvari et al., 2022) shows that ESG disclosures by PE firms increase around fundraising events.

### 2.3. Carbon emissions effect on publicly traded companies

Several papers examine the relationship between carbon exposure and risk. (Giuzio et al., 2019) shows that climate change-related risks have the potential to become systemic for the euro area, in particular, if markets are not pricing the risks correctly. (Nguyen & Phan, 2020) indicates that increased carbon risk leads to higher financial distress risk and (Jung et al., 2018) states that a one standard deviation increase in carbon risk mapping into between a 38 and 62 basis point increase in the cost of debt. Regarding the effect of carbon exposure on the cost of capital, (Kim et al., 2015b) finds that carbon intensity is positively related to the cost of equity capital. Therefore, companies' efforts to improve carbon productivity are suggestively compensated by the reduction in the cost of capital, which then increases the firm's value. In addition, (Bui et al., 2020b) find firms'

GHG emission intensity to be positively associated with COC (cost of equity capital) and provide evidence that the extent of carbon disclosure helps reduce the premium required by investors to compensate for poor carbon performance. As increased carbon risk has been found to lead to higher financial distress risk and increased borrowing costs in public equity markets, private equity funds should evaluate the carbon risk profiles of their portfolio companies and start planning for transitions to net-zero portfolios. As a result, investors in private markets would be willing to pay a premium for firms with lower carbon emissions, since such companies are perceived to offer reduced risk and lower cost of capital, leading to an exit premium for Private Equity funds. This argument provides initial support to elaborate Hypothesis 1.

Another stream of literature has studied the valuation effect of carbon emissions in publicly traded firms. (Griffin et al., 2017a) finds that investors price firms' greenhouse gas (GHG) emissions as a negative component of equity value. Their results suggest that, for the median S&P 500 firm, GHG emissions impose a market-implied equity discount of $79 per ton, representing about one-half of 1 percent of market capitalization. (Matsumura et al., 2014) find that, on average, for every additional thousand metric tons of carbon emissions, the firm value decreases by $212,000. Moreover, they indicate that the markets penalize all firms for their carbon emissions, but a further penalty is imposed on firms that do not disclose emissions information. (Basse Mama & Mandaroux, 2022) shows that looming regulatory and transition risks are the cause of this market penalization. Furthermore, using corporate carbon emissions filled to the Japanese Government from more than 1.000 firms, (Saka & Oshika, 2014) find that carbon emissions have a negative relation with the market value of equity. The same results are obtained by (Zhao-Yong Sun et al., 2022) using information of companies from the Shanghai and Shenzhen 300 (CSI 300) Index. Lastly, (Friede et al., 2015) assess the findings of about 2200 individual studies and show that the business case for ESG investing is empirically very well founded. Roughly 90% of studies find a nonnegative ESG–financial performance relation. More importantly, the large majority of studies report positive findings.

Given the evidence in public markets indicating a valuation premium for firms with lower carbon emissions, it is reasonable to expect a similar valuation premium for lower carbon emissions within the private equity industry. If investors in public markets are willing to pay a premium for companies with lower carbon footprints due to reduced risk and lower cost of capital, it follows that investors in private companies would also recognize the value in supporting and investing in portfolio firms with lower carbon emissions. Therefore, private equity funds can anticipate valuation benefits in terms of higher exit multiple by actively addressing carbon emissions of their portfolio firms, leading to our primary research expectation and hypothesis 1:

***Hypothesis 1:*** *Lower carbon emissions of PE portfolio companies are associated with higher exit valuation*

If we can confirm our Hypothesis 1, we will be able to conclude that Private Equity firms are compensated for working towards a net-zero portfolio by exiting their portfolio companies at higher valuations, and, therefore, we will provide an incentive to these PE funds to engage in sustainability strategies to decarbonize their investees, and, consequently, their overall portfolio. Furthermore, apart from the previous literature that provides evidence on the carbon premium in public markets, we reason our hypothesis on the likely fact that a portfolio company that is contributing to net-zero, or is clearly on a science-based path towards it, will be better positioned at exit since the potential buyer has made climate commitments, is aware of the carbon premium and/or have pressure from institutional investors to reduce the carbon footprint of the portfolio, and, consequently, have the incentive to pay a premium on the transaction multiple for lower carbon emissions firms.

### 2.4. How PE fund characteristics affect their investment decisions

Institutional investors have been the main source of capital for private equity funds (2020 Preqin Global Private Equity & Venture Capital Report | Preqin. 2020). In addition, (Bain & Company's 2021 Global Private Equity Report.2021) report confirms that institutional investors have become increasingly important in the private equity industry over the past decade, with pension funds, sovereign wealth funds, and insurance companies among the largest sources of capital. As a result, these institutional investors have a significant influence on the decision-making process of private equity funds. Given their crucial role and impact on fundraising and management, we examine the potential impact of this relationship on private equity decisions. (Labatt & White, 2011) states that institutional investors are showing an increasing degree of concern regarding climate-related impacts on their investments, and they are likely to play a proactive role in initiatives for carbon emissions reduction. In this regard, (Safiullah et al., 2022) find that institutional investors help reduce carbon emissions. (Emirhan Ilhan et al., 2019) provide systematic evidence that institutional investors value and demand climate risk disclosures and (Patrick Bolton & Marcin T. Kacperczyk, 2020) find that there is a widespread divestment based on carbon emissions by institutional investors around the world. On the other hand, the working paper (Tim Kievid et al., 2021), studies to what extent institutional investors' ownership affected corporate carbon emissions 68 countries for the period of 2007 to 2018, showing no evidence of a carbon footprint reduction. In conclusion, private equity funds with institutional investors as limited partners (LPs) are subject to their influence and are pressured to reduce their portfolio's carbon intensity to avoid divestment and meet their expectations, which serve as basis for Hypothesis 2:

***Hypothesis 2:*** *Greater institutional pressure on PE funds is associated with lower carbon portfolio firms*

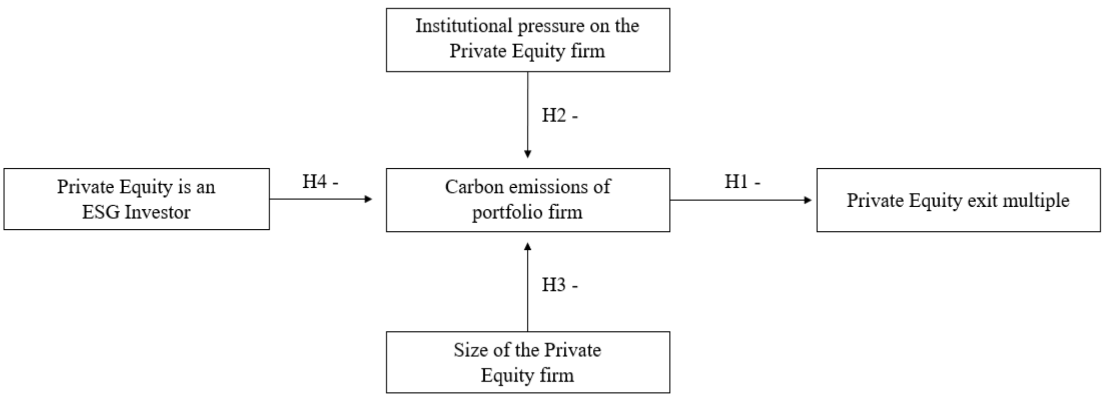
Furthermore, provided that large PE funds have a higher proportion of institutional investors as LPs (Bain & Company's 2021 Global Private Equity Report.2021) (2020 Preqin Global Private Equity & Venture Capital Report | Preqin. 2020), they receive greater pressure from institutional investors to invest in sustainable businesses. Furthermore, the substantial influence and public scrutiny surrounding large private equity firms in the economy should drive them to make more sustainable investment decisions, from which the next hypothesis 3 derives:

***Hypothesis 3:*** *Large Private Equity funds exit lower carbon portfolio firms compared to non-Large PE*

(Andonov et al., 2021; Barber et al., 2021) and (Lingshan Xie & Stanimira Milcheva, 2022) identify ESG investors using UN PRI signatories as a proxy for socially responsible and ESG-committed investors. As described in Section 2.2., UN PRI is one of the most influential motivators that encourage more investments with ESG considerations. By committing to integrating ESG issues into their investment decision-making processes, signatories assume a pivotal role in promoting and facilitating ESG investment practices. In this line of research, (Aneesh Raghunandan & Shiva Rajgopal, 2022) finds that ESG funds hold stocks with higher average ESG scores, but with higher carbon intensity. This is possible because ESG scores are correlated with the quantity of voluntary ESG-related disclosures but not with firms' actual levels of carbon emissions. In our study, we employ the direct measurement of carbon emissions generated by portfolio companies. Consequently, we are able to evaluate whether ESG investors effectively diminish their carbon footprint, as opposed to relying on third-party assessments grounded in broad-based metrics. (Rajna Gibson et al., 2022) find that signatories outside the US have superior ESG scores than non-signatories, but US signatories have at best similar ESG ratings, and worse scores in some scenarios. (Soohun Kim & Aaron Yoon, 2021) do not observe improvements in fund-level ESG scores after active US mutual funds sign the PRI, and that PRI signatories are not superior performers in ESG issues prior to signing. Our research and available data presents an opportunity to empirically examine how Private Equity funds that have signed the UN PRI (ESG Investors) are incorporating environmental factors into their investment decision-making. ESG investors are expected to invest in companies with lower carbon emissions, thereby aligning their financial objectives with their sustainability goals. We hence formulate hypothesis 4 as follows:

***Hypothesis 4:*** *PE ESG Investors exit lower carbon portfolio firms compared to non-ESG Investors*

**Figure 2 - Conceptual Framework**



# 3. DATA AND METHODOLOGY

## 3.1. Sample and data collection

The sample for this research have been extracted from the finance database FactSet. The data is restricted to completed M&A deals of private companies over a 6-year period, from January 01, 2017, for a minimum transaction value of 1MM in North America, Europe, and Asia Pacific, where there has been an acquisition or a majority stake transaction. Three crucial filters enable the research objectives of this study. Firstly, the data provider FactSet permits limiting the data sample to "Private Equity Exit – Full", this filter allows examining the valuation of portfolio companies at exit and test hypothesis 1, by ensuring that the studied deals only involve private equity firms' fully exiting their position. Secondly, the "Disclosed Multiples" filter limits the search results to transactions where multiples data is available, and, lastly, the "Unofficial Price" filter to "No," in order to obtain valuation details from an official source and ensure the reliability and accuracy of the data. We exclude reverse mergers transactions in which the target company will own a majority of the combined company as a result of the transaction. We limit our data sample to transactions in which target firm Revenue and EBITDA data at exit are available. This information is integral to our research as it serves as the foundation for constructing control variables and, more notably, estimating the carbon emissions of portfolio firms, as explained in Section 3.2.2. This leaves us with 191 transactions in which a PE fully exited their position, for which the exit multiples EV/Revenue were disclosed and are officially recognized, and we have information about the Revenue and EBITDA of the portfolio firm at the moment of exit. Figure 4 in Appendix A illustrates the search parameters and logic used for this study.

## 3.2. Variables and summary statistics

The main focus of this study is to empirically examine the relationship between the level of carbon emissions of PE portfolio companies and their exit valuation. The multiple EV/Revenue of the deal is used as a metric for market valuation and premium, aligned with (Arcot et al., 2015) and (Hammer et al., 2022) and attributed to its higher prevalence compared to the EV/EBITDA multiple. EV/Revenue multiples are truncated at the $99^{th}$ percentile and winsorized at the 95th percentile to mitigate the effect of outliers. We take the natural logarithm for our analysis since the variable is highly skewed.

### *3.2.1 Carbon emissions*

Carbon emissions data are commonly disclosed according to the Greenhouse Gas (GHG) protocol and are measured in tons of CO2 equivalent (tCO2e) annually. The GHG protocol defines three categories of emissions. Scope 1 refers to direct emissions originating from sources that are owned or controlled by a company. For instance, it includes emissions generated by the internal combustion engines of a trucking company's fleet. Scope 2 emissions result from the consumption of purchased electricity, heat, or steam used in a company's operations. Scope 3 covers all additional emissions associated with a company's activities that are not directly owned or controlled by the company, both upstream and downstream. Examples of scope 3 emissions include emissions generated by the transportation of goods by a company using third-party logistics providers or shipping companies, or those generated by employees’ business travel. Due to the broad definition of scope 3 emissions, they typically constitute the largest portion of a company's overall emissions footprint.

Our database consists of deals in which PE exited private companies, therefore, we can expect that these firms are not disclosing their carbon emissions, particularly

Scope 3 emissions. This research benefits from having access to the PCAF emission factor database to infer the carbon emissions of the PE-backed portfolio firms. To the best of our knowledge, we are the first to use the PCAF emission factor database. (Shrimali, 2022) (Marc Roston, 2021) and (Emily Spittle & Martin Dietrich Brauch, 2021) refer to PCAF as they cover existing methodologies to harmonize carbon emissions accounting and approaches to measure and disclose Scope 3 emissions for financial institutions. However, this research uses the PCAF emission factor database to actually calculate the emissions associated with portfolio firms. Access to this database provides this research with an accurate and standardized methodology to quantify the emissions associated with the activities of portfolio companies and, subsequently, their effect on private equity exit multiples.

*3.2.1.1. PCAF emission factor database*

PCAF is a global partnership of financial institutions that work together to develop and implement a harmonized approach to assess and disclose the greenhouse gas (GHG) emissions associated with their loans and investments (About PCAF | PCAF. ). PCAF advises the following approach to measure the carbon emissions of financial institutions:

• Option 1: Reported emissions, where emissions are collected from the company directly (e.g., company sustainability report) or indirectly via verified third-party data providers.

• Option 2: Physical activity-based emissions, where emissions are estimated based on primary physical activity, such as actual energy consumption (e.g., megawatt-hours of natural gas consumed) or production (e.g., tons of steel produced) data reported by companies.

• Option 3: Economic activity-based emissions, where emissions are estimated based on economic activity data such as revenue or assets and using region and sector-specific average emission factors expressed per economic activity (e.g., tCO2 e/$ of revenue or tCO2 e/$ of sectoral assets).

PCAF's emission factor database provides a large set of emission factors for Options 2 and 3. We derive the carbon emissions associated with each portfolio company as follows: given the specific sector and region of the primary business activity of the portfolio company, the PCAF database provides an economic emission factor (tCO2e/M. of revenue) that is applied to a measure of the economic activity of the company (revenue), which is available in our sample at exit. For instance, Aleris Corp. is a US company that manufactures aluminum rolled and extruded products. According to The North American Industry Classification System (NAICS & SIC Identification Tools), as provided by FactSet, the portfolio company Aleris Corp. operates in the alumina and aluminum products industry, in the manufacturing sector, and in the sub sector primary metal manufacturing. We filter in the PCAF emission-factor database for United States of America, Classification Level 1: Metal & Metal Products, and classification Level 2: Aluminum and aluminum products. This search provides us with an economic emission factor for Scopes 1, 2, and 3, for the sector and country per unit of revenue (e.g., tCO2e per million dollars of revenue earned in the Aluminum and aluminum products sector in the USA). Given that the portfolio company revenue at exit is known, we can calculate the carbon emissions associated with the portfolio firm as:

$$\text{Firm emissions}_{\text{p}} = \text{Revenue of the portfolio firm}_{\text{p}} \times \text{Economic emission factor}_{\text{s,c}}$$

Where p=portfolio firm, s=sector in which portfolio firm p operates, c=country

Total carbon emissions (i.e., unscaled by firm size) are the sum of Scope 1, Scope 2, and Scope 3 emissions. This process has been manually performed for each of the 191 transactions on our database. After a careful study of the business description, and with the help of different industry classifications provided by FactSet following NAICS and SIC guidelines, we identify the most appropriate economic emission factor for each portfolio firm.

*3.2.1.2. PCAF Economic Emission Factors – Methodology*

This section describes the methodology that PCAF uses to calculate the economic-based emission factors from the EXIOBASE database. EXIOBASE is a global database, owned and managed by a consortium of organizations including NTNU, TNO, Universiteit Leiden, WU, and 2.-0 LCA Consultants, that encompasses Multi-Regional Environmentally Extended Supply-Use Tables (MR-SUT) and Input-Output Tables (MR-IOT). The development of EXIOBASE involved estimating, harmonizing, and detailing supply-use tables for numerous countries, while also estimating industry-specific emissions and resource extractions. These country-level tables were then interconnected through trade relationships to form the MR-SUT and MR-IOTs, and they express the interdependencies among different industry sectors in terms of monetary transactions, showcasing the materials and resources required for production. By utilizing the IOTs, it becomes possible to examine the interconnectedness of sectors within a country's economy. Moreover, since the tables include information on emissions, water and material extraction, and land use per unit of production for each industry, it becomes feasible to estimate the environmental impacts associated with the consumption of specific goods or services in a given country. The data can be disaggregated to estimate scope 1, 2, and 3 emissions for different sectors (Merciai & Schmidt, 2018).

EXIOBASE database covers 44 explicitly modelled countries (EU 27 plus 16 major economies) and 5 rest of the world (RoW) regions (per continent), 200 products, 163 industries (including 12 different electricity generation technologies) and a broad range of environmental extensions. The 16 non-EU countries included in EXIOBASE were selected on the basis of contribution to global GDP, trade with the EU and the amount of pollution embodied in trade. Together, the 16 selected RoW countries cover 92% of non-EU global GDP and over 80% of trade with the EU (Merciai & Schmidt, 2018). Using the EXIOBASE IOTs, PCAF calculates the carbon emissions per sector, country and scope as follows:

Scope 1 emissions refer to the direct emissions released by each sector or region in a database. To calculate Scope 1 emissions, different types of air emissions are combined using a global warming potential with a 100-year time frame, which allows for a standardized measurement of emissions in CO2-equivalents. Scope 1 emission intensities are then calculated by dividing the CO2-equivalent emissions by the sector's revenue or output. (The Global GHG Accounting and Reporting Standard for the Financial Industry | PCAF. ).

Scope 2 emissions are associated with the purchase of electricity and heat. The emissions linked to electricity consumption in each sector are determined by multiplying the scope 1 emissions intensity of electricity by the sector's electricity consumption. (The Global GHG Accounting and Reporting Standard for the Financial Industry | PCAF. )

Scope 3 emissions encompass all indirect emissions along the supply chain, excluding direct (scope 1) and direct electricity (scope 2) emissions. To capture these indirect emissions, the quantification of indirect inputs into each sector is necessary. This is achieved using the Leontief inverse, which expresses the total amount of production (direct and indirect) per unit of final goods or services produced by each sector. Scope 3 emission intensities are then calculated by multiplying the direct emissions intensities of production by the total production required per unit of final product, subtracting the emissions already accounted for in scope 1 and scope 2 calculations. (The Global GHG Accounting and Reporting Standard for the Financial Industry | PCAF. ). Finally, PCAF removed most visual outlier data and removed values with low precision. We acknowledge that emission factor database has a limitation: it relies on sector averages, assuming homogeneity and similar emission intensities among companies within a sector. Yet, companies vary in their processes, technology, and suppliers, leading us to overlook the degree of sustainable practices implemented by portfolio companies. However, our analysis compares emissions across 17 sectors. The activities and the sector a company operates in determine the majority of a company's emissions. Therefore, specific practices of portfolio companies are less relevant to our analysis.

To provide a broader insight into how the environmental footprint affects the PE industry, carbon emission data is used as: carbon intensity (GHG emissions divided by the revenue of the portfolio firm at exit) to account for different scales in portfolio businesses and unscaled carbon emissions, as well as scope 1, 2, and 3 emissions across both carbon intensity and unscaled emissions. (Patrick Bolton, M. T. K., 2020) explains that total emissions are a metric on which regulators frequently focus when developing policies, providing the example of the Bank of England, which only did climate stress tests only to large firms and measured the risk in terms of the level of emissions. From the point of view of private equity investors, this logic remains, since, for instance, if a PE fund is going to measure and disclose the carbon footprint of its portfolio, the main disclosure figure will be the total tonnes (t) of carbon dioxide (CO2) equivalent (e) that their investments have financed. Carbon intensity serves as a measure of the carbon efficiency or “greenness” of a firm. Because the above-mentioned carbon emission variables are highly skewed, we take the natural logarithm of them for our analysis.

### *3.2.2. Other variables*

Valuations at the funding stage are affected by the state of the stock markets (Gompers & Lerner, 1997), and market returns significantly affects the cash multiple (ratio of cash received from exit divided by the cash invested by private equity investors) of private equity firms (Gohil & Vyas, 2016). The PE market underlies certain cycles (Acharya et al., 2007). To account for differences in market timing we control for the year of exit of the PE deal – Year FE. (Das et al., 2004) finds that Private Equity returns depend upon the industry, the stage of the firm being financed, and the prevailing market sentiment. Therefore, the industry of the target company is included as a control variable. To control for different pricing behaviors depending upon the stage of acquisition, we use the definitions of micro, small, medium, and large firms adopted by the European Commission (recommendation 2003/361/EC) to create a variable that controls for the size of the portfolio firm. Micro firms are those with Revenue lower than € 2m, Small firms have revenue larger than € 2m and < € 10m, Medium firms have revenue larger than € 10m < € 50m, and Large firms have revenue over € 50m. 74.87% of our sample portfolio firms are large, 21.99% are medium size, 2.62% are small and only 1 company is considered a micro company.

**Table 1: Portfolio firm size distribution in our sample**

| Portfolio firm size | Freq. | Percent | Cum. |
|---|---|---|---|
| Micro | 1 | 0.52 | 0.52 |
| Small | 5 | 2.62 | 3.14 |
| Medium size | 42 | 21.99 | 25.13 |
| Large | 143 | 74.87 | 100.00 |
| Total | 191 | 100.00 | |

Given that PE firms are usually highly experienced in structuring buyout negotiations and are highly aware of the potential sources of bargaining power and their distribution (Ahlers et al., 2016), a dummy variable $PEIfund$ is included to control for the differences in bargaining power when negotiating the exit multiple between different size private equity funds. This variable has been manually constructed by identifying the Private Equity firm exiting each transaction, and matching them with the PEI 300 list, a ranking of private equity managers based on how much capital they have raised in the last 5 years (PEI 300 | The Largest Private Equity Firms in the World.2023). $PEIfund$ is a binary indicator that equals one if the private equity exiting the company i is included in the PEI 300 list and zero otherwise. We can expect that larger PE firms have greater negotiation power to sell at higher multiples. The geographical distribution of the percentage of large PE funds is provided in Table 2. Overall, we observe that non-large PE are predominant in our database, being the large PE mostly concentrated in North America.

**Table 2: Tabulation of PEIfund by Region**

| PEIfund | Region | | | | |
|---|---|---|---|---|---|
| | Asia Pacific | Eastern Europe | North America | Western Europe | Total |
| Non-large PE | 7 | 4 | 41 | 70 | 122 |
| | 63.64 | 100.00 | 50.62 | 73.68 | 63.87 |
| | 3.66 | 2.09 | 21.47 | 36.65 | 63.87 |
| Large PE | 4 | 0 | 40 | 25 | 69 |
| | 36.36 | 0.00 | 49.38 | 26.32 | 36.13 |
| | 2.09 | 0.00 | 20.94 | 13.09 | 36.13 |
| Total | 11 | 4 | 81 | 95 | 191 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| | 5.76 | 2.09 | 42.41 | 49.74 | 100.00 |

First row has *frequencies*; second row has *column percentages,* and third row has *cell percentages*
*Tables were created using asdoc, a Stata program written by Shah (2018).*

According to (Kairat Perembetov et al., 2014) operational factors account for 51% of value creation drivers in Private Equity deals and are an important aspect of the transaction multiple paid. Therefore, we include the EBITDA margin (EBITDA/Revenue) of the portfolio firm as a control variable. It is worth reiterating that these metrics are recorded at the time of exit to ensure portfolio firm-specific financial variables do not distort our analysis.

To measure the institutional pressure received by PE funds, we follow (Emirhan Ilhan et al., 2019) results and use stewardship codes. Stewardship codes contain recommendations about how large investors ought to play a role as active and engaged investors (Klettner, 2017) to create long-term value for clients and beneficiaries and promote corporate sustainability, including engagement and monitoring of investee companies (Katelouzou & Siems, 2020). As (Yutaro et al., 2019) demonstrate that stewardship codes positively impact institutional investors' monitoring activities, we expect that the existence of stewardship codes in a country would result in greater institutional pressure on private equity firms operating within that country. Moreover, (Bonacchi et al., 2022) show that compliance with the UK's stewardship code has been found to enhance the ESG performance of portfolio firms. Based on this evidence, it is reasonable to expect that private equity funds that are subject to stewardship codes and, consequently, face greater institutional pressure, would prioritize investment in portfolio firms with lower carbon emissions. To determine whether the PE home country has a stewardship code in place, we use (Katelouzou & Siems, 2020) data that record the phased implementation of these codes in different countries. From there, we manually construct a dummy variable $InstPress$ that equals one if the private equity HQ country, at the moment of exit, has a stewardship code in place and zero otherwise. The geographical distribution of the percentage of PE funds facing institutional pressure is provided in

Table 3. Overall, we observe that both the United States and Canada have a stewardship code in place. The distribution is different in Europe, where approximately 50% of the PE home countries have stewardship codes in place and 50% do not.

**Table 3: Tabulation of Stewardship Code by Region**

| Stewardship code in place | Target Region | | | | |
|---|---|---|---|---|---|
| | Asia Pacific | Eastern Europe | North America | Western Europe | Total |
| Stewardship code NOT in place | 1 | 4 | 0 | 46 | 51 |
| | 9.09 | 100.00 | 0.00 | 48.42 | 26.70 |
| | 0.52 | 2.09 | 0.00 | 24.08 | 26.70 |
| Stewardship code in place | 10 | 0 | 81 | 49 | 140 |
| | 90.91 | 0.00 | 100.00 | 51.58 | 73.30 |
| | 5.24 | 0.00 | 42.41 | 25.65 | 73.30 |
| Total | 11 | 4 | 81 | 95 | 191 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| | 5.76 | 2.09 | 42.41 | 49.74 | 100.00 |

First row has *frequencies*; second row has *column percentages,* and third row has *cell percentages*

To construct the variable ESG Investor, we follow (Andonov et al., 2021; Barber et al., 2021) and (Lingshan Xie & Stanimira Milcheva, 2022) approach and identify ESG investors using UN PRI signatories as a proxy. Firstly, we obtain the list of UN PRI signatories and their signing years from the UN PRI website. We then manually match the PE exiting the portfolio firm with the UN PRI signatories in the signing list. The dummy variable $ESG\ Investor$ equals one if at least one of the PE funds holding the exited firm is a UN PRI signatory and the signing date precedes the deal date, and zero otherwise. The geographical distribution of the percentage of ESG investors is provided in Table 4. We observe that ESG and non-ESG investors are equally distributed in Europe, while PE funds in North America are more reluctant to commit to ESG considerations when investing.

**Table 4: Tabulation of ESG Investor by Region**

| UN_PRI_Signatory | Region | | | | |
|---|---|---|---|---|---|
| | Asia Pacific | Eastern Europe | North America | Western Europe | Total |
| Non-ESG investor | 10 | 3 | 58 | 48 | 119 |
| | 63.64 | 100.00 | 50.62 | 73.68 | 63.87 |
| | 3.66 | 2.09 | 21.47 | 36.65 | 63.87 |
| ESG Investor | 1 | 1 | 23 | 47 | 72 |
| | 9.09 | 25.00 | 28.40 | 49.47 | 37.70 |
| | 0.52 | 0.52 | 12.04 | 24.61 | 37.70 |
| Total | 11 | 4 | 81 | 95 | 191 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| | 5.76 | 2.09 | 42.41 | 49.74 | 100.00 |

First row has *frequencies*; second row has *column percentages,* and third row has *cell percentages*

Tables 5, 6, and 7 present the sample distribution along various dimensions. Table 5 shows that "Manufacturing" is the most represented sector (36.65%) in our sample, followed by "Professional, Scientific, and Technical Services" and "Information" sectors. Table 6 reports the sample distribution across the portfolio firm's country. We cover a total of 21 countries, and most observations come from the US (38.74%), followed by the UK (16.75%), France, and Sweden. Table 7 represents the distribution and summary statistics by year of the deals in our sample database. We observe that we have fewer observations in 2020 and 2022 compared to the rest of the years, which could be due to the slowdown of the PE market in the year after Covid-19, with the subsequent recovery in the private capital markets due to the low interest rates, which was followed by an increase of the interest rates in 2022 and, therefore, a less active market. The EV/Revenue multiple is steady over the years, while we observe a slight rise in EBITDA margin.

### Table 5: Distribution by NAICS Sector

| Target Primary NAICS Sector | Freq. | Percent | Cum. |
|---|---|---|---|
| Accommodation and Food Services | 3 | 1.57 | 1.57 |
| Administrative and Support and Waste Management and Remediation Services | 4 | 2.09 | 3.66 |
| Construction | 6 | 3.14 | 6.81 |
| Educational Services | 4 | 2.09 | 8.90 |
| Finance and Insurance | 9 | 4.71 | 13.61 |
| Health Care and Social Assistance | 3 | 1.57 | 15.18 |
| Information | 29 | 15.18 | 30.37 |
| Management of Companies and Enterprises | 1 | 0.52 | 30.89 |
| Manufacturing | 70 | 36.65 | 67.54 |
| Mining, Quarrying, and Oil and Gas Extraction | 3 | 1.57 | 69.11 |
| Other Services (except Public Administration) | 4 | 2.09 | 71.20 |
| Professional, Scientific, and Technical Services | 29 | 15.18 | 86.39 |
| Real Estate and Rental and Leasing | 4 | 2.09 | 88.48 |
| Retail Trade | 7 | 3.66 | 92.15 |
| Transportation and Warehousing | 2 | 1.05 | 93.19 |
| Utilities | 4 | 2.09 | 95.29 |
| Wholesale Trade | 9 | 4.71 | 100.00 |
| Total | 191 | 100.00 | |

### Table 6: Distribution by Country

| Target Country | Freq. | Percent | Cum. |
|---|---|---|---|
| Australia | 4 | 2.09 | 2.09 |
| Belgium | 1 | 0.52 | 2.62 |
| Canada | 7 | 3.66 | 6.28 |
| Denmark | 3 | 1.57 | 7.85 |
| Estonia | 1 | 0.52 | 8.38 |
| Finland | 9 | 4.71 | 13.09 |
| France | 12 | 6.28 | 19.37 |
| Germany | 2 | 1.05 | 20.42 |
| Hungary | 1 | 0.52 | 20.94 |
| India | 4 | 2.09 | 23.04 |
| Ireland | 2 | 1.05 | 24.08 |
| Italy | 6 | 3.14 | 27.23 |
| Netherlands | 8 | 4.19 | 31.41 |
| Norway | 5 | 2.62 | 34.03 |
| Poland | 2 | 1.05 | 35.08 |
| Singapore | 1 | 0.52 | 35.60 |
| South Korea | 2 | 1.05 | 36.65 |
| Spain | 4 | 2.09 | 38.74 |
| Sweden | 11 | 5.76 | 44.50 |
| United Kingdom | 32 | 16.75 | 61.26 |
| United States | 74 | 38.74 | 100.00 |
| Total | 191 | 100.00 | |

**Table 7: Distribution by year of exit**

| 2017 | mean | p25 | p75 | N |
|---|---|---|---|---|
| EVtoRevenue | 1.868 | .857 | 2.386 | 28 |
| EBITDA margin | 0.179 | .086 | 0.238 | 28 |
| CarbonIntensity | 306.371 | 100.499 | 473.519 | 28 |
| **2018** | | | | |
| EVtoRevenue | 2.493 | 1.304 | 3.347 | 38 |
| EBITDA margin | 0.176 | .106 | 0.222 | 38 |
| CarbonIntensity | 8048.255 | 91.182 | 530.069 | 38 |
| **2019** | | | | |
| EVtoRevenue | 2.627 | 1.219 | 3.704 | 39 |
| EBITDA margin | 0.191 | .104 | 0.257 | 39 |
| CarbonIntensity | 449.393 | 182.38 | 541.547 | 39 |
| **2020** | | | | |
| EVtoRevenue | 2.569 | .872 | 4.589 | 21 |
| EBITDA margin | 0.198 | .119 | 0.255 | 21 |
| CarbonIntensity | 286.134 | 135.213 | 391.874 | 21 |
| **2021** | | | | |
| EVtoRevenue | 3.002 | 1.201 | 4.749 | 43 |
| EBITDA margin | 0.222 | .118 | 0.260 | 43 |
| CarbonIntensity | 296.412 | 91.182 | 452.120 | 43 |
| **2022** | | | | |
| EVtoRevenue | 2.587 | 1.224 | 3.886 | 19 |
| EBITDA margin | 0.222 | .105 | 0.275 | 19 |
| CarbonIntensity | 466.742 | 150.929 | 575.713 | 19 |
| **2023** | | | | |
| EVtoRevenue | 2.824 | 2.357 | 3.101 | 3 |
| EBITDA margin | 0.265 | .121 | 0.363 | 3 |
| CarbonIntensity | 349.949 | 91.182 | 490.586 | 3 |

Table 8 presents summary statistics for the main variables used in our regression models. The mean (median) EV/Revenue multiple in our sample is 2.566 (2.048), and the mean (median) EV/EBITDA multiple is 13.61 (11.294). Our sample exit multiples are slightly higher than those in similar papers studying PE exits. (Lopez-de-Silanes et al., 2015) median EV/Revenue exit multiple is 1.90, compared to 2.048 in our sample, while in (Acharya et al., 2013), the median exit EV/EBITDA multiple is 7.9, lower than the 11.29 in our database. This difference is partly driven by the deals in the "Information" (15.18% of the sample) sector, which include software companies that usually receive higher exit multiples (3.378 EV/Revenue mean exit multiple) and deals in high-level services sectors such as Finance and Insurance (4.33 EV/Revenue mean exit multiple). The mean (median) EBITDA margin accounts for 19.80% (17.50%). There are more non-ESG investors and non-large PE funds in our sample. The mean Revenue of the portfolio firms at exit is 615 million USD, while the mean EBITDA is 73 million USD. As expected, Scope 3 emissions account for the majority of the carbon emissions, being the median total Carbon intensity of 270.645 tCO2e per million of revenue. The median total GHG emissions of our companies' database are 33.474,163 tCO2e, being Scope 3 emissions the largest contributor.

**Table 8: Summary statistics**

| | N | Mean | Std. Dev. | p25 | Median | p75 |
|---|---|---|---|---|---|---|
| EVtoRevenue | 191 | 2.566 | 1.854 | 1.147 | 2.048 | 3.665 |
| EVtoEBITDA | 191 | 13.61 | 7.801 | 7.887 | 11.294 | 16.489 |
| EV | 191 | 1189.73 | 2818.55 | 80.5 | 264.63 | 1016.79 |
| RevenueTarget | 191 | 615.13 | 2785.77 | 46 | 123 | 415.25 |
| EBITDATarget | 191 | 73.36 | 172.09 | 6.85 | 22.05 | 74.53 |
| PEIfund | 191 | 0.361 | 0.482 | 0 | 0 | 1 |
| ESG Investor | 191 | 0.377 | 0.486 | 0 | 0 | 1 |
| InstPress | 191 | 0.733 | 0.444 | 0 | 1 | 1 |
| Scope1 GHGIntensity | 191 | 1430.79 | 18409.13 | 10.72 | 23.10 | 54.72 |
| Scope2 GHGIntensity | 191 | 43.33 | 124.609 | 0.7 | 5.586 | 19.316 |
| Scope3 GHGIntensity | 191 | 413.90 | 2147.83 | 80.08 | 215.12 | 390.49 |
| CarbonIntensity | 191 | 1888.02 | 20554.59 | 109.82 | 270.65 | 488.14 |
| Scope 1 GHG | 191 | 524744.78 | 5334114.95 | 654.32 | 2965.26 | 11551.98 |
| Scope 2 GHG | 191 | 7878.817 | 25010.716 | 97.898 | 589.597 | 3485.51 |
| Scope 3 GHG | 191 | 152298.37 | 662618.39 | 7772.66 | 22421.22 | 95435.03 |
| GHGemissions | 191 | 684921.97 | 5946379.33 | 9795.84 | 33474.16 | 126996.11 |
| Portfoliofirmsize | 191 | 3.712 | 0.539 | 3 | 4 | 4 |
| EBITDA margin | 191 | 0.198 | 0.128 | 0.111 | 0.175 | 0.254 |

## 3.3. Research Design

### *3.3.1. Lower carbon emissions of PE portfolio companies leads to higher exit multiple*

We employ the following regression model to test Hypothesis 1, whether the exit multiple is significantly impacted by carbon emissions, without subscripts i:

$$log\frac{EV}{REVENUE} = \alpha + \beta_1 logCarbon\_Emissions + \beta_2 Micro\ firm + \beta_3 Small\ firm + \beta_4 Medium\ firm + \beta_5 Large\ firm + \beta_6 PEIfund + \beta_7 EBITDA\_Margin + IND + COUNTRY + YEAR + \varepsilon \quad (1)$$

where *logEV/Revenue* is the logarithm of the exit multiple of deal i, to account for skewness in the distributions of the exit multiple; $\alpha$ is a constant term; $logCarbon\_Emissions$ is portfolio firm i's logarithm of different carbon measures; *Micro, Small, Medium and Large firm* variables are defined in section 3.2.2. and control for target company size; $PEIfund$ is a binary indicator that equals one if the private equity exiting the company i is included in the PEI 300 list and zero otherwise; *EBITDA margin* is the EBITDA/Revenue ratio at exit of portfolio firm i; *IND*, *COUNTRY* and *YEAR* represent the Industry, Country and Year fixed effects to control for heterogeneity in exit multiples and carbon emissions across industries and due to different countries' economic, institutional and legal environments (LIANG & RENNEBOOG, 2017), as well as for timing of the PE in exit their portfolio firms; and $\varepsilon$ is an error term. Standard errors are clustered by country.

Our variable of interest to test Hypothesis 1 is $\beta_1$. Following our line of reasoning, we expect a carbon premium for low carbon emission firms, and, therefore, a negative relationship between the exit multiple and carbon emissions ($\beta_1 < 0$).

### *3.3.2. How PE fund characteristics affect their investment decisions regarding carbon emissions*

The following regression model is used to address Hypothesis 2, Hypothesis 3, and Hypothesis 4, without subscripts i:

$$logCarbon\_Emissions = \alpha + \beta_1 InstPress + \beta_2 PEIfund + \beta_3 ESG\ Investor + \beta_4 Micro\ firm + \beta_5 Small\ firm + \beta_6 Medium\ firm + \beta_7 Large\ firm + IND + COUNTRY + YEAR + \varepsilon$$

(2)

where $logCarbon\_Emissions$ is portfolio firm i's logarithm of different carbon measures; $InstPress$ is a binary indicator that equals one if the private equity exiting firm i headquarters has a stewardship code in place and zero otherwise; $PEIfund$ is a binary indicator that equals one if the private equity exiting the company i is included in the PEI 300 list and zero otherwise; $ESG\ Investor$ is a dummy variable that equals 1 if the PE fund exiting company i was a UN PRI Signatory at exit; *Micro, Small, Medium and Large firm* variables are defined in section 3.2.2. and control for target company size; *IND, COUNTRY and YEAR* represent the Industry, Country and Year fixed effects to control for heterogeneity; and $\varepsilon$ is an error term. We control for the size of the portfolio firm since it has been found to be an important factor influencing a firm's emission intensities (Cole et al., 2013).

Our variable of interest to test Hypothesis 2 is $\beta_1$ in regression (2). As discussed in the previous literature review, stewardship codes increase the monitoring activities of institutional investors (Yutaro et al., 2019) and compliance with them enhances the ESG performance of portfolio firms (Bonacchi et al., 2022). Therefore, it is expected that stewardship codes are negatively associated with the amount of carbon emissions of portfolio firms: $\beta_1 < 0$. Our variable of interest to test Hypothesis 3 is $\beta_2$ in regression

(2). Given large PE funds have a greater proportion of institutional investors as LPs, and these are pressuring for the decarbonization of their investments, we expect a negative coefficient, $\beta_2 < 0$, meaning that large private equity managers backed portfolio companies with lower carbon emissions. Regarding Hypothesis 4, our variable of interest is $\beta_3$ in regression (2). ESG investors, driven by their commitment to incorporate ESG factors into their investment decision-making, should invest in companies with lower carbon emissions, $\beta_3 < 0$.

Table 14 in Appendix B studies the correlation between the three types of carbon emissions (scope 1, 2, and 3) and total emissions, in terms of both unscaled emissions and emissions intensity and logRevenue. Carbon variables have strong and significant correlations with each other. To avoid potential multicollinearity and the risk of spurious inferences, it is important to only include one carbon measure in each regression.

# 4. RESULTS AND INTERPRETATION

## 4.1 Carbon emissions relationship with PE exit multiple

Table 9 presents results from estimating Equation (1) by running an OLS regression of the dependent variable logEVtoRevenue to the logarithm of carbon intensity and unscaled emissions of the portfolio firm with different sets of control variables. Standard errors are clustered by country for all specifications. Columns 1, 3, and 5 correspond to the natural logarithm of the total GHG emissions (i.e., unscaled by firm size) of the portfolio company, in metric tonnes of CO2e. Columns 2, 4, and 6 correspond to the logarithm of the Carbon Intensity (GHG emissions/Revenue) of portfolio companies. Columns 1-2 report a minimal specification, not including control variables or industry and country fixed effects. We find no relationship between emissions and the exit multiple, measured as the logarithm of the EV/Revenue. Columns 3-4 introduce industry and country fixed effects to the model. In this case, we find a negative and statistically significant at a 10% level relationship between the unscaled GHG emissions and the exit multiple of the PE funds. The estimated coefficient indicates that a 1% decrease in the total GHG emissions by the portfolio firm leads to a 0.064% increase in the exit multiple for the PE fund. Columns 5-6 add the control variables mentioned in Equation (1). Doing so causes the coefficient on logGHGemissions to become not statistically significant. Regarding the control variables, at a 1% significance level, a 1% increase in the EBITDA margin turns out to increase the EV/Revenue exit multiple by around 3.417% and 3.546%. The estimated coefficients for the logarithm of Carbon Intensities, which captures the relative carbon efficiency or "greenness" of a firm, are statistically insignificant across all specifications, signaling that investors in the private equity market are not willing to pay a premium for "greener" companies, but for overall lower-emitting companies.

**Table 9: Logarithm of EV/Revenue multiple and logarithm of carbon emissions measures**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Mult | Mult | Mult | Mult | Mult | Mult |
| logGHGemissions | -0.034 | | -0.064* | | -0.059 | |
| | (0.045) | | (0.035) | | (0.044) | |
| logCarbon_Inten~y | | -0.051 | | 0.028 | | -0.033 |
| | | (0.045) | | (0.077) | | (0.065) |
| Micro portfolio firm | | | | | | |
| Small portfolio firm | | | | | 0.296 | 0.237 |
| | | | | | (0.55) | (0.54) |
| Medium-size p. firm | | | | | 0.289 | 0.152 |
| | | | | | (0.249) | (0.186) |
| Large portfolio firm | | | | | 0.525* | 0.253 |
| | | | | | (0.302) | (0.168) |
| PEIfund | | | | | 0.105 | 0.07 |
| | | | | | (0.097) | (0.102) |
| EBITDA_margin | | | | | 3.417*** | 3.546*** |
| | | | | | (0.421) | (0.329) |
| _cons | 1.005* | 0.938*** | 0.441 | -0.437 | -0.692* | -0.854 |
| | (0.562) | (0.293) | (0.548) | (0.577) | (0.35) | (0.513) |
| Observations | 191 | 191 | 191 | 191 | 191 | 191 |
| R-squared | 0.007 | 0.004 | 0.383 | 0.369 | 0.598 | 0.592 |
| Industry FE | No | No | YES | YES | YES | YES |
| Country FE | No | No | YES | YES | YES | YES |
| Year FE | No | No | YES | YES | YES | YES |

*Standard errors are in parentheses*

**** p<.01, ** p<.05, * p<.1 / Tables were created using asdoc, a Stata program written by Shah (2018).*

Table 15 in Appendix B presents results estimating Equation (1) using the logarithms of Scope 1, 2, and 3 carbon emission intensities. Columns 1-3 report a minimal specification, not including control variables or industry and country fixed effects. We find a negative and statistical significance at a 10% level between Scope 2 emissions intensity and the exit multiple. However, when control variables and fixed effects controls are included, this relationship becomes statistically insignificant. Scope 1 and Scope 3 emissions intensity are negative and statistically insignificant across all specifications. The portfolio company's EBITDA margin coefficient remains positive and statistically significant at a 1% level, suggesting that investors are willing to pay more for more profitable companies, consistent with prior literature.

Table 10 presents results estimating Equation (1) using the logarithms of Scope 1, 2, and 3 GHG total emission. The regression specifications function in the same form as in Table 9. The log of Scope 1 total portfolio company unscaled emissions is statistically insignificant across all regressions. The coefficient of the log of Scope 3 total emissions is statistically significant at a 10% level when including the fixed effects controls but becomes statistically insignificant when including control variables. Lastly, there is a negative relationship between Scope 2 total GHG emissions of the portfolio company and the EV/Revenue multiple at exit for the PE. This relationship is statistically significant at the 5% level when including country, industry, and year fixed effects and control variables. A 1% decrease in the Scope 2 emissions of the portfolio company leads to an increase in the exit multiple for PE of 0.033% - 0.057%. These results suggest that private investors are mostly concerned about Scope 2 type of emissions, namely the emissions resulting from the consumption of purchased energy used in a company's operations. Hence, PE funds have the financial incentive to reduce their portfolio firms' Scope 2 emissions, by reducing the amount of energy consumed or switching to renewable energy sources through PPAs or on-site generation (Horne, 2011), as they will be able to exit the company at a higher EV/Revenue multiple. Furthermore, although the results are less robust, PE funds also have financial incentives to encourage their portfolio firms to reduce their Scope 3 emissions. The EBITDA Margin coefficient remains statistically significant and positive. Table 16 in Appendix B includes interaction terms between unscaled Scope 2 carbon emissions and the size of the PE, the institutional pressure at the PE home country, and whether the PE is an ESG investor. We find no evidence that the carbon premium for unscaled Scope 2 emissions vary depending on the size of the PE and the institutional pressure on the PE's home country. However, we find that the Scope 2 exit premium for PE differs based on whether the PE fund is classified as an ESG investor or not. If the PE is an ESG Investor, a 1% decrease in the Scope 2 emissions of the portfolio company leads to an increase in the exit multiple of 0.088%, compared to a 0.033% - 0.057% increase for non-ESG private equity firms. We argue that private investors place greater reliance on the decarbonization initiatives undertaken by a PE fund that has signed the UN PRI. The inclusion of a PE fund as a signatory of the UN PRI instills market confidence regarding the commitment of the fund in reducing carbon emissions, which translates into a higher exit premium. Figure 5 in Appendix B shows a visual representation of the estimated coefficients and their correspondent confidence intervals in Tables 10 and 15. We observe that all carbon emissions measures have a negative effect on the logarithm of the exit multiple (EV/Revenue). Scope 1 and Scope 3 unscaled emissions coefficients are larger than the coefficient on Scope 2. However, they are not statistically significant, potentially due to the observed large variability in these variables and the relatively small sample size employed in the study. The same applies to our estimated coefficients of carbon intensity variables.

**Table 10: Logarithm of EV/Revenue multiple and logarithm of Scope 1, 2, and 3 unscaled carbon emissions**

| | (1)<br>Mult | (2)<br>Mult | (3)<br>Mult | (4)<br>Mult | (5)<br>Mult | (6)<br>Mult | (7)<br>Mult | (8)<br>Mult | (9)<br>Mult |
|---|---|---|---|---|---|---|---|---|---|
| logScope_1_GHG | -0.034 | | | -0.059 | | | -0.046 | | |
| | (0.046) | | | (0.038) | | | (0.034) | | |
| logScope_2_GHG | | -0.05* | | | -0.057** | | | -0.033** | |
| | | (0.027) | | | (0.023) | | | (0.015) | |
| logScope_3_GHG | | | -0.043 | | | -0.066* | | | -0.061 |
| | | | (0.049) | | | (0.034) | | | (0.048) |
| Micro portfolio firm | | | | | | | | | |
| Small portfolio firm | | | | | | | .293 | .285 | .301 |
| | | | | | | | (0.561) | (0.561) | (0.548) |
| Medium-size p. firm | | | | | | | .269 | .253 | .291 |
| | | | | | | | (0.22) | (0.207) | (0.259) |
| Large portfolio firm | | | | | | | .462* | .402* | .538 |
| | | | | | | | (0.244) | (0.204) | (0.33) |
| PEIfund | | | | | | | 0.106 | 0.087 | 0.103 |
| | | | | | | | (0.096) | (0.099) | (0.098) |
| EBITDA_margin | | | | | | | 3.433*** | 3.425*** | 3.406*** |
| | | | | | | | (0.434) | (0.401) | (0.426) |
| _cons | .927* | .971*** | 1.087* | .285 | .068 | .444 | -.846** | -1.008*** | -.702* |
| | (0.471) | (0.255) | (0.588) | (0.513) | (0.291) | (0.529) | (0.337) | (0.264) | (0.346) |
| Observations | 191 | 191 | 191 | 191 | 191 | 191 | 191 | 191 | 191 |
| R-squared | .009 | .026 | .009 | .384 | .39 | .383 | .598 | .597 | .597 |
| Industry FE | No | No | YES | YES | YES | YES | YES | YES | YES |
| Country FE | No | No | YES | YES | YES | YES | YES | YES | YES |
| Year FE | No | No | YES | YES | YES | YES | YES | YES | YES |

*Standard errors are in parentheses*

**** p<.01, ** p<.05, * p<.1 / Tables were created using asdoc, a Stata program written by Shah (2018).*

### 4.2 Carbon emissions and PE fund characteristics

This section discusses the results regarding Hypotheses 2, 3, and 4. In this part of the study, we focus on determining how different PE characteristics relate to their choices in selecting portfolio firms. We argue that PE funds receiving greater institutional pressure, large PE funds, and ESG investors, defined as those PE that are signatories of the UN PRI, should emphasize portfolio firms with superior carbon emissions performance. Table 17 in Appendix B presents the results of tests for mean differences for the logarithm of the carbon intensity of portfolio firms across large and non-large PE funds, PE countries where a stewardship code is in place or not, and between ESG and non-ESG investors. We only find a significant difference in the means depending on the size of the PE fund selling the portfolio firm. This relationship, significant at the 10% level, indicates that non-large PE funds, compared to large PE, are exiting the most sustainable companies (i.e., portfolio companies with lower carbon intensity).

Table 11 presents the results of Equation (2) using different carbon intensity measures (total, Scope 1, 2, and 3). We run an OLS regression controlling for country, industry, and year fixed effects, and the size of the portfolio firm. Standard errors are clustered by country. We find that PE funds receiving greater institutional pressure to decarbonize their portfolios are exiting the higher emission-intensive companies. This relationship holds across all emission Scopes and is significant at the 1% level. Our results differ from those of (Patrick Bolton, M. T. K., 2020), that finds that in public markets, institutional investors do significantly divest from companies associated with high Scope 1 emission intensity, while they do not screen companies based on the level of their emissions. Larger PE funds are more likely to hold lower carbon intensity firms in general, and those that have lower Scope 3 carbon intensities in particular with respect to non-large PE funds, screening out companies with high levels of emission intensity in their supply chain. Lastly, we observe no difference between ESG investors and non-ESG investors except for Scope 2 intensity. ESG investors are associated with higher Scope 2 carbon intensity firms at a 1% significance level, suggesting that PE ESG Investors hold companies with high emissions derived from energy consumption.

**Table 11: OLS regression using the logarithm of carbon intensities and variables of study**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | logCarbonInt | logScope1_Int | logScope2_Int | logScope3_Int |
| InstPress | 1.247*** | 2.085*** | 2.628*** | 0.861*** |
| | (0.312) | (0.413) | (0.655) | (0.3) |
| PEIfund | -0.292** | -0.163 | -0.589 | -0.342*** |
| | (0.128) | (0.168) | (0.513) | (0.12) |
| ESG Investor | -0.043 | 0.033 | 0.426*** | -0.015 |
| | (0.13) | (0.213) | (0.141) | (0.129) |
| Micro portfolio firm | | | | |
| Small portfolio firm | -0.125 | 0.115 | 0.589 | -0.05 |
| | (0.509) | (0.649) | (0.748) | (0.463) |
| Medium-size p. firm | -.081 | .125 | .747* | -.116 |
| | (0.402) | (0.601) | (0.388) | (0.362) |
| Large portfolio firm | -.113 | -.218 | -.121 | -.028 |
| | (0.54) | (0.6) | (0.792) | (0.44) |
| _cons | 5.14*** | 2.65*** | -1.063 | 5.149*** |
| | (0.265) | (0.374) | (0.706) | (0.316) |
| Observations | 191 | 191 | 191 | 191 |
| R-squared | 0.625 | 0.561 | 0.481 | 0.631 |
| Industry FE | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES |

*Standard errors are in parentheses / *** p<.01, ** p<.05, * p<.1*

Figure 3 shows a visual representation of the estimated coefficients and their correspondent confidence intervals in Table 11. We observe how institutional pressure, measured by having a stewardship code in place, positively affect all measures of emission intensities. ESG investors are associated with higher Scope 2 carbon intensity firms. Large PE funds are associated with lower carbon intensity firms in all measures. The negative coefficient on Scope 2 carbon intensity is the largest, but statistically insignificant, possibly due to the substantial variability observed in this variable.

**Figure 3 - Visual representation of Table 11 coefficients and its CI**

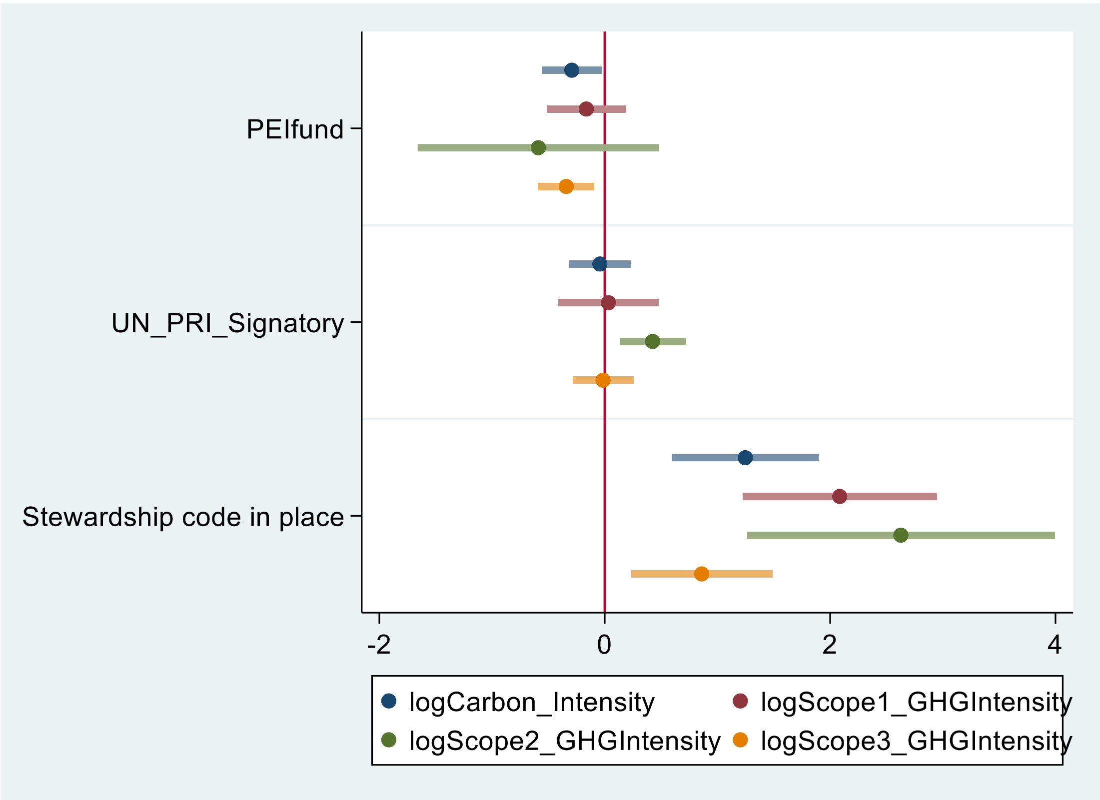


Table 12 presents the results of Equation (2) using different unscaled carbon emissions measures (total, Scope 1, 2, and 3). The methodology is the same as used in Table 11. As with carbon intensity measures, PE funds receiving greater institutional pressure are selecting portfolio firms with higher levels of carbon emissions across all scope measures. These results are significant at the 1% level. However, it is important to mention our sample country distribution when analyzing these results. Our deals database is distributed across 22 countries, and 39.20% of the deals (78) are based in the United States. As the United States has a stewardship code, almost half of our observations have this code in place. Therefore, to find more robust results for this concrete analysis, this study would benefit from having a more diverse country distribution and more observations from PE operating in countries without established stewardship codes. In terms of unscaled emissions, we find no evidence of strong statistical differences between large and non-large PE.

Lastly, we do not find evidence that PE ESG investors hold portfolio companies with better carbon emissions performance. In fact, we show that they are investing in companies with higher levels of Scope 2 emissions, both in intensity and unscaled terms. These results are partly consistent with those of (Aneesh Raghunandan & Shiva Rajgopal, 2022), which find that ESG-focused mutual funds invest in portfolio firms with higher levels of scope 2 and 3 emissions. These results present an important source of concern for society and the financial industry. The empirical evidence demonstrates that ESG investors do not act as they committed and tend to choose companies with higher levels of Scope 2 emissions. Moreover, deals in which stewardship codes are established, which should encourage investors to promote corporate sustainability, led to higher carbon emissions (both unscaled and emissions intensity). Our findings reveal a disparity between the stated objectives of PE firms and the actual investment decisions, hinting at the presence of greenwashing in the industry. To address this issue, it is crucial to implement robust and transparent mechanisms for measuring the efforts of ESG investors in incorporating ESG issues into their investment analysis and decision-making processes. By holding these investors accountable and ensuring that their actions align with their stated commitments, we can foster progress toward sustainability and environmental responsibility in the financial industry.

**Table 12: OLS regression using the logarithm of unscaled carbon emissions and variables of study**

| | (1) logGHG | (2) logGHGScope1 | (3) logGHGScope2 | (4) logGHGScope3 |
|---|---|---|---|---|
| InstPress | 1.104** | 1.942*** | 2.489*** | 0.717* |
| | (0.389) | (0.469) | (0.618) | (0.414) |
| PEIfund | 0.462 | 0.591* | 0.19 | 0.413 |
| | (0.324) | (0.323) | (0.697) | (0.318) |
| ESG Investor | -0.07 | 0.006 | 0.447** | -0.042 |
| | (0.201) | (0.24) | (0.186) | (0.21) |
| Micro portfolio firm | | | | |
| Small portfolio firm | 1.23** | 1.47** | 1.996*** | 1.305** |
| | (0.5) | (0.611) | (0.701) | (0.479) |
| Medium-size p. firm | 2.494*** | 2.7*** | 3.381*** | 2.459*** |
| | (0.331) | (0.464) | (0.259) | (0.307) |
| Large portfolio firm | 4.847*** | 4.743*** | 4.877*** | 4.932*** |
| | (0.256) | (0.291) | (0.367) | (0.255) |
| _cons | 4.616*** | 2.126*** | -1.676*** | 4.625*** |
| | (0.328) | (0.298) | (0.476) | (0.414) |
| Observations | 191 | 191 | 191 | 191 |
| R-squared | .677 | .62 | .459 | .684 |
| Industry FE | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES |

*Standard errors are in parentheses / *** p<.01, ** p<.05, * p<.1*

### 4.3 Robustness tests

This section presents a series of supplementary analyses aimed at assessing the robustness of our previous findings. First, we use an alternative dependent variable in our regression model (1) by substituting the natural logarithm of the EV/Revenue exit multiple with the natural logarithm of the EV/EBITDA multiple. The regression equation estimated in this context is as follows:

$$log\,\frac{EV}{EBITDA} = \alpha + \beta_1 logCarbon\_Emissions + \beta_2 Controls_t + IND + COUNTRY + YEAR + \varepsilon$$

We use the same controls as in Equation (1). We employ industry, country, and year fixed effects. Standard errors are clustered by country. The variable $logCarbon\_Emissions$ takes the form of the natural logarithm of unscaled emissions and carbon intensity, as well as Scopes 1, 2, and 3 across these 2 measures.

Table 18 in Appendix B reports the results from this specification. When measuring the exit premium for carbon emissions with the logarithm of the EV/EBITDA multiple, coefficients on the log of total unscaled carbon emissions and carbon intensity remain negative and statistically insignificant. The coefficient on the log of Scope 2 unscaled emissions remains negative but becomes non-significant. The relationship between the log of Scope 3 unscaled emissions and the exit multiple is practically zero and lacks statistical significance. These results do not contradict our prior findings but introduce uncertainty regarding the robustness of the established associations. Notably, when employing the EV/EBITDA as the dependent variable, the EBITDA margin does not exhibit statistical significance. Strong evidence exists of the effect of profitability measures on the exit multiple, suggesting that the EV/EBITDA multiple represents a less effective variable in capturing the premium paid by investors. Consequently, the utilization of EV/Revenue proves to be a more reliable approach for estimating causal relationships in our research question.

Our second robustness test assesses if the carbon premium paid by investors for lower Scope 2 and 3 emissions emitting companies is due to improved operational performance. (Aneesh Raghunandan et al., 2023) explain that emissions may have an indirect effect on stock returns via a link to profitability. Moreover, (Trinks et al., 2020) find that carbon-efficient firms achieve superior operating performance and carbon efficiency can partly be regarded as 'Resource efficiency in disguise'. Therefore, we examine the existence of a transition mechanism in which lower carbon emitters are more efficient in their operations, which could explain why private investors are willing to pay higher multiples for PE portfolio companies with lower carbon emissions. We test the relation between emissions in which we found a significant result to the exit multiple (log of unscaled total, Scope 2 and Scope 3 GHG emissions), and the EBITDA margin, a measure of profitability and operating performance. Table 13 is an OLS regression of the EBITDA margin to the above-mentioned carbon emissions measures, controlling for industry, country, and year fixed effects. Standards errors are clustered by industry. We find that lower total, Scope 2, and Scope 3 carbon emissions emitting portfolio companies are associated with higher EBITDA margins. Companies with lower indirect emissions are more efficient in their operations, which partially explains why investors are willing to pay higher EV/Revenue multiples for PE portfolio companies with lower Scope 2 and Scope 3 unscaled emissions. We remark that this mechanism does not completely explain why investors pay a premium for portfolio companies with lower indirect unscaled emissions since, in our main regression, the coefficients are statistically significant when controlling for the EBITDA margin. Fully comprehending the transmission mechanisms behind this premium offer researchers an interesting avenue for future research.

**Table 13: OLS regression of the EBITDA margin and significant carbon measures**

| | (1) | (2) | (3) |
|---|---|---|---|
| | EBITDA_Margin | EBITDA_Margin | EBITDA_Margin |
| logGHGemissions | -0.015* | | |
| | (0.008) | | |
| logScope_2_GHG | | -0.01*** | |
| | | (0.003) | |
| logScope_3_GHG | | | -0.017* |
| | | | (0.009) |
| _cons | 0.3*** | 0.193*** | 0.313*** |
| | (0.086) | (0.048) | (0.089) |
| Observations | 191 | 191 | 191 |
| R-squared | 0.313 | 0.31 | 0.318 |
| Industry FE | YES | YES | YES |
| Country FE | YES | YES | YES |
| Year FE | YES | YES | YES |

*Standard errors are in parentheses*

**** p<.01, ** p<.05, * p<.1*

## 5. CONCLUSION

In this study, we empirically examine the relationship between portfolio companies' carbon emissions and private equity (PE) funds at various levels. A crucial aspect of this research involves leveraging the PCAF economic emission factor database, which enables the assessment of carbon emissions associated with portfolio companies. We investigate how portfolio companies' carbon emissions impact the exit multiple of PE deals, and how several PE characteristics affect this relationship. We find a carbon premium of about 0.033%-0.057% for every 1% decrease in unscaled Scope 2 emissions of portfolio companies. This premium is not affected by the size of the PE selling the company or the institutional pressure on the PE's home country. However, if the PE is an ESG Investor—defined as a UN PRI signatory—the premium in the exit multiple increases to 0.088% for a 1% decrease in portfolio company unscaled Scope 2 emissions. We find no evidence of the existence of such a premium when using carbon intensity measures (emissions scaled by revenue). Our findings contribute to the literature that studies the relationship between carbon emissions and public firms' value (Saka & Oshika, 2014) (Zhao-Yong Sun et al., 2022) (Griffin et al., 2017a) (Bui et al., 2020a) (Matsumura et al., 2014) by providing evidence in the private equity industry. This must serve as an incentive for PE investors to decarbonize their portfolios in the light of an exit multiple premium.

In the second part of our study, we investigate the influence of PE characteristics on their investment decisions regarding carbon emissions. We provide evidence that PE funds facing greater institutional pressure tend to select portfolio companies with higher levels of carbon emissions across both unscaled and intensity carbon emissions measures. Large PE funds were observed to exit firms with lower carbon intensity emissions, focusing on reducing the Scope 3 emission intensity of their portfolios. Consistent with (Aneesh Raghunandan & Shiva Rajgopal, 2022) results on mutual funds, we find no evidence that PE ESG investors hold portfolio companies with better carbon emissions performance. In fact, ESG investors are associated with higher Scope 2 emissions, both in terms of unscaled and intensity emissions. Our results raise concerns regarding the effectiveness of both regulation and environmental initiatives such as the UN PRI. Stewardship codes are meant to, among other things, promote sustainability, but PE funds under these are associated with higher emissions. Evidence indicates the need for robust evaluation mechanisms to ensure PE ESG investors' actions align with their sustainability commitments and address the potential issue of greenwashing.

We end with the caveat that our results rely on the PCAF economic emission factor database to estimate portfolio companies' emissions, instead of using reported emissions by companies. This presents a limitation: we rely on sector averages, assuming uniform emission intensities among companies within a sector. Nonetheless, specific sustainable practices of portfolio companies are of lesser relevance for our analysis, since the primary drivers of a company's emissions are its activities and the sector it operates in. Furthermore, (Aneesh Raghunandan et al., 2023) show that emissions estimated using environmentally extended input-output (EEIO) models are not significantly different from disclosed emissions for Scope 3 emissions, and Scope 1 and 2 emissions vary around 2-4% from disclosed to estimated. Increased disclosure of portfolio carbon emissions by Private Equity firms will allow researchers to gain a deeper understanding of the relationships at play and further study the transmission mechanisms behind the carbon premium. However, until such disclosures become more widespread, estimated emissions remain the sole means through which our analysis can be addressed. This underscores the urgent need for greater transparency and efforts in measuring and disclosing the financed emissions of the private equity industry.

## REFERENCES

*2020 Preqin Global Private Equity & Venture Capital Report | Preqin.* (2020). Retrieved Apr 1, 2023, from https://www.preqin.com/insights/global-reports/2020-preqin-global-private-equity-venture-capital-report

*About PCAF | PCAF.* Retrieved Mar 28, 2023, from https://carbonaccountingfinancials.com/about

Acharya, V. V., Franks, J., & Servaes, H. (2007). Private Equity: Boom and Bust? *Journal of Applied Corporate Finance, 19*(4), 44-53. 10.1111/j.1745-6622.2007.00158.x

Acharya, V. V., Gottschalg, O. F., Hahn, M., & Kehoe, C. (2013). Corporate Governance and Value Creation: Evidence from Private Equity. *The Review of Financial Studies, 26*(2), 368-402. http://www.jstor.org/stable/23356858

Ahlers, O., Hack, A., Kellermanns, F., & Wright, M. (2016). Opening the black box: Power in buyout negotiations and the moderating role of private equity specialization. *Journal of Small Business Management, 54*(4), 1171-1192.

Aneesh Raghunandan, Jitendra Aswani, & Shivaram Rajgopal. (2023). Are Carbon Emissions Associated with Stock Returns? by Jitendra Aswani, Aneesh Raghunandan, Shivaram Rajgopal. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3800193

Aneesh Raghunandan, & Shiva Rajgopal. (2022). Do ESG funds make stakeholder-friendly investments? https://link.springer.com/article/10.1007/s11142-022-09693-1#Sec12

APEX RESEARCH. (2021). What is Private Equity Doing in the Fight Against Climate Change? https://www.peievents.com/en/wp-content/uploads/2022/02/Apex-ESG-Carbon-Footprint-Research-Paper.pdf

Arcot, S., Fluck, Z., Gaspar, J., & Hege, U. (2015). Fund managers under pressure: Rationale and determinants of secondary buyouts. *Journal of Financial Economics, 115*(1), 102-135. 10.1016/j.jfineco.2014.08.002

Bain & Company's 2021 Global Private Equity Report. (2021). *Bain & Company, Inc.,* https://www.bain.com/globalassets/noindex/2021/bain_report_2021-global-private-equity-report.pdf

Basse Mama, H., & Mandaroux, R. (2022). Do investors care about carbon emissions under the European Environmental Policy? *Business Strategy and the Environment, 31*(1), 268-283. 10.1002/bse.2886

Bonacchi, M., Klein, A., Longo, S., & Strampelli, G. (2022). The Effects of Credible Voluntary Disclosures: Institutional Investor Engagement and Investees' ESG Performances. *European Corporate Governance Institute-Law Working Paper,* (620) Bui, B., Moses, O., & Houqe, M. N. (2020a). Carbon disclosure, emission intensity and cost of equity capital: multi-country evidence. *Accounting & Finance, 60*(1), 47-71. 10.1111/acfi.12492

Bui, B., Moses, O., & Houqe, M. N. (2020b). Carbon disclosure, emission intensity and cost of equity capital: multi-country evidence. *Accounting & Finance, 60*(1), 47-71. 10.1111/acfi.12492

Das, S., Jagannathan, M., & Sarin, A. (2004). Private Equity Returns: An Empirical Examination of The Exit of Venture Backed Companies. *Journal of Investment Management, 1*

Emily Spittle, & Martin Dietrich Brauch. (2021). Carbon Accounting by Public and Private Financial Institutions: Can We Be Sure Climate Finance Is Leading to Emissions Reductions? by Emily Spittle, Martin Dietrich Brauch :: SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3914387

Emirhan Ilhan, Philipp Krueger, Zacharias Sautner, & Laura T. Starks. (2019). Climate Risk Disclosure and Institutional Investors by Emirhan Ilhan, Philipp Krueger, Zacharias Sautner, Laura T. Starks :: SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3437178

Florin P. Vasvari, Marcel Olbert, & Jefferson Kaduvinal Abraham. (2022). ESG Disclosures in the Private Equity Industry. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4265171

Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: aggregated evidence from more than 2000 empirical studies. *Journal of Sustainable Finance & Investment, 5*(4), 210-233. 10.1080/20430795.2015.1118917

Giuzio, M., Krušec, D., Levels, A., Melo, A. S., Mikkonen, K., & Radulova, P. (2019). Climate change and financial stability. *Financial Stability Review, 1*

*The Global GHG Accounting and Reporting Standard for the Financial Industry | PCAF*. Retrieved May 22, 2023, from https://carbonaccountingfinancials.com/standard

Gohil, R. K., & Vyas, V. (2016). Factors Driving Abnormal Returns in Private Equity Industry: A New Perspective. *The Journal of Private Equity, 19*(3), 30-36. http://www.jstor.org/stable/44397544

Gompers, P. A., & Lerner, J. (1997). Risk and Reward in Private Equity Investments: The Challenge of Performance Assessment. *The Journal of Private Equity (Retired), 1*(2), 5-12. 10.3905/jpe.1997.409670

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. 10.1111/1911-3846.12298

Hammer, B., Marcotty-Dehm, N., Schweizer, D., & Schwetzler, B. (2022). Pricing and value creation in private equity-backed buy-and-build strategies. *Journal of Corporate Finance, 77*, 102285. 10.1016/j.jcorpfin.2022.102285

Horne, M. (2011). *Opportunities to reduce emissions.* ().Pembina Institute. Retrieved from JSTOR http://www.jstor.org/stable/resrep00261.5

Joseph A. McCahery, & Paolo Giudici. (2022). Alternative Investments and Institutional Investors | SpringerLink. https://link.springer.com/article/10.1007/s40804-022-00267-x#citeas

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://ideas.repec.org//a/kap/jbuset/v150y2018i4d10.1007_s10551-016-3207-6.html

Kairat Perembetov, Ivan Herger, Reiner Braun, & Benjamin Puche. (2014). Value Creation in Private Equity by Kairat Perembetov, Ivan Herger, Reiner Braun, Benjamin Puche :: SSRN. *Cefs,* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2917112

Kim, Y., An, H. T., & Kim, J. D. (2015a). The effect of carbon risk on the cost of equity capital. *Journal of Cleaner Production, 93*, 279-287. 10.1016/j.jclepro.2015.01.006

Kim, Y., An, H. T., & Kim, J. D. (2015b). The effect of carbon risk on the cost of equity capital. *Journal of Cleaner Production, 93*, 279-287. 10.1016/j.jclepro.2015.01.006

Labatt, S., & White, R. R. (2011). *Carbon finance: the financial implications of climate change*. John Wiley & Sons.

LIANG, H., & RENNEBOOG, L. (2017). On the Foundations of Corporate Social Responsibility. *The Journal of Finance, 72*(2), 853-910. 10.1111/jofi.12487

Lingshan Xie, & Stanimira Milcheva. (2022). ESG Investors and Local Greenness: Evidence from Infrastructure Deals by Lingshan Xie, Stanimira Milcheva :: SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4264934

Lopez-de-Silanes, F., Phalippou, L., & Gottschalg, O. (2015). Giants at the Gate: Investment Returns and Diseconomies of Scale in Private Equity. https://www.scopus.com/record/display.uri?eid=2-s2.0-84923272374&origin=inward&txGid=cbfe80264e0d46a30a9836a72c11a00f

Marc Roston. (2021). The Road from Scope 3 to Net Zero | SpringerLink. https://link.springer.com/chapter/10.1007/978-3-030-83650-4_4

Marco Ceccarelli, Stefano Ramelli, & Alexander F. Wagner. (2023). Low Carbon Mutual Funds. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3353239

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. http://www.jstor.org/stable/24468367

McKinsey Global Private Markets Review 2023: Private markets turn down the volume | McKinsey. https://www.mckinsey.com/industries/private-equity-and-principal-investors/our-insights/mckinseys-private-markets-annual-review#private-markets-advance-ESG-agendas

Merciai, S., & Schmidt, J. (2018). Methodology for the Construction of Global Multi-Regional Hybrid Supply and Use Tables for the EXIOBASE v3 Database. *Journal of Industrial Ecology, 22*(3), 516-531. 10.1111/jiec.12713

Michael J. Mauboussin, & Dan Callahan, C. (2020). Public to Private Equity in the United States: A Long-Term Look. https://www.morganstanley.com/im/publication/insights/articles/articles_publictoprivateequityintheusalongtermlook_us.pdf

*NAICS & SIC Identification Tools.* NAICS Association. Retrieved May 22, 2023, from https://www.naics.com/search/

Nguyen, J. H., & Phan, H. V. (2020). Carbon risk and corporate capital structure. *Journal of Corporate Finance, 64*, 101713. 10.1016/j.jcorpfin.2020.101713

Pascal Böni, Jurian Hendrikse, & Philip Joos. (2022). ESG Transparency of Private Equity and Debt Firms. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4289573

Patrick Bolton, M. T. K. (2020). Do Investors Care about Carbon Risk? https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3398441

Patrick Bolton, & Marcin T. Kacperczyk. (2020). Carbon Premium Around the World by Patrick Bolton, Marcin T. Kacperczyk :: SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3594188

PEI 300 | The Largest Private Equity Firms in the World. (2023). *Private Equity International,* https://www.privateequityinternational.com/pei-300/

Rajna Gibson, Simon Glossner, Philipp Krueger, Pedro Matos, & Tom Steffen. (2022). Do Responsible Investors Invest Responsibly? by Rajna Gibson , Simon Glossner, Philipp Krueger, Pedro Matos, Tom Steffen :: SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3525530

Safiullah, M., Alam, M. S., & Islam, M. S. (2022). Do all institutional investors care about corporate carbon emissions? *Energy Economics, 115*, 106376. 10.1016/j.eneco.2022.106376

Saka, C., & Oshika, T. (2014). Disclosure effects, carbon emissions and corporate value. *Sustainability Accounting, 5*10.1108/SAMPJ-09-2012-0030

Shrimali, G. (2022). Scope 3 Emissions: Measurement and Management. *The Journal of Impact and ESG Investing,* 10.3905/jesg.2022.1.051

Soohun Kim, & Aaron Yoon. (2021). Analyzing Active Fund Managers' Commitment to ESG: Evidence from the United Nations Principles for Responsible Investment by Soohun Kim, Aaron Yoon :: SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3555984

The Boston Consulting Group, UK LLP. 2023.VALUING CARBON IN PRIVATE MARKETS. https://a.storyblok.com/f/109506/x/477eb3084f/valuing-carbon-in-private-markets.pdf

Tim Kievid, Gianfranco Gianfrate, & Angelo Nunari. (2021). Institutional Investors and Corporate Carbon Footprint. *Global Evidence,* https://www.rsm.nl/fileadmin/Faculty-Research/Centres/EPSVC/Institutional_investors_and_corporate_carbon_footprint_-_global_evidence.pdf

Trinks, A., Mulder, M., & Scholtens, B. (2020). An Efficiency Perspective on Carbon Emissions and Financial Performance. *Ecological Economics, 175*, 106632. 10.1016/j.ecolecon.2020.106632

*What are the Principles for Responsible Investment?* PRI. Retrieved Mar 21, 2023, from https://www.unpri.org/about-us/what-are-the-principles-for-responsible-investment

Wright, M., Amess, K., Weir, C., & Girma, S. (2009). Private Equity and Corporate Governance: Retrospect and Prospect. *Corporate Governance: An International Review, 17*(3), 353-375. 10.1111/j.1467-8683.2009.00744.x

Yutaro, S., Naoshi, I., Yasuhiro, A., & Kotaro, I. (2019). Stewardship Code, Institutional Investors, and Firm Value: International Evidence. *Discussion Papers,* https://ideas.repec.org//p/eti/dpaper/19077.html

Zhao-Yong Sun, Shu-Ning Wang, & Dongdong Li. (2022). The impacts of carbon emissions and voluntary carbon disclosure on firm value. https://link.springer.com/article/10.1007/s11356-022-20006-6

Andonov, A., Kräussl, R., & Rauh, J. (2021). Institutional investors and infrastructure investing. Review of Financial Studies, 34(8), 3880–3934. https://doi.org/10.1093/rfs/hhab048

Shah, A. (2018). ASDOC: Stata module to create high-quality tables in MS Word from Stata output. *Statistical Software Components S458466, Boston College Department of Economics*.

# APPENDICES

## Appendix A: Variable Definitions and Sample Construction

This table describes the construction and sources of the dependent and independent variables used in this research.

| Variable | Definition | Data Source |
|---|---|---|
| logEV/REVENUE | Natural logarithm of the disclosed enterprise value divided by portfolio firm´s revenue at exit. Multiples are truncated at the $99^{th}$ percentile and winsorized at the 95th percentile. | FactSet |
| Revenue - Target (LTM) (MM) | Revenue in $ MM of the portfolio firm at the moment of exit. | FactSet |
| logGHGemissions | Natural logarithm of the total carbon emissions (i.e., unscaled by firm size) of the portfolio company, in metric tonnes of CO2e. | Manually constructed using the PCAF database |
| logCarbon_Intensity | Natural logarithm of the Carbon Intensity (GHG emissions/Revenue) of the portfolio company, in metric tonnes of CO2e. | Manually constructed using the PCAF database |
| logScope_1_GHG | Natural logarithm of scope 1 emissions (measured in tons of CO2 equivalent, tCO2e). Scope 1 emissions cover direct emissions from establishments that are owned or controlled by the company. | Manually constructed using the PCAF database |
| logScope_2_GHG | Natural logarithm of scope 2 emissions (measured in tons of CO2 equivalent, tCO2e). Scope 2 emissions come from the generation of purchased heat, steam, and electricity consumed by the company. | Manually constructed using the PCAF database |
| logScope_3_GHG | Natural logarithm of scope 3 emissions (measured in tons of CO2 equivalent, tCO2e). Scope 3 emissions are caused by the operations and products of the company but occur from sources not owned or controlled by the company. | Manually constructed using the PCAF database |
| logScope1_GHGIntensity | Natural logarithm of the ratio of scope 1 emission (tCO2e) to portfolio firm revenue at exit (millions of dollars). | Manually constructed using the PCAF database |
| logScope2_GHGIntensity | Natural logarithm of the ratio of scope 3 emission (tCO2e) to portfolio firm revenue at exit (millions of dollars). | Manually constructed using the PCAF database |
| logScope3_GHGIntensity | Natural logarithm of the ratio of scope 3 emission (tCO2e) to portfolio firm revenue at exit (millions of dollars). | Manually constructed using the PCAF database |

| | | |
|---|---|---|
| Micro portfolio firm | Target firms are considered micro firms if their revenue at exit is smaller than 2 million EUR | FactSet + the EC (recommendation 2003/361/EC) |
| Small portfolio firm | Target firms are considered small firms if their revenue at exit is equal to or larger than 2 million EUR and smaller than 10 million EUR | FactSet + the EC (recommendation 2003/361/EC) |
| Medium-size p. firm | Target firms are considered medium firms if their revenue at exit is equal to or larger than 10 million EUR and smaller than 50 million EUR | FactSet + the EC (recommendation 2003/361/EC) |
| Large portfolio firm | Target firms are considered large firms if their revenue at exit is equal to or larger than 50 million EUR | FactSet + the EC (recommendation 2003/361/EC) |
| EBITDA margin | Portfolio firm's ratio of earnings before interest, taxes, depreciation, and amortization to total revenue at exit. | FactSet |
| PEIfund | PEIfund is a binary indicator that equals one if the private equity exiting the company i is included in the PEI 300 list and zero otherwise. Manually constructed by identifying the Private Equity firm exiting each transaction and matching them with the PEI 300 list, a ranking of private equity managers based on how much capital they have raised in the last 5 years (PEI 300 \| The Largest Private Equity Firms in the World.2023). | PEI 300 + FactSet |
| InstPress | InstPress is a binary indicator that equals one if the private equity exiting firm i headquarters has a stewardship code in place and zero otherwise. We use (Katelouzou & Siems, 2020) tables and manually match them to the PE fund if, at the moment of exit, the PE home country had a stewardship code in place. | (Katelouzou & Siems, 2020) + FactSet |
| ESG Investor | We obtain the list of UN PRI signatories and their signing years from the UN PRI website. We then manually match the PE exiting the portfolio firm with the UN PRI signatories in the signing list. The dummy variable ESG Investor equals one if at least one of the PE funds holding the exited firm is a UN PRI signatory and the signing date precedes the deal date, and zero otherwise. | UN PRI list + FactSet |
| logEV/EBITDA | Natural logarithm of the disclosed enterprise value divided by portfolio firm´s EBITDA at exit. Multiples are winsorized at the 95th percentile. | FactSet |

**Figure 4 – Search Parameters and Logic**

| | |
|---|---|
| P1 | Announcement Date: >= 01/01/2017 |
| P2 | Transaction Value (MM): >= 1.00 |
| P3 | Target Location (Target): Included: North America; Western Europe; Asia Pacific; Eastern Europe |
| P4 | Transaction Status: Included: Complete |
| P5 | Deal Type: Included: Acquisition / Merger; Majority Stake |
| P6 | Target Ownership Type (Target): Included: Private Company \| Excluded: Government; Joint Venture; Public Company; Subsidiary |
| P7 | Private Equity Exit - Full: Yes |
| P8 | Unofficial Price: No |
| P9 | Disclosed Multiples: Yes |
| P10 | Target Revenue (LTM) (MM): >= 0.01 |
| P11 | Target EBITDA (LTM) (MM): >= -100,000,000,000.00 |
| P12 | Enterprise Value/Revenue: >= 0.01x |
| P13 | Reverse Merger: No |
| Logic | (P1 AND P7 AND P4 AND P3 AND P6 AND P2 AND P8 AND P9 AND P5 AND P10 AND P11 AND P12 AND P13) |

# Appendix B

## Table 14: Pairwise correlations between different emission measures

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| (1) logEVtoRevenue | 1.000 | | | | | | | | |
| (2) logScope_1_GHG | -0.096 | 1.000 | | | | | | | |
| | (0.188) | | | | | | | | |
| (3) logScope_2_GHG | -0.153* | 0.596* | 1.000 | | | | | | |
| | (0.034) | (0.000) | | | | | | | |
| (4) logScope_3_GHG | -0.097 | 0.815* | 0.593* | 1.000 | | | | | |
| | (0.183) | (0.000) | (0.000) | | | | | | |
| (5) logGHGemissions | -0.081 | 0.882* | 0.646* | 0.980* | 1.000 | | | | |
| | (0.266) | (0.000) | (0.000) | (0.000) | | | | | |
| (6) logScope1_GHGI~y | -0.078 | 0.702* | 0.374* | 0.265* | 0.387* | 1.000 | | | |
| | (0.281) | (0.000) | (0.000) | (0.000) | (0.000) | | | | |
| (7) logScope2_GHGI~y | -0.131 | 0.177* | 0.780* | 0.039 | 0.119 | 0.440* | 1.000 | | |
| | (0.071) | (0.015) | (0.000) | (0.595) | (0.102) | (0.000) | | | |
| (8) logScope3_GHGI~y | -0.100 | 0.432* | 0.391* | 0.464* | 0.481* | 0.619* | 0.450* | 1.000 | |
| | (0.168) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | | |
| (9) logCarbon_Inte~y | -0.067 | 0.578* | 0.493* | 0.465* | 0.550* | 0.780* | 0.535* | 0.932* | 1.000 |
| | (0.360) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |

**** p<0.01, ** p<0.05, * p<0.1*

## Figure 5 – Visual representation of carbon emissions coefficients and its CI

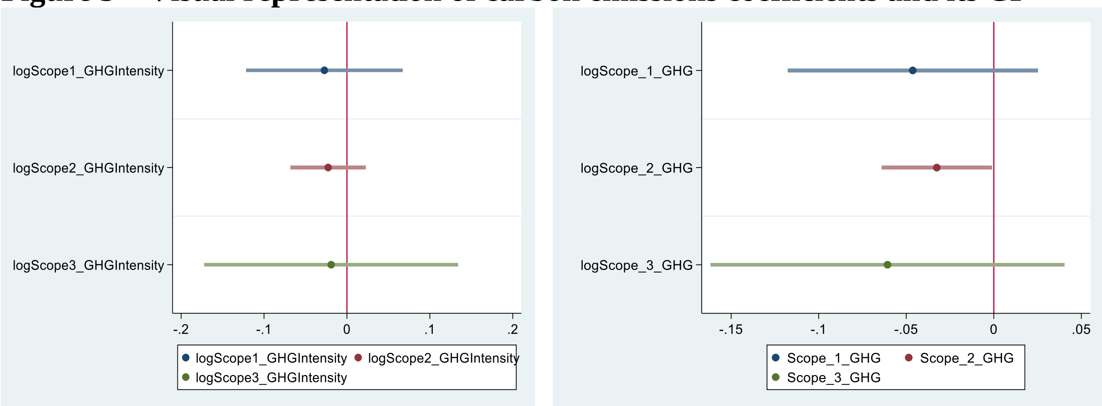


**Table 15: Logarithm of EV/Revenue multiple and the natural logarithm of Scope 1, 2, and 3 carbon intensity of portfolio firm**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | Mult | Mult | Mult | Mult | Mult | Mult | Mult | Mult | Mult |
| logScope1_GHGIn~y | -0.038 | | | -0.01 | | | -0.027 | | |
| | (0.038) | | | (0.057) | | | (0.045) | | |
| logScope2_GHGIn~y | | -0.046* | | | -0.023 | | | -0.023 | |
| | | (0.022) | | | (0.024) | | | (0.022) | |
| logScope3_GHGIn~y | | | -0.09 | | | 0.044 | | | -0.019 |
| | | | (0.068) | | | (0.082) | | | (0.073) |
| Micro portfolio firm | | | | | | | | | |
| Small portfolio firm | | | | | | | 0.242 | 0.248 | .238 |
| | | | | | | | (0.548) | (0.554) | (0.539) |
| Medium-size p. firm | | | | | | | 0.157 | 0.169 | 0.151 |
| | | | | | | | (0.187) | (0.187) | (0.185) |
| Large portfolio firm | | | | | | | 0.25 | 0.252 | 0.254 |
| | | | | | | | (0.17) | (0.168) | (0.168) |
| PEIfund | | | | | | | 0.075 | 0.067 | 0.073 |
| | | | | | | | (0.099) | (0.103) | (0.102) |
| EBITDA_margin | | | | | | | 3.538*** | 3.523*** | 3.534*** |
| | | | | | | | (0.341) | (0.351) | (0.33) |
| _cons | .773*** | .722*** | 1.128*** | -.223 | -.245 | -.521 | -.934** | -1.025*** | -.947* |
| | (0.213) | (0.102) | (0.373) | (0.376) | (0.178) | (0.571) | (0.405) | (0.281) | (0.511) |
| Observations | 191 | 191 | 191 | 191 | 191 | 191 | 191 | 191 | 191 |
| R-squared | 0.006 | 0.017 | 0.01 | 0.369 | 0.371 | 0.37 | 0.593 | 0.594 | 0.592 |
| Industry FE | No | No | YES | YES | YES | YES | YES | YES | YES |
| Country FE | No | No | YES | YES | YES | YES | YES | YES | YES |
| Year FE | No | No | YES | YES | YES | YES | YES | YES | YES |

*Standard errors are in parentheses*
**** p<.01, ** p<.05, * p<.1*

**Table 16: Logarithm of EV/Revenue multiple and the natural logarithm of unscaled Scope 2 emissions with interaction terms**

This table provides results from equation (1) including interaction terms. We regress the logarithm of the EV/Revenue on the logarithm of unscaled Scope 2 emissions, including interaction terms between unscaled Scope 2 carbon emissions and the size of the PE (PEIfund), the institutional pressure at the PE home country (InstPress), and whether the PE is an ESG investor (ESG Investor). In all columns 1-4, we control for the size of the portfolio firm, EBITDA margin, PEIfund, and include Industry, Country and Year of exit fixed effects. Please refer to Appendix A for variable definitions. Standard errors are clustered by country. We report standard errors in parentheses beneath coefficient estimates.

| | (1)<br>Mult | (2)<br>Mult | (3)<br>Mult | (4)<br>Mult |
|---|---|---|---|---|
| logScope_2_GHG | -0.033** | -0.017 | 0.0000894 | 0.005 |
| | (0.015) | (0.027) | (0.02) | (0.046) |
| PEIfund | 0.087 | 0.368 | 0.082 | 0.068 |
| | (0.099) | (0.364) | (0.104) | (0.092) |
| EBITDA_margin | 3.425*** | 3.393*** | 3.548*** | 3.413*** |
| | (0.401) | (0.419) | (0.393) | (0.405) |
| logScope_2_GHGxPEIfund | | -0.042 | | |
| | | (0.056) | | |
| logScope_2_GHGxESG Investor | | | -0.088** | |
| | | | (0.035) | |
| ESG Investor | | | 0.577** | |
| | | | (0.242) | |
| logScope_2_GHGxInstPress | | | | -0.042 |
| | | | | (0.051) |
| InstPress | | | | -0.203 |
| | | | | (0.369) |
| _cons | -1.008*** | -1.089*** | -1.177*** | -0.544*** |
| | (0.264) | (0.233) | (0.24) | (0.184) |
| Observations | 191 | 191 | 191 | 191 |
| R-squared | 0.597 | 0.6 | 0.611 | 0.599 |
| Size of the portfolio firm | YES | YES | YES | YES |
| Industry FE | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES |

*Standard errors are in parentheses / *** p<.01, ** p<.05, * p<.1*

## Table 17: Mean comparison tests between the natural log of carbon intensity and different PE characteristics

**Mean comparison t-test of logCarbon_Intensity between Large-PE and Non-Large PE**

| | Non-Large PE Mean | Large PE Mean | dif | p-value | Significance |
|---|---|---|---|---|---|
| Carbon Intensity by PEIfund | 5.66999 | 5.41013 | 0.2598619 | 0.099 | * |

**Mean comparison t-test of logCarbon_Intensity depending on Institutional Pressure**

| | Non-Stew Mean | Stewardship Mean | dif | p-value | Significance |
|---|---|---|---|---|---|
| CarbonIntensity by Stewardship code in place | 5.508 | 5.601 | -0.092 | 0.529 | |

**Mean Comparison t-test of logCarbon_Intensity between ESG PE funds and non-ESG PE funds**

| | Non-ESG PE Mean | ESG PE Mean | dif | p-value | Significance |
|---|---|---|---|---|---|
| CarbonIntensity by ESG Investor | 5.618 | 5.506 | 0.112 | 0.477 | |

**Table 18: OLS regression (1) using the natural logarithm of the EV/EBITDA exit multiple as the dependent variable**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Mult | Mult | Mult | Mult | Mult | Mult |
| logGHGemissions | -0.009 | | 0.012 | | -0.004 | |
| | (0.019) | | (0.024) | | (0.038) | |
| logCarbon_Inten~y | | -0.084*** | | -0.037 | | -0.027 |
| | | (0.027) | | (0.056) | | (0.054) |
| Micro portfolio firm | | | | | | |
| Small portfolio firm | | | | | .369 | .364 |
| | | | | | (0.291) | (0.291) |
| Medium-size p. firm | | | | | .322* | .312** |
| | | | | | (0.158) | (0.12) |
| Large portfolio firm | | | | | .385* | .365*** |
| | | | | | (0.203) | (0.119) |
| PEIfund | | | | | .114 | .105 |
| | | | | | (0.077) | (0.089) |
| EBITDA_margin | | | | | 0.24 | 0.266 |
| | | | | | (0.399) | (0.327) |
| _cons | 2.563*** | 2.936*** | 1.675*** | 2.034*** | 1.346*** | 1.486*** |
| | (0.226) | (0.171) | (0.293) | (0.369) | (0.425) | (0.425) |
| Observations | 191 | 191 | 191 | 191 | 191 | 191 |
| R-squared | .001 | .028 | .304 | .305 | .317 | .318 |
| Industry FE | No | No | YES | YES | YES | YES |
| Country FE | No | No | YES | YES | YES | YES |
| Year FE | No | No | YES | YES | YES | YES |

*Standard errors are in parentheses*

**** p<.01, ** p<.05, * p<.1*

**Table 18 continuation: OLS regression (1) using the natural logarithm of the EV/EBITDA exit multiple as the dependent variable**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Mult | Mult | Mult | Mult | Mult | Mult |
| logScope_1_GHG | -.018 | | | | | |
| | (0.026) | | | | | |
| logScope_2_GHG | | -.021 | | | | |
| | | (0.013) | | | | |
| logScope_3_GHG | | | .001 | | | |
| | | | (0.044) | | | |
| logScope1_GHGIn~y | | | | -.034 | | |
| | | | | (0.035) | | |
| logScope2_GHGIn~y | | | | | -.028 | |
| | | | | | (0.018) | |
| logScope3_GHGIn~y | | | | | | -.017 |
| | | | | | | (0.061) |
| Micro portfolio firm | | | | | | |
| Small portfolio firm | .387 | .395 | .364 | .371 | .378 | .365 |
| | (0.297) | (0.299) | (0.292) | (0.3) | (0.305) | (0.29) |
| Medium-size p. firm | .358** | .375*** | .309* | .318** | .333** | .311** |
| | (0.13) | (0.129) | (0.168) | (0.118) | (0.119) | (0.12) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Large portfolio firm | .449** | .459*** | .361 | .361*** | .364*** | .366*** |
| | (0.167) | (0.143) | (0.228) | (0.118) | (0.116) | (0.123) |
| PEIfund | .123 | .117 | .112 | .107 | .098 | .107 |
| | (0.08) | (0.08) | (0.077) | (0.085) | (0.083) | (0.091) |
| EBITDA_margin | .212 | .185 | .25 | .266 | .246 | .257 |
| | (0.379) | (0.363) | (0.412) | (0.341) | (0.344) | (0.331) |
| _cons | 1.404*** | 1.352*** | 1.313*** | 1.476*** | 1.362*** | 1.417*** |
| | (0.322) | (0.264) | (0.447) | (0.314) | (0.258) | (0.436) |
| Observations | 191 | 191 | 191 | 191 | 191 | 191 |
| R-squared | .319 | .322 | .317 | .322 | .325 | .317 |
| Industry FE | YES | YES | YES | YES | YES | YES |
| Country FE | YES | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES | YES |

*Standard errors are in parentheses / *** p<.01, ** p<.05, * p<.1*