



DISSERTATION

Masters in Corporate Finance

Do firms with low carbon emissions have higher value?

Edson Domingos Alfredo

Leiria, September 2022



Dissertation

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Dissertation carried out under the orientation of Doctor Maria João da Silva Jorge, Professor at the School of Technology and Management of the Polytechnic of Leiria and co-orientation of Doctor Elisabete Fernanda Mendes Duarte, Professor at the School of Technology and Management of the Polytechnic of Leiria.

Leiria, September 2022

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“Lack of money is a temporary issue, but poverty is a state of mind”

Lair Ribeiro

Dedication

This dissertation is especially dedicated to my older siblings, who have always believed and invested in my academic training: Victória Alfredo, António Alfredo and Samba Alfredo.

I also dedicate this training to my parents for the affection and love they have for me in all circumstances.

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Abstract

This dissertation aims to investigate whether low-carbon companies have higher market values. To achieve this objective, we use the companies belonging to the STOXX Europe 600 Index, for the period 2021.

The variable Tobin'Q was used as proxy for the market value of the companies and the STOXX® Europe Low Carbon 100 Index to classify companies as low-carbon. We collected the financial and market data of all companies in the selected market from the DataStream database and, using the Gretl software, performed the tests on the mentioned data. Although the results found show evidence of a positive relationship between companies' market value and their level of carbon emissions, this evidence is not statistically significant, meaning that our starting hypothesis was not validated.

Perhaps the unexpected finding that low-carbon strategies can be a value-diminishing strategy for firms can be explained by the fact that, in the short run, strategies that reduce carbon emissions increase firms' overall costs. Possibly the use of panel data methodology would prove more appropriate, as it would analyze our hypothesis over a longer period.

Keywords: Corporate Performance; Low Carbon Emissions; Energy Efficiency; Tobin's Q.

Resumo

Esta dissertação visa investigar se as empresas com baixas emissões de carbono apresentam valores de mercado mais elevados. Para concretizar esse objetivo utilizamos as empresas pertencentes ao índice STOXX Europe 600, para o período de 2021.

Foi utilizada a variável Tobin'Q como medida do valor de mercado das empresas e o índice STOXX® Europe Low Carbon 100 para classificar as empresas como empresas de baixas emissões. Recolhemos os dados financeiros e de mercado de todas as empresas do mercado selecionado na base de dados DataStream e, utilizando o software Gretl, realizámos os testes sobre os dados mencionados. Embora os resultados encontrados mostrem evidência de uma relação positiva entre o valor de mercado das empresas e o seu nível de emissões de carbono, esta evidência não é estatisticamente significativa, o que indica que a nossa hipótese de partida não foi validada.

Talvez a descoberta inesperada de que as estratégias que reduzem as emissões de carbono reduzem o valor da empresa possa ser explicada pelo facto de que, a curto prazo, as estratégias que reduzem as emissões de carbono aumentam os custos globais das empresas. Talvez a utilização da metodologia de dados em painel se revelasse mais adequada, uma vez que analisaria a nossa hipótese num período de tempo mais alargado.

Palavras-chave: Performance financeira da empresa; Baixas Emissões de Carbono; Eficiência Energética; *Tobin's Q*.

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List of Acronyms

BVCE – Book Value of Common Equity

CDP – Carbon Disclosure Project

CE – Carbon Emissions

CEO – Chief Executive Officer

CER – Corporate Environmental Responsibility

CO₂ – Carbon Dioxide

CV – Coefficient of Variation

CSR – Corporate Social Responsibility

ECSR – Environmental Corporate Social Responsibility

E – Emissions (GEE)

ECSR – Environmental Corporate Social Responsibility

EE – Energy Efficiency

ER – Energy Resources

ETF – Exchange-Traded Funds

GCP – Google Cloud Products Databases

GE – Gas Emissions

GHG – Greenhouse Gas

GRI - Global Reporting Initiative

IEA – International Energy Agency

ENV – Environmental

EU – European Union

LCI – Low Carbon Index

LN – Natural Logarithm

MLE – Maximum Likelihood Estimation

MVCE – Market Value of Common Equity

NI_Sales – Ratio of Net Income to Sales

OLS – Ordinary Lasty Square

OED – Other Emission Disclosure

R&D - Research and development intensity

ROA – Return on Assets

ROE – Return on Equity

ROS – Return on Sales

SD – Standard Deviation

SMEs – Small and Medium-Sized Enterprises

TA_Sales – Ratio of Total Assets to Sales

TCE – Total Carbon Emission

TL_Sales – Ratio of Total Liabilities to Sales

TQ – Tobin´s Q

UK – United Kingdom

USA – United States of America

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1. Introduction

In recent times, having energy efficiency policies and low carbon emissions has proved to be a pivotal factor in a company's high position in the market. Perhaps this view has credibility because, in recent decades government policies recommend the efficient use of climate's influential factors.

The European project, through European Chief Executive Officer CEO Alliance,¹ creates the opportunity to discuss ideas with companies that offer solutions for the implementation of the European Green Deal, namely the decarbonization of the economy, the ecological transition, and energy efficiency. The objective is reducing carbon emissions (CE) by 55% by 2030. In this organization, companies play a fundamental role in promoting the energy transition and have a responsibility to lead by example.²

The effect of corporate responsibility, concerning the environment and responsible logistics to enable good social practices of the company, varies across non-governmental organizations, (Stekelorum *et al.*, 2020). Thus, when analysing the factors that lead companies to engage in social responsibility behaviours, Martínez *et al.* (2016) concluded that these are strategic decisions. In fact, these practices are considered part of the company's core values and are prone to create market advantages and business opportunities. The authors concluded similarly that being Corporate Environmental Responsibility (CER) oriented positively influences the company's sales growth. Also, in the study by Yang *et al.* (2015) it is concluded that strategic flexibility influences green management practices, and institutional support contributes to the firm's value.

In light of what was mentioned above, and focusing essentially on corporate social responsibility (CSR), this dissertation aims to verify if companies with low carbon emissions (efficiency in the use of greenhouse gases GHG) systematically have a better financial performance than other companies in the market.

¹ The CEO Alliance for Europe is a cross-sector Action Tank, working towards a more prosperous, sustainable, and resilient Europe. The Alliance's shared goal is to make the EU (European Union) the world's leading region for prosperity, sustainability, and resilience by unlocking investments, fueling innovations in new technologies and creating future-proof jobs.

² Retrieved from: <https://www.smartplanet.pt/news/energias>, on July 14,2021.

The empirical analysis was based on companies listed in the STOXX Europe 600 Index, where we identified the companies belonging to the STOXX® Europe Low Carbon 100³ with a dichotomous variable to differentiate them from the companies that emit more carbon in the studied market. To pursue the objective of the study, we collected and used the economic and financial information of the year 2021 of the companies that make up these indices, through the DataStream database.

In the research conducted in previous studies, the use of several methodologies and several markets was verified, but our innovator factor lies in the fact that we used a different market in relation to other studies. Moreover, we used the linear regression method to verify if the companies belonging to the STOXX® Europe Low Carbon 100 outperform the market value of their peers in the STOXX Europe 600 Index.

This dissertation, being divided in four parts, will be organised as it follows: the following section initially discusses the literature review, mentioning some concepts based on the theme and the main results of previous research. In the third section, we explain the procedure of data collection, research method, formulate our hypothesis and our model and identify the dependent, independent and control variables, according to the reviewed literature. The fourth section presents the results and analysis of the results obtained. And finally, in the last section, we talk about the conclusions, the implications and limitations of the study, and future research paths.

³ The STOXX Industry Leaders Low Carbon Indices represent the key industry leaders (as defined by the ICB Industry classification Benchmark) with the lowest carbon emissions considering estimated and reported carbon intensity data. Specifically, the components of this Index are European. Currently, the STOXX® Europe Low Carbon 100 has 83 components from 13 countries in Europe.

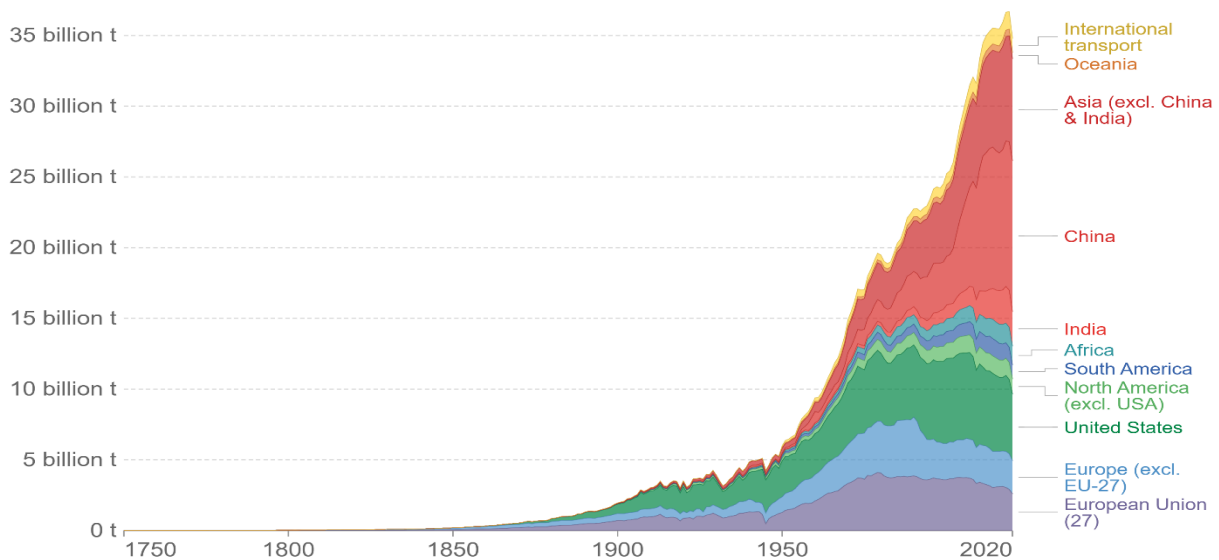
2. Literature Review

2.1. Overview of Carbon Emissions

Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented when compared to at least the last 800,000 years. Their effects, together with those of other anthropogenic factors, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed global warming since the mid-20th century. At a time when global emissions need to be reduced, they are, in fact, still rising, as it is showed in Figure 1. It seems that the “world has not yet peaked”.⁴

Figure 1

Annual Carbon Dioxide (CO₂) Emissions From Fossil Fuels, by World Region



Note. This measures CO₂ emissions from fossil fuels and cement production only – land use change is not included. Statistical differences (included in the GCP Google Cloud Products Databases dataset) are not included here. Retrieved from <https://ourworldindata.org/Global Carbon Project>, in August, 2020.

⁴ Retrieved from: <https://ourworldindata.org/> , in August, 2020.

According to the report *Doubling Down - The Low Carbon Investment Opportunity in Europe* – written by the non-profit organization Carbon Disclosure Project (CDP) and consultancy Oliver Wyman, 882 European listed companies reported 59 billion euros in new low-carbon capital investments and 65 billion euros in new research and development spending in 2019.⁵ Similarly, since 2020, according to a report by the International Energy Agency (IEA), investment in clean energy has risen by 12%, after having registered a slow growth (2%) since the signing of the Paris Agreement, in 2015. The record clean energy bet, which is believed to be reaching 1.4 billion by 2022, is expected to account for almost three quarters of energy growth. The conclusions of the report state that the increase in resources was sustained through fiscal support from governments and aided by the growth of sustainable finance, especially in advanced economies. In this context, in 2021, the largest investments in clean energy were made in China (with 380 billion dollars), in the European Union (with 260 billion dollars), and in the United States (with 215 billion dollars).⁶

As seen in the results of several studies, the less carbon released in the atmosphere, the better it is for nature, and so, we tried, in this work, to find out if companies that emit small amounts of carbon are more valued in the market and if this influences their financial returns.

2.2. Carbon Emission and Firm Value

The study by Galama and Scholtens (2021) confirms the existence of a positive effect between the GHG performance of companies and their financial performance, with the hope that the less GHG emissions, the greater the performance, and this result is in line with the objective here intended. However, for Semieniuk *et al.* (2021) climate policies and low carbon technologies can cause barriers between market agents, or even cause a general change in expectations of their impacts. For these authors, the transition factors cause physical assets to lose their ability to generate revenue and managers must anticipate this.

In Finland, regional targets are related to the reduction of GHG emissions and general improvements in the energy system efficiency, since regional GHG efficiency requires that energy system operators and their interests are linked to local decision-making processes (Viholainen *et*

⁵ Retrieved from: Portuguese agency, <https://www.observador.pt>, on February 24, 2020.

⁶ Retrieved from: <https://www.sapo.pt/>, on June 6, 2022.

al., 2016). In the opinion of Zhang *et al.* (2016), policymakers may assume that energy efficiency (EE) is more cost-effective to prevent damage to health than to pay for the resulting damage later.

Albertini (2013) states that organizational resources and capabilities, rooted in the company's interaction with its natural environment, can enable them to be competitive. As a result, managers tend to seek to reduce GHG emissions as part of their strategy to increase financial performance. The impact in the performance of companies, in relation to carbon emissions and the efficient use of renewable energy, has been measured several times through market-based variables and organizational measures, for example Tobin's Q (Dowell *et al.*, 2000).

Some companies understand that it is only financially worth to engage in climate change mitigation after a minimum level of carbon performance has been exceeded and no less than that, because it is believed that low carbon companies face a trade-off between this and competitiveness (Lewandowski, 2017). Thus, this factor (low carbon emissions) can increase or decrease the firm's revenue, which facilitates the aspect of monetary comparison between firms over time (Hoffmann & Busch, 2008).

Palea and Santhia (2022) found results that suggest greater difficulties in generating income in the medium and long term, for more polluting companies, but after reviewing their GHG emissions, they also concluded that the relationship between lowering their carbon output and the firm's performance is negative. However, the negative impact is more prominent for companies in countries that have a more bureaucratic national carbon emissions trading scheme. In addition, corporate governance reduces the negative value effect of Gas Emissions GE, indicating that shareholders trust managers in relation to carbon management (Choi & Luo, 2021). In a study carried out by Griffin *et al.* (2017), it was surprisingly found that investors price the companies' greenhouse gas (GHG) emissions as a negative component of the book's value, and it does not matter if the company has low or high emissions.

Lee *et al.* (2015) verified that the market 'penalizes' firms' negative environmental performance more consistently than its positive performance. So, the low carbon factor and the financial factor complement each other. In addition, national policies define this relationship, through collectivism in the national culture, presence of an emissions trading scheme and regulatory governance (Luo & Wu, 2019). Another issue is that accepting a fixed trade-off between environmental regulation

and competitiveness unnecessarily raises costs and slows down environmental progress. Rather than simply adding to cost, properly crafted environmental standards can trigger innovation offsets, allowing companies to improve their resource productivity (Porter & Van der Linde, 1995). For smaller firms there is no association between economic performance and pollution disclosures (Freedman & Jaggi, 1982).

From a theoretical point of view, a company's environmental investment behaviour causes a budget-constrained regulator to divert its enforcement efforts to other companies. This puts companies in a risky perspective, where each imposes higher monitoring costs on the other, (Decker, 2002). Economic theory suggests that a firm's commitment to higher levels of disclosure should reduce the information asymmetry component of the firm's cost of capital. Also, the bid and ask spread and trading volume, behave in the expected direction, when compared to companies less related to the market reporting regime, namely in German market (Leuz & Verrecchia, 2000). In addition, companies with superior GHG performance are more likely to engage in voluntary disclosure, and the company's statute has strong importance in this aspect. Leung and Philomena (2013) support that stakeholders play a crucial role in this issue.

For Linares-Rodriguez *et al.* (2022) the volume of carbon emissions is not related to the value of the firm. Furthermore, the disclosure of their carbon emissions is unrelated to the value of the company, although Disclosure of Carbon Management Practice is linked to it, but in developing countries, they should be motivated to report carbon emission by mandatory government reporting, not only for large industries (Sudibyo 2018).

Therefore, cash reserves can help in terms of betting on innovations, and investors and managers tend to manage better so that their funds cover these liabilities (Alam *et al.*, 2022). Companies that have high carbon emissions face more uncertainties in cash flow, which can result in less future investments (Safiullah *et al.*, 2021).

There are now several initiatives proposed as solutions to human-induced climate change, and the global carbon market involves a multitude of different interests, contradictions, and tensions. Certainly, carbon has the potential to become a key empirical term in value discussions (Dalsgaard, 2013).

The most widely deployed carbon practice in the sampled European carbon-intensive firms is carbon trading, and their practices are an improvement in general end-use energy efficiency (Cadez & Czerny, 2016).

Popescu *et al.* (2012) in their studies, in the United States, support the idea of the existence of a relationship between the market value of a real estate asset and its energy efficiency EE, because the EE produces tangible benefits. Additionally, they verify that the payback period, for investments in EE, depends on two factors: i) potential energy savings and ii) value added to the property.

By measuring the value of the company by Tobin's Q, Rokhmawati (2015) concluded that the lower the carbon level, the higher the Tobin's Q. This author states that the market values carbon-oriented activities. On the contrary, Wang *et al.* (2014) stated that a high Tobin's Q tends to be correlated with higher GHG emissions, no matter the type of industry. While for Delmas *et al.* (2015) investors are more likely to get a return on low-carbon companies in a long-term perspective, based on Tobin's Q.

In the view of Ganda and Ngwakwe (2014) the exploitation of inexhaustible sources of energy is only sustainable if they are consumed in a way that does not cause damage to existing environments, and so, to Türkoğlu and Kardoğan (2017), markets that use energy efficiently are economically more competitive. This is also true in the Chinese market, where low energy intensity can generate improvements in financial performance (Fan *et al.*, 2017). Under various proposed carbon trading schemes around the world, firms must manage carbon to meet required targets, earn revenue and reduce costs (Ratnatunga *et al.*, 2011).

It has been observed that states have failed to support the carbon market accumulation strategy due to tensions between the socio-ecological relationships of appropriation and capitalization, that are internal to the carbon commodity (Bryant, 2018). Despite this, environmental processes moderate the relationship between the aspects discussed in this work and reinforce the financial performance of companies through better management of stakeholders (Misani & Pogutz, 2015).

To reduce pollution caused by China's coal industry, Shang *et al.* (2016) say that China's policy has led a strategic transfer of energy industries to other regions, demanding good coal power projects and ensuring greater quality in use, with the focus always being: (1) clean production; (2)

reduction in consumption, and (3) reuse, with the aim of meeting the efficiency of the main producing areas.

According to the study of Lipsy and Schipper (2013), in Japan the biggest factors of EE are the policies dictated by the government. Despite economic development, compared to the West, the Japanese continue to travel shorter distances and are less likely to travel by car. In Japan, there is little energy expenditure on bus and train travel when it comes to high load factors. According to Lipsy (2012), EE policies in Japan aim to encourage efficiency by increasing the cost of energy-inefficient transport.

In terms of energy efficiency, in the field of European transport, the study by Ruzzenenti and Basosi (2009) show that EE has considerably improved in the last three decades in Europe. The three main improvements are: (1) the technological progress that reduced the fuel economy of the means of transport; (2) the search for more powerful vehicles, and (3) the shift of the transport fleet towards heavier vehicles. These factors account for 60% of the improvement in energy efficiency in Europe.

According to the study by Kwon (2006), in the period from 1979 to 2000, the fuel consumption rate of new gasoline cars improved annually by 0.9% in Great Britain. Other studies show that there are possibilities that the most polluting companies will have difficulties in accessing capital in the future (Palea & Santhià, 2022).

It appears that the relationship between environmental and economic performance is inverted, implying that efforts to improve environmental performance are accompanied by increased economic benefits at the beginning, but beyond a certain point, the relationship becomes one of trade-offs (Tatsuo, 2010). Process-oriented carbon performance is positively associated with market value, while actual carbon performance has no effect on market value, and executive compensation affects carbon performance in this respect, but not as in carbon performance real (Haque & Ntim, 2020). In this context, the voluntary carbon disclosure is positively associated with a firm's financial performance (Alareeni & Hamdan, 2020; Alsaifi *et al.*, 2020).

At least until the year 2017, in China, few companies and investors expressed a strong interest in trading emission allowances for profit. Until that date, uncertainties associated with enhanced state intervention and the introduction of new regulatory provisions were persistent (Cong & Lo, 2017).

The commencement of GHG emissions' disclosure had a positive and significant effect on companies' value, as emissions' disclosure shows concern for the environment that is positively responded to by the market and becomes the basis for investors to make their considerations. In addition, companies categorized in the high-profile industrial type have been trying to change their unfavourable image and avoid lawsuits, carrying out the disclosure of their emissions, to obtain positive responses from the market (Hardiyansah *et al.*, 2021). In light of what was mentioned, environmental performance measures through GHGs play very important roles to support corporate-level business strategies and environmental policies in general (Hassan & Romilly 2018), regardless of the type of industry or sector of activity (Chaklader & Gulati, 2015).

In a Chinese survey, it was found that, carbon efficiency positively and significantly influences total asset turnover and Tobin's Q, while total market risk negatively impacts it, especially for firms in carbon intensive industries (Wang *et al.*, 2021). In another study, Kim *et al.* (2015) found that carbon intensity can decrease possible negative effects of carbon risk on the cost of capital, resulting in an improvement in the relationship between low carbon and the cost of equity, and this has strong implications for CEOs, management, policymakers and corporate investors.

The Abu Dhabi's government has made a careful decision for the low carbon economy that will be developed over the course of this century. It seeks to become a model for what can be achieved in other countries at an economic level. There, sustainable development is no longer an option; it's the only way forward. The intention is that human capital, regional pool of talent and knowledge, will allow the region to grow and become a sophisticated driver on this topic in the United Arab Emirates, and the world (Nader, 2009).

The study of Kumar and Firoz (2018) measure carbon intensity of the sample firms based on historical carbon emissions. Using the panel's data analysis methodology, this analysis consistently provides evidence that the carbon emission intensity adversely affects corporate entities financial performance. This research demonstrated that carbon emissions have a negative impact of Return on Net Worth and Earnings Per Share of emissions-labile companies. Similarly, Brouwers *et al.* (2018) found that good carbon emissions performance does not always pay off, and lower carbon emission levels are only rewarded if companies do not pass carbon costs on to consumers.

In Table 1 we summarize several on studies on the relationship between low carbon emission and firm value.

Table 1.*Previous Research on the Relationship Between Low Carbon Emission and Firm Value*

Author(s)	Country	Time Span	Sample	Dependent Variable	Independent Variable	Control Variable	Empirical Methods	Outcomes
Alam <i>et al.</i> (2022)	UK	2007-2017	943 EUA companies	LN of Total CE, direct CE and indirect CE	Cash holdings	size, sales growth, capital expenditure, leverage, profitability, institutional ownership, board independence	Multiple regression model, Descriptive statistics	The carbon emissions are lower in firms with higher corporate cash holdings
Palea and Santhià (2022)	Italy	2009-2018	66 automobile manufacturing, engines & parts, tires, and rubber products industry groups	ROE, ROA, ROS	Corporate carbon risk as the LN of CE	Revenue growth, Capital intensity, Leverage, and R&D Intensity	Multiple regression model, Descriptive statistics, and correlation	Possible difficulties in accessing capital in the future, or more expensive, for higher-polluting firms, and need to cleaner production.
Choi and Luo (2021)	Australia	2008-2015	1748 firm-year observations, involving 28 countries	Firm Value	MVCE, CE, BVCE, Income before extraordinary items.	Sectors	Multiple regression model, MLE, probit model	The level of CE is negatively related to firm value. Good CSR is found to reduce the negative value effect of CE
Lee and Cho (2021)	Korea	2013-2017	841 Korean firms, 514 chaebols and 335 non-chaebols companies, CDP database	1 if discloses its CE data to the CDP and public disclosure, and, 0 otherwise	(ENV) environmental responsibility in a particular period	TA_Sales, TL_Sales and NI_Sales	OLS, Descriptive statistics, multiple regression model	The companies with good environmental performance tend to disclose CE. The investors consider CE to be destructive.

Table 1.*Previous Research on the Relationship Between Low Carbon Emission and Firm Value (cont.)*

Author(s)	Country	Time Span	Sample	Dependent Variable	Independent Variable	Control Variable	Empirical Methods	Outcomes
Linares-Rodríguez <i>et al.</i> (2022)	Colombia	2016-2019	280 company-year, sustainability reports from the GRI database, ORBIS database.	Direct Emissions Disclosure; Indirect Emissions Disclosure; Other Emissions Disclosure	Carbon Management Strategy, Size, tax, Region	ROA, shareholders, Indebtedness	Regression model, Hausman test, fixed effects, the random-effects	The CE efficiency model shows a connection with corporate debt as a leverage mechanism to acquire technology or manage innovation projects for a more efficient management of GHGs
Safiullah <i>et al.</i> (2021)	USA	2004-2018	3116 firm-year observations, ESG Thomson Reuters, ASSET4 database, Standard & Poor's long-term issuer credit rating	Credit rating	Carbon Emission, Industry, year	Tangibility, ROA, Size, LN of total assets, Price Volatility, Default, Price/Book	Merton's formula, Descriptive statistics,	There is a negative and economically significant impact of CE on credit ratings
Cadez and Czerny (2016)	German	2005-2012	158 Carbon-Intensive firms from three European countries	Company's total CO ₂ emissions in tones	19 carbon practices. A 7-point Likert scale, values 1 (not at all) and 7 (to a large extent).	Industry	Questionnaire survey of European carbon-intensive firms, factor model, extraction method, varimax rotation	The most widely deployed carbon practice, are improvement in general end-use energy efficiency.

Table 1.*Previous Research on the Relationship Between Low Carbon Emission and Firm Value (cont.)*

Author(s)	Country	Time Span	Sample	Dependent Variable	Independent Variable	Control Variable	Empirical Methods	Outcomes
Misani and Pogutz (2015)	Italy	2007-2013	CDP, 998 organizations reporting GHG Emissions between 2007 and 2013	ROE, ROSe ROA, Tobin´s Q	Financial performance, carbon performance	Environmental management, industry, year, size, debt/equity intensity, Corporate Governance Score	Hierarchical least squares Regression.	Companies achieve the highest financial performance when are neither low nor high CE, but in between

Note. This table shows some literature on carbon emissions and the relation of company performance: we identify the authors, country of the study, interval of research carried out, sample used, variables, methodology and the main results obtained.

2.3. Carbon Emissions and Corporate Responsibility

Environmental corporate social responsibility (ECSR) stimulates business innovation and Small and Medium-Sized Enterprises (SMEs) that promote ECSR by improving their profile in terms of product and process innovation. Environmental focus helps technological advancement in SMEs, since the ECSR generates improvements in existing technological resources; and has the potential to convert a non-innovative company into an innovative one through the development of technological resources (Forcadell *et al.*, 2021).

An effective communication model is necessary to have a legitimate corporate image and one way to do a good image communication is to have (Corporate Social Responsibility) CSR-related initiatives, created and disseminated in organizations among stakeholders (Allen & Craig, 2016). Large companies and large volumes of business are more likely to disclose information about emissions to the market, and this can make large companies seen as more responsible in relation to others (Desai, 2022).

The study by Tanthanongsakkun *et al.* (2022) shows that the company's governance structure plays an important role in shaping not only general business strategies, but also environmental strategies.

According to Scott (2007), promoting corporate social responsibility (CSR) means sustaining the company's relationship with the environment, economy, and society. Williamson (2006) adds that CSR is a variable of competitive advantage, since this aspect makes firms attract more and more investors. Furthermore, Damert *et al.* (2018) refers to stakeholders outside the company that put pressure companies on their responsibilities and influence the measures that companies adopt, in order to gain more prestige in the market.

Wang *et al.* (2021) examined the relationship between air pollution and CSR performance. The study supports the hypothesis of a positive relationship between air pollution and CSR performance, thus indicating that more severe air pollution has a significant and positive effect on CSR performance, and that this positive relationship will be stronger when past performance is superior. For Merton (1987), when an investment decision considers corporate social

responsibility, it adds another dimension to the mean-variance framework that modern portfolio theory addresses.

According to Kuo *et al.* (2012), environmentally sensitive industries and state-owned companies are more engaged in the dissemination of environmental information, especially EE and the development of high technologies and carbon reduction. As seen in several studies, from a long-term perspective, CSR and profit maximization can be compatible. Some companies commit to spending large sums to deal with climate change. Like Amazon, which expects to spend 10.00 billion dollars over the next few years on an initiative called the Terra de Bezos Fund.⁷

For Agudelo *et al.* (2020), energy companies, for example, take proactive roles in their CSR actions, with responsible behaviors as a reaction on some specific motivations, such as stakeholder expectations. CSR is one of the characteristics of companies that generate the most "admiration" in the world, as it translates in social involvement with the community where companies are located.

As we can see in Simon's (1995) research the market does not see CSR as a philanthropic action but considers it as tool that goes far beyond the interests of its stakeholders. The author considers the impact of CSR actions on other market actors and on the social good. In short, the contributions generated by CSR activities can be equated to an entity's insurance, generating better market positions and greater value for the company, especially when investments are directed at stakeholders. From Lee and Cho (2021) point of view, investors think that carbon emissions can be destructive and look for companies that are responsible for this issue.

From the point of view of motivation, CSR practices aim to improve the environment and improve the market. Stakeholder theory provides a foundation of the relationship between CSR and green innovation from a pressure perspective. From the stakeholder's theory point of view the exchange and sharing of various resources between the company and its stakeholders contributes to corporate success (Yuan & Cao, 2022).

⁷ Retrieved from: <https://www.theverge.com>, on November 16, 2020.

Yang *et al.* (2015) when examining how companies in emerging economies respond to green management pressures and measuring what they gain by adopting green management practices, realized that the business ethics perspective must be proactive and that it improves the company's competitiveness and increases social responsibility.

The results of the study by Rusli (2019) show that environmental performance will have a strong impact whether or not we consider the existence of moderating variables of environmental media exposure that have a strong influence on financial performance. Although the industry type moderates the environmental exposure, the effect is not significant on financial performance.

Andrian (2020) shows that carbon emissions disclosure has a significant positive effect on financial performance. However, corporate social responsibility disclosure has a significant negative impact on financial performance. The first result may have been achieved as stakeholders see the efforts made by the company to preserve the environment through its activities which is clearly a sign that investors perceive that mitigating climate change by reducing carbon emissions is a priority. A possible justification for the second and inconsistent conclusion of Andrian (2020) is advanced by Blasi *et al.*, (2018). These authors settle that, in general, CSR engagement raises firms' total stock returns and reduces financial risks, but this depends on the prominence of the area of CSR in which the firms invest. Busch *et al.* (2022) stated that companies should be forced to be more efficient.

Saeed *et al.* (2021) find that the existence of a CSR committee improves the company's social responsibility and effectively alleviates carbon intensity. Furthermore, this study shows that a large CSR committee with more experienced board members is effective in implementing sustainable business practices. Kurnia *et al.* (2020) highlight that the existence of CSR governance is conducive to focusing on social issues and environmental issues. Thus, lower carbon emissions disclosure and good corporate governance do not make sense to the investor if no improvement in financial performance is associated (Jung *et al.*, 2021). There is a successful trend for directors to move with their companies to become environmentally friendly. So, the role of corporate governance in promoting green finance is crucial.

However, efficient energy management policies have emerged not only to address commercial interests, but also to maintain a good market environment and its stakeholders (Berrone & Mejia,

2009). Accordingly, companies are expected to add this component to their market strategies. In short, good management of energy resources contributes to sustainability, improves financial savings and reduces air pollution (Mohammadi *et al.*, 2008).

Finally, Rusli *et al.* (2019) found that disclosure of carbon emissions does not have a significant effect on financial performance, but a competitive business strategy strengthens the effect of environmental performance on corporate financial performance not affecting disclosure of carbon emissions.

In Table 2 we summarize several studies on the relationship between low carbon emissions and CSR.

Table 2*Previous Research on the Relationship Between Carbon Emissions and Corporate Social Responsibility*

Author(s)	Country	Time Span	Sample	Dependent Variable	Independent Variable	Control Variable	Empirical Methods	Outcomes
Forcadell <i>et al.</i> (2021)	Spain	2009-2016	Manufacturing firms with 10 or more employees. 2405 firms and 9853 observations	Technological effort; product innovation; process innovation	SMEs' expenditures on environmental protection	Export intensity, Size, Group membership, Advertising, ROA	Tobit panel data; Probit panel data; descriptive statistics	ECSR stimulates firms innovativeness and SMEs that promote ECSR improve their innovative profile
Tanthanon gsakkun <i>et al.</i> (2022)	Tailand	2002-2019	Compustat: 7284 observations; unbalanced panel data set	Carbon emissions	Corporate governance	Board independence; board gender diversity; leverage; investments; size; profitability; intangible assets; discretionary spending	Regression Model	The governance structure plays an important role in shaping not only business strategies, but also ENV strategies.
Rusli <i>et al.</i> (2019)	Indonesia	2015-2017	All public companies listed on Indonesian Stock Exchange	Corporate Financial Performance	Corporate Carbon Emissions Disclosure	Corporate Environmental Performance; Competitive Business Strategy	Regression Model	The ENV performance is good and have a significant and positive influence on corporate financial performance

Table 2*Previous Research on the Relationship Between Carbon Emissions and Corporate Responsibility (cont.)*

Author(s)	Country	Time Span	Sample	Dependent Variable	Independent Variable	Control Variable	Empirical Methods	Outcomes
Wang <i>et al.</i> (2021)	China	2014-2020	Chinese non-state-owned listed companies	CEO Pay–performance sensitivity	Measurement for air pollution	Cash Flow; firm size; leverage; board size; growth	Descriptive Statistics; Baseline regression; Logistic regression	Air pollution increases the firms' difficulty, and effectiveness of compensation contracts and reduces the performance sensitivity of the CEO pay by increasing explicit.
Asif Saeed <i>et al.</i> (2021)	Saudi Arabia	2002-2017	128082 observations from firms that are from Metal Mining, Coal, Oil and Gas and Sanitary Services	Corporate Responsibility	Social Responsibility Committee	Gender Committee; Independence Committee; Committee Size; Committee Tenure	Descriptive Statistics; Correlations	The existence of a CSR committee improves the social responsibility and effectively mitigates the carbon footprint

Note. This table shows some literatures on carbon emissions and corporate responsibility: we identify the authors, country of the study, interval of research carried out, sample used, variables, methodology and the main results obtained.

3. Sample, hypothesis, and Empirical models

3.1. Sample

We designed the research using low carbon companies to analyze their financial performance and compare it with the performance of other companies belonging to the same market.

To do this we collected financial data on companies from the Stoxx Europe 600 index, where we identified a group of low carbon companies constitutes the Stoxx® Europe Low Carbon 100 index. The Stoxx Europe 600, also called Stoxx 600, SXXP, is a stock index of European companies designed by Stoxx Ltd. This index has a fixed number of 600 components representing large, mid and small capitalization companies present in 17 European countries, covering approximately 90% of the free European stock market capitalization (not limited to the Euro zone). All the financial data was extracted from the DataStream database.

Companies with incomplete financial information were excluded and a final total of 576 companies was obtained from the initial 600.

A dichotomous variable was used to identify companies with low carbon emissions. This variable takes the value "1" if the company has low carbon emissions, and 0 otherwise. Of the 100 companies in the Stoxx® Europe Low Carbon 100 index, financial information was only available for 87 of them. Table 3 shows the total number of companies in the sample, after excluding those that did not contain all financial information.

Table 3

Final Sample Collected on the Companies in the Index

Companies Stoxx 600 Index Total	Stoxx® E. L. Carbon 100 (1)	Other Companies
576	87	489

Note. This table presents the summary of the samples collected. The total number of companies collected excludes companies that lack some information about our research, in the general index and in the index of low carbon companies.

3.2. Hypothesis

The hypothesis of this paper is based on the results of some previously studied research, such as Fan *et al.* (2017). For these authors energy efficiency is positively related to the financial return of companies, as manufacturing companies are responsible for the emission of thousands of harmful gases to the atmosphere.

As some organizations create policies and rules to encourage low carbon emissions, and their disclosure, Alareeni and Hamdan (2020) in their research, found that disclosure of carbon emissions positively affects the performance measures of companies. On the other hand, Hassan and Romilly (2018) concluded that these environmental performance measures (through greenhouse gases), play a very important method in helping corporate level business strategies and environmental policy as a whole.

For Kim *et al.* (2015), the efforts that the firm makes to produce low carbon are likely to reduce the cost of capital and in return increase the firm's value. These theories lead to the assumption that investors consider environmental responsibility as one of the crucial factors for them to be truly valued in the stock market.

From the previous analysis we infer that investors consider low-carbon companies as socially responsible companies, which safeguard financial performance in the long term, as a guarantee of competitiveness in the market. Thus, the following hypothesis was tested:

Hypothesis 1. Companies classified as low carbon have a positive relationship with firm value.

3.3. Empirical Models

The study was carried out based on multiple regression models and descriptive statistics.

3.3.1. Independent Variables

For the independent variable, we used a dichotomous variable with the value 1, if the companies belong to the STOXX® Europe Low Carbon 100, and 0 otherwise, as used in the study by Desai (2022) and Damert *et al.* (2018).

3.3.2. Dependent Variable

Following Doidge *et al.* (2004) and Allayannis and Weston (2001) we used Tobin's Q, as a measure of a firm's value. We computed Tobin's Q as the ratio of market value to replacement cost of assets, evaluated at the end of the fiscal year for each firm. We used the book value of total assets minus book value of equity plus market value of equity as a proxy for market value of assets, and book value of total assets as a proxy for replacement cost of assets. The equation for calculating our dependent variable is as follows:

$$Tobin's\ Q = \frac{Total\ Assets - Total\ Capital + Market\ Capitalization}{Total\ Assets}$$

A Tobin's Q greater than 1 indicates that investors have a positive outlook for the company's growth opportunities. The use of this variable is consistent with several other studies, such as that of Rokhmawati (2015), which uses Tobin's Q as an indicator of a firm's value when analyzing the impacts of CO₂ on the firm.

Wang *et al.* (2014) stated that a stronger Tobin's Q is often correlated with higher greenhouse gas (GHG) emissions across industries. Nonetheless, in Delmas *et al.* (2015) investors see the potential long-term value of better environmental performance manifested by an increase in Tobin's Q.

3.3.3. Control Variables

Likewise, to Lee and Cho (2021), we use the following financial characteristic variables as control variables:

- TA_Sales is calculated as follows:

$$TA_Sales = \frac{Total\ Assets}{Sales}$$

- TL_Sales is calculated as follows:

$$TL_Sales = \frac{Total\ liabilities}{Sales}$$

- and, NI_Sales is calculated as follows:

$$NI_Sales = \frac{Net\ Income}{Sales}$$

Although this research has a huge sample of industrial and service companies, information on corporate sector was not inserted in the analysis, similarly to Lee and Cho's study (2021). The authors do not believe that the impact of carbon emission levels on firm value by business sector is significant in the same way Chaklader and Gulati (2015) don't.

4. Results and Analysis of the Results

To be able to establish the relationship between the dependent and independent variables, we followed the methods tested and analyzed in the research of Busch *et al.* (2022), Lee and Cho (2021) and Delmas *et al.* (2015). We analyzed the descriptive statistics of each variable in our sample and the correlations between variables and then we performed our Ordinary Least Square tests. As we already mentioned, the objective of this research is to study the relationship between firm market value, proxied by Tobin's Q, and low carbon emissions of companies in the Stoxx Europe 600 index market. The results of our test, performed using the Gretl software, are presented, and analyzed below.

4.1.Descriptive Statistics

We will now describe the summary of our sample dataset, as shown in Table 4. The efficiency of assets over sales presents a positive value of 7.201 and the ratio of liabilities over sales presents the value of 4.833. The ratio Tobin's Q (*TQ*), under study, has an average of 2.432. As for the median, statistics show that the sample has a value of 1.260, 1.815; 1.065 and 0.1, for *TQ*, *TA_Sales*, *TL_Sales*, and *NI_Sales*, respectively.

Table 4

Descriptive Statistics

	Mean	Median	Minimum	Maximum	SD	CV
<i>TQ</i>	2.432	1.260	0.110	53.040	3.488	1.434
<i>TA_Sales</i>	7.201	1.815	0.290	310.460	17.962	2.494
<i>TL_Sales</i>	4.833	1.065	0.700	112.920	11.258	2.329
<i>NI_Sales</i>	0.236	0.100	-2.180	8.6300	0.7062	2.987

Note. This table presents the descriptive statistics of the data tested by the Gretl program: the mean, median, standard deviation (SD), minimum, maximum and coefficient of variation (CV). As *CE* represents the firms that have low carbon emissions and is a dichotomic variable, we do not present descriptive statistics. *TQ* represents the ratio Tobin's Q, the proxy for market value; *TA_Sales* represents the ratio of total assets to sales; *TL_Sales* represents the ratio of total liabilities to sales, and *NI_Sales* represent the ratio of net income to sales.

All the variables show positive values in terms of descriptive statistics, except the minimum value of the *NI_Sales* which is equal to -2.18.

4.2. Correlation Coefficient

Table 5 indicates that the variable that represents firms with low carbon emissions (*CE*) is positively correlated with our proxy for firm market value (*TQ*). On the other hand, *CE* has a negative correlation with asset and liability management and a positive correlation with net income. Tobin's Q (*TQ*) presents a negative correlation with the other variables (*TA_Sales*, *TL_Sales* and *NI_Sales*), while *TA_Sales*, *TL_Sales* and *NI_Sales* are positively correlated. It seems that from a market point of view, low carbon emissions can create value, but from an internal management point of view, they translate into costs.

Table 5

Correlation Coefficients Between the Analyzed Variables

	<i>CE</i>	<i>TQ</i>	<i>TA_Sales</i>	<i>TL_Sales</i>	<i>NI_Sales</i>
<i>CE</i>	1.000	0.125	-0.074	-0.089	0.026
<i>TQ</i>		1.000	-0.142	-0.162	-0.026
<i>TA_Sales</i>			1.000	0.661	0.201
<i>TL_Sales</i>				1.000	0.203
<i>NI_Sales</i>					1.000

Note. This table presents the correlation coefficients between all the variables tested and was performed using the Gretl software. *CE* represents the firms that have low carbon emissions and is a dichotomic variable; *TQ* represents the ratio Tobin's Q, the proxy for market value; *TA_Sales* represents the ratio of total assets to sales; *TL_Sales* represents the ratio of total liabilities to sales, and *NI_Sales* represent the ratio of net income to sales.

The results of our correlation coefficients analysis are in line with the studies of Brouwers *et al.* (2018), when it is stated that good carbon emissions performance does not always pay off, and lower carbon emission levels are only rewarded if companies are unable to pass carbon costs on to consumers, either due to industry characteristics or specific carbon efficiency from the company.

4.3. Linear Least Squares Method

In Table 6 we present the results of our cross-section analysis, made through OLS model. We found a positive relationship between low carbon emissions (*CE*) and firm market value (*TQ*), however, this relationship is not statistically significant. This result is in line with the study of Busch *et al.* (2022) which did not identify a significant relationship between the practices of lower carbon emissions and Tobin's Q. This may be justified by the fact that we used data from a single year. The literatures studied with panel's data have had a result with significant robustness.

Table 6*Ordinary Least Squares Model*

Description	Constant	CE	TA_Sales	TL_Sales	NI_Sales
Coefficient.	2.525	1.081	- 0.0113	-0.035	-0.027
P-Value	2.66E-058***	0.116	0.079*	0.001***	0.815

Note. This table presents the results of our OLS analysis. Testing was done by Gretl software. *CE* represents the firms that have low carbon emissions and is a dichotomic variable; *TQ* represents the ratio Tobin's Q, the proxy for market value; *TA_Sales* represents the ratio of total assets to sales; *TL_Sales* represents the ratio of total liabilities to sales, and *NI_Sales* represent the ratio of net income to sales. Significant level: ***p < 0.01, **p < 0.05. *p < 0.1. Our R-Square is equal to 0.041 and Adjusted R-Square 0.034.

The tested model gives us the following estimated linear equation:

$$TQ = 2,525 + 1,081.CE - 0,0113.TA_Sales - 0,035.TL_Sales - 0,027.NI_Sales$$

Analyzing the control variables of the study, the results reveal a significant and negative relationship between *TA_Sales* and Tobin's Q (*TQ*), and this means that when the efficiency of companies in terms of managing their assets increases by 1%, the market value of the company (*TQ*) decreases in the order of 0.0113. Concerning the management of the liabilities, we find that in the condition of the increase of 1% in the monetary units, the market value decreases in the order of 0.035, and in terms of the net income from sales per company, we find a negative relationship with the performance of the market under study, but without statistical significance.

All the results may lead us to the perception that low carbon companies tend to admit decreases in the (internal) management of their assets and liabilities relative to other companies in the market, at least when it comes to a short-term perspective. Therefore, these costs verified in the variables of management of liabilities and assets, can cause a decrease in the market value of low carbon companies. On the other hand, one can see this negative relationship existing, such as the study by Griffin *et al.* (2017), who found evidence that the low carbon factor can be considered a negative factor when it comes to company accounting.

It is possible to verify that the coefficient of determination (R^2) shows us a very low model quality measure with 0.041, which may have happened because we have a relatively low sample of 576 observations per variable (Gallego-Álvarez *et al.*, 2015), and because we studied financial information for only 1 year, which may condition the comparison of the trend of the low carbon effect over several years.

5. Conclusions

This research was tested using the ordinary least squares model, with data extracted from the DataStream on the financial information of companies that incorporate the Stoxx 600 index.

According to the literature analyzed, most of the authors report that the positive point about low carbon emission has usually been its disclosure and not the low carbon factor by itself. Some studies indicate a negative carbon relationship, but after disclosure, the impact causes a significant increase in the financial performance of companies.

Based on the researchers studied, we verify that low carbon is a cost factor for companies' internal management, but it can generate value in a long-term perspective, since many investors look at this factor as a good strategic tool to gain long term dividends. According to the result of the study analysis, we found a positive relationship between low carbon and financial performance of companies, but this relationship was not statistically significant, so we do not validate our hypothesis.

On the other hand, the control variables have a negative and significant relationship with the firm market value (Tobin's Q) and this can be seen from the perspective that the high costs to emit low carbon condition the financial management of the company in the short term. The issue of the negative relationship between market value and the control variables (asset and liability management) may be intrinsically linked to the fact that we carried on a cross-section study. Our results are in line with the study of Delmas *et al.* (2015), so we concluded that improving the environmental performance of companies causes a drop in a short-term financial performance indicator.

For this paradigm to meet the prospect of future studies and find positive and significant effects between the variables representing low carbon emissions and the market value of the company, we understand that it is necessary to have incentives and policies that create motivation for investors to prefer the cleaner companies. Policies must also advocate that companies that generate GHG damage to the environment should be punished. We believe that "regional" entities should dictate the market from this perspective and that companies should financially benefit from this. There needs to be more incentives and more policies that favor low-carbon companies and energy efficiency in the financial aspect, so that

corporate governance can make large investments and be aware that it brings them financial returns.

This study has several limitations, starting with the fact that we have studied financial information for only 1 year, that is we carried on a cross-sectional study, which may have conditioned our results. In this sense, we suggest conducting the same type of study, applied to the same market but with panel data methodology.

This study supports the incentive to energy efficiency and low carbon emission and suggests that potential investors should analyze this aspect as an extremely important factor in the market. Low-carbon companies are socially responsible, and they can use that to create a high level of confidence in the long-term investor's mind, as shown in the results of several studies, and this should be rewarded by governments and market regulators. Social responsibility improves the image of the company, and so it is suggested that companies consider social responsibility in the management of their business.

6. References

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7. Appendices

7.1. Appendix 1 - Stoxx® Europe Low Carbon 100

1	ADECCO GROUP
2	ADIDAS AG
3	ADYEN NV
4	AEDIFICA NV
5	AKZO NOBEL N.V.
6	ALLFUNDS GROUP PLC
7	ATOS SE
8	AUTO TRADER
9	BEIERSDORF AG
10	BELIMO HOLDINGS AG
11	BERKELEY GROUP
12	BIG YELLOW PLC
13	BP PLC
14	BRENNTAG SE
15	BT GROUP PLC
16	CENTRICA PLC
17	COLOPLAST A/S
18	COMPAGNIE FINAN RICHEMONT N
19	COVIVIO SA
20	DNB BANK ASA
21	E ON SE
22	EDP RENOVAVEIS
23	ELEKTA AB (PUBL)
24	ELIA GROUP
25	ELISA CORP
26	EMSCHEMIE HOLDING
27	ENAGAS SA
28	EURAZEO
29	EXPERIAN PLC

30	FREENET AG
31	FUTURE PLC
32	GALENICA AG
33	GALP ENERGIA
34	GETINGE AB
35	GETLINK SE
36	GIVAUDAN SA
37	GROEP BRUSSEL LAM
38	HANNOVER RUECK SE
39	HAYS PLC
40	HELLOFRESH SE
41	HERA SPA
42	HEXPOL AB
43	HOLMEN AB
44	IMCD GROUP BV
45	IMPERIAL BRANDS
46	INVESTOR AB
47	ITALGAS SPA
48	JOHNSON MATTHEY PLC
49	JUST EAT TAKEAWAY
50	KESKO OYJ
51	KINDRED GROUP
52	KONINKLIJKE KPN NV
53	KONINKLIJKE PHILIPS
54	LOGITECH INTERNAT
55	LONDONMETRIC PRO
56	LUNDIN ENERGY
57	NESTE OYJ
58	NEXI SPA
59	NORDIC SEMICONDUCTOR
60	NOVO NORDISK A/S
61	PRIMARY HEALTH PROP.
62	PROSIEBENSAT.1 MEDIA

63	PROXIMUS NV
64	PUMA SE
65	RANDSTAD NV
66	REMY COINTREAU SA
67	RIGHTMOVE PLC
68	RS GROUP PLC
69	SALMAR ASA
70	SCHIBSTED ASA
71	SEVERN TRENT PLC
72	SIEMENS
73	SIEMENS GAMESA RE
74	SIMCORP AS
75	SOFTCAT PLC
76	SOPRA STERIA
77	ST JAMES'S
95	STOREBRAND ASA
78	STRAUMANN HOLDING AG
79	SWEDISH ORPHAN
80	SWISS RE
81	SWISSCOM
82	TECAN GROUP AG
83	TELE2 AB
84	TELIA COMPANY AB
85	TERNA SPA
86	TRITAX BIG BOX
87	UMICORE SA
88	UNITED UTILITIES PLC
89	VESTAS WIND SYSTEMS
90	VIAPLAY GROUP
91	VIFOR PHARMA AG
92	WORLDLINE SA
93	ZALANDO SE
94	ZURICH INSURANCE