DOES CORPORATE CLIMATE PERFORMANCE AFFECT CORPORATE FINANCIAL PERFORMANCE? A CROSS-REGION AND CROSS-SECTOR ANALYSIS ON RETURN, VALUE, AND LIQUIDITY

ABSTRACT

The widespread, rapid, and intensifying climate transformation brought an additional sense of urgency to the CSR-CFP discussion, particularly on how corporate management of climate risks affect firms' outcomes. In this paper, we evaluate the relationship between corporate climate performance (CCP) and corporate financial performance (CFP) by analyzing a cross-country sample of 17,191 firm-years between 2010 and 2020, including 2,148 unique firms, through an unbalanced panel with fixed effects. In addition to the standard carbon intensity measure, we contribute to the literature by proxying CCP with the CDP Score, a measure of the corporate management of climate risks and opportunities based on voluntary disclosures. We use as metrics to CFP the following dependent variables: profitability (ROA), firm value (Price-to-Book), and liquidity (Quoted Spread). The results for ROA show a positive and linear relationship for both CDP score and carbon intensity, indicating that improvements in climate performance are associated with an increase in profitability. We found a "U-shaped" relationship for CDP Score and Firm Value and a positive linear relationship for CDP score and liquidity, suggesting positive impacts of a positive CCP on market-based metrics. Still, for firm value, only after a minimum level which the investments climate risk management pay off. Regarding both firm value and liquidity, either an "inverted U-shape" or negative linear relation were found for carbon intensity. We argue that the market can more easily value and account for overall improvements on climate-related issues management but still struggles to understand and effectively incorporate specific metrics, such as carbon intensity, on its valuations and investment decisions. And, despite market value and liquidity might not yet reflect properly improvements on CCP, by implementing better climate risks and opportunities management practices firms can enhance their profitability.

Keywords: CSR. ESG. Climate. Carbon Intensity. Corporate Finance.

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LIST OF ABBREVIATIONS

CCP	Corporate Climate Performance
CDSB	Climate Disclosures Standards Board
CEO	Chief Executive Officer
CFP	Corporate Finance Performance
CSR	Corporate Social Responsibility
DJSI	Down Jones Sustainability Index
ESG	Environmental social and governance
GHG	Greenhouse gases emissions
GICS	The Global Industry Classification Standard
GRI	Global Reporting Initiative
KP	Kyoto Protocol
MDG	Millennium Development Goals
OECD	Organization for Economic Co-operation and Development
P/B	Price-to-Book
PRI	Principles for Responsible Investments
ROA	Return on Assets (Results considering Profitability)
ROE	Return on Equity
ROS	Return on Sales
SDGs	Sustainable Development Goals
TCFD	Task Force on Climate-related Financial Disclosures
TLGT	“Too-little-of-a-good-thing”
TMGT	“Too-much-of-a-good-thing”

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1 INTRODUCTION

Since the United Nations Convention on Environment and Development in 1992, the Rio-92, the impacts of climate change on the society and economy have been discussed within the United Nations to promote a global transition towards a low carbon economy that would avoid the catastrophic effects of a global temperature increase above two degrees Celsius. More recently, the climate change discussion stopped being an isolated agenda and became part of a broad framework of human development within the United Nations, companies, investors, and other agents of society and economy (UNITED NATIONS, 2015a and 2015b).

According to Latapí Agudelo, Johannsdottir and Brynhilddur (2019), these events, such as Rio-92, helped to shape the understanding of corporate social responsibility (CSR) and initiated the discussions on corporate management of climate-related issues as being an additional social responsibility of companies. The Paris Agreement (UNITED NATIONS, 2015a) and the Sustainable Development Goals (UNITED NATIONS, 2015b), in 2015, consolidated the climate agenda on the CSR discussions with more concrete recommendations and responsibilities on how firms and investors could collaborate on mitigating and adapting to climate change.

The CSR and climate discussion reached more explicitly the investment community in the past few years when investors started to realize they would also be impacted by risks and opportunities related to climate change. Hong, Karolyi and Scheinkman (2020) discuss how climate change represents risks to firm profits and capital markets in various sectors of the economy, and the challenge to understand the damage distribution, appropriate pricing of the risks generated, and mitigation strategies on financing. In this context, the Financial Stability Board established a Task Force on Climate-related Financial Disclosures (TCFD) in 2017, intending to guide investors and companies with a big reaction from the finance sector. Larry

Fink, Chairman, and Chief Executive Officer (CEO) of BlackRock, for instance, dedicated his two last annual letters to CEOs to climate-related issues, mentioning the TCFD and the importance of corporate transparency on climate directly.

The academy, however, has been trying to understand the effects of firms' CSR activities on corporate financial performance (CFP) for decades. In the CSR-CFP literature, several empirical studies have been published to evaluate how corporate performance under different CSR dimensions influence firms' financial aspects (ALSHEHHI; NOBANEE; NILESH, 2018; BENLEMLIH, 2017; FRIEDE; BUSCH; BASSEN, 2015). But despite all the advances, there is still a remaining question: whether a positive CSR performance has a positive, negative, neutral, or curvilinear effect on the CFP. The only consensus in the literature is that the answer is probably much more complex, depends on a series of determinants and the relationship found to one component cannot easily be transferred to another (BUSCH *et al*., 2020; GILLIAN; KOCH; STARKS, 2021; TRUMPP; GUENTHER, 2017).

The climate crisis scenario brought an additional sense of urgency to the CSR-CFP discussion and the critical need to understand how climate change and measures are taken to tackle it would affect corporate finance and investments. The literature on corporate climate performance is more recent, but fundamentally based on the CSR-CFP, and with that carry all the uncertainties and complexity. Although advances have been made, there is still a gap to understand if and which known effects of CSR on CFP are valid when we evaluate the CCP component alone. Moreover, there is a lack of studies embracing more holistic metrics for CCP, going beyond carbon emissions intensity. In this context, this study aims to answer one question: Does corporate climate performance affect corporate financial performance?

To do that, we use CDP, former Carbon Disclosure Project, and S&P Capital IQ database to extract a sample of 17,191 firm-year observations, between 2010 and 2020, including 2,148 unique firms, to evaluate the relationship between corporate climate performance (CCP) and the corporate finance performance (CFP). As CFP metrics, we use profitability (ROA), firm value (Price-to-Book), and liquidity (Quoted Spread) as dependent variables. As CCP metrics, we use CDP Score and Carbon Intensity.

Our results for profitability show a linear and positive relationship between ROA and both CDP Score and Carbon Intensity, indicating that improvements in climate performance are associated with an increase in profitability. On firm value, we found a significative and non-linear "U-Shape" relationship with CDP Score, in line with Trumpp and Guenther (2017), indicating that investments on a better climate-related issues management only payoff after a minimum level of CCP. For liquidity, we found a significant, positive, and linear relationship with CDP Score, suggesting that better climate performance leads to higher liquidity.

Interestingly, when analyzing carbon intensity for both firm value and liquidity, the results were in line with Busch *et al*. (2020), meaning that higher carbon intensity might be related to a higher value. One explanation would be that while there are already several investors and initiatives promoting climate disclosure and transparency, there is still a gap for the efficient use of these insights and data to include low-carbon criteria on investment decisions and companies' valuation.

This study contributes in four different aspects to the existing literature:

a) it utilizes a unique database for its empirical analysis, expanding the observed time frame, geographical and sectorial coverage utilized by the great majority of other studies in the field;

b) to our knowledge, it uses CDP Score as a proxy for corporate climate performance more broadly than any other study (BUSCH; HOFFMANN, 2011; BUSCH et al, 2020; TRUMPP; GUENTHER, 2017) and demonstrates statistically significant correlations with corporate financial metrics;

c) it corroborates the complexity in the CSR-CFP relationships that makes it impossible to easily hypothesize linear, non-linear, positive, or negative relationships, which makes each interaction between a specific CSR component and different CFP dimensions unique;
d) very few empirical studies were found on CSR and Liquidity, and none on CCP and Liquidity, which makes this work a pioneer. However, we recognize that a lot of the theoretical foundation is still missing.

This manuscript is structured as follows: After the introduction, the literature review starts by contextualizing CSR concepts and their link with the corporate management of climate-related issues, accompanied by an analysis of exciting studies theories on the influence of CSR and CCP on firms' financial aspects. After the literature review, we will describe the climate and financial databases utilized in this study, along with the econometric model utilized and the sample characteristics. The results are arranged by CFP metrics: profitability (ROA), succeeded by firm value (price-to-book), and closed with liquidity (quoted spread). Lastly, we finalize this work with the conclusions and recommendations.

2 LITERATURE REVIEW

2.1 Corporate Social Responsibility (CSR)

The concept of corporate social responsibility, or CSR, has been more widely discussed within the private sector and the academy since the 70’s due to a polemic publication of the renowned expert Friedman (1970). He stated that the corporate role is to maximize shareholders' value, therefore companies shouldn’t allocate resources to social and environmental activities to bring value to society. In his view, these are the Government’s responsibilities. This debate brought an important reflection to the society regarding not only the corporate role to bring value to shareholders, but if it is indeed its *only* function. And if not, what values, and how, the private sector could bring to the society as a whole.

Latapí Agudelo, Johannsdottir and Brynhilddur (2019), in a literature review of how the CSR concept evolved, remember that the social role of companies has been discussed since 1930, fifty years before Friedman, with its first academic definition presented by Bowen (1953). In his view, the business executives had the responsibility of making decisions according to the values of society and therefore had a social responsibility. Since then, the understanding and definitions of the term have evolved to incorporate what would be the specific responsibilities of the corporations (CARROLL, 1979), more practical proposals of implementation models (JONES, 1980), connections with the stakeholder theory (BROWN; FOSTER, 2013), and other relevant facts and discoveries in the field.

Besides the literature review, one of the most interesting contributions of Latapí Agudelo, Johannsdottir and Brynhilddur (2019) was the analysis of how relevant facts in the history of sustainability shaped new understandings and definitions of CSR. For instance, one important discussion is how the publication of the Millennium Development Goals (MDG) by the United Nations (2000) brought a new perspective to CSR and one year later the European Commission (2001) presented one of the most prevailing CSR definitions even nowadays. After that, the concept has expanded in the early 2010s to adjust to the need for shared value creation and the strategic use of CSR to improve corporate competitiveness (PORTER; KRAMER, 2006).

Finally, most recent the CSR notion has also been integrated within complementary approaches, such as corporate sustainability, environmental social and governance (ESG) criteria, and many others, that collaborates for the continued expansion and institutionalization of CSR (CARROLL, 2015). Gillian, Koch and Starks (2021) differentiate the concepts of CSR and ESG by identifying the governance aspect more explicitly present on the second and by defining ESG as "how corporations and investors integrate environmental, social and governance concerns into their business models", also including the investors' decision in a more prominent manner. Nonetheless, the authors opt to use ESG and CSR interchangeably, for understanding that one (ESG) is only an extension of the other (CSR). The same approach will be adopted in this work.

Regardless of the utilized term, the interest in CSR/ESG has grown dramatically in the past few years. According to Gillian, Koch and Starks (2021), the number of S&P 500 companies that release CSR reports grew from 20% in 2011 to 85% in 2018; in 2019 the total invested in mutual funds with ESG mandate was 4 times greater than in the previous year; and more than 3000 institutional investors, representing US$ 86 trillion in assets under management, signed to the Principles for Responsible Investments (PRI) in 2019. In this context, the debate today is no longer "if" or "why" corporations should pursue the creation of social and environmental value to society, but "what", "where" and "how" to implement CSR actions most efficiently and what would be the effects on value creation to both shareholders and stakeholders.

2.2 Corporate Social Responsibility (CSR) and the Climate Agenda

In the same way that relevant facts in the sustainability agenda shaped the CSR discussion and concepts, it also influenced how and when it would embrace more explicitly the climate change question. The first and definitive event in this direction was the UN Summit on the Environment and Development held in Rio de Janeiro, known as Rio-92 (UNITED NATIONS, 1992). By itself, this conference brought new discussions and understanding to the CSR agenda through the search for the balance between challenges and opportunities (LATAPÍ AGUDELO; JOHANNSDOTTIR; BRYNHILDDUR, 2019). However, one of its most relevant contributions was the establishment of the United Nations Convention on Climate Change (UNFCCC), which changed permanently the course of climate change discussions (UNITED NATIONS, 1992).

The formation of the UNFCCC in 1992, years later, led to the signature of the Kyoto Protocol (UNITED NATIONS, 1997), under which all the countries from the Annex 1[1] were committed to reducing their emissions to the pre-industrial levels. These commitments were not only a governmental agenda but also reflected heavily on the corporations, especially those operating within carbon-intensive sectors. With the Kyoto Protocol (KP) carbon-intensive industries based in the Annex 1 countries started to be regulated and incentivized to reduce their greenhouse gases (GHG) emissions, and even companies that were not being pressured to reduce their emissions could also be involved through a cap-and-trade mechanism created by the KP. As a result, climate change and reducing GHG began to be incorporated into companies' CSR strategies and actions.

[1] "Annex I Parties include the industrialized countries that were members of the OECD (Organization for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States". (UNITED NATIONS CLIMATE CHANGE, 2021, online).

In 2015, emerged two other milestones that would decisively consolidate climate change within the CSR agenda: The Paris Agreement (UNITED NATION, 2015a) and the Sustainable Development Goals (UNITED NATION, 2015[B]). Both represented new social contracts with corporations regarding the role they have to play on global social and environmental issues (LATAPÍ AGUDELO; JOHANNSDOTTIR; BRYNHILDDUR, 2019), including climate change. The Paris Agreement expanded the need for urgent action to include non-Annex I countries, subsequently all countries would have to contribute to the global goal of reducing GHG, and the role of corporations was extended. The Sustainable Development Goals (SDGs), a continuation of the MDG, brought climate change explicitly as one of its seventeen goals for corporations to tackle in partnerships with governments.

With this context, corporate reporting frameworks started to incorporate climate change-specific indicators, to support companies with the implementation and performance measurement of their CSR actions related to climate change. The main ones created were the Global Reporting Initiative (GRI, 2021) and the CDP, former Carbon Disclosure Project, among several others. The demand for frameworks and standards on the reporting and implementation of corporate climate actions grew so much that in 2007 it was formed a consortium of business and environmental organizations, called the Climate Disclosures Standards Board (CDSB, 2021), harmonized the integration of climate change and environmental information into mainstream corporate reporting.

In the last few years, investors also joined the agenda, seeking a deeper understanding of the financial risks and opportunities related to climate change and how this would affect their investment decisions. As consequence, the Financial Stability Board established a TCFD in 2017, which joined the list of recommendations that corporations should comply with on the topic. To reinforce its relevance, Larry Fink, Chairman and CEO of BlackRock, one of the biggest asset managers in the world, dedicated his two last annual letters to CEOs to climate-related issues. He stated that climate change is part of investor’s fiduciary duty and will fundamentally reshape investments, adding that corporate disclosure on climate will enable more sustainable and inclusive capitalism (BLACKROCK, 2020, 2021).

Hong, Karolyi and Scheinkman (2020) discuss how climate change represents risks to firm profits and capital markets in various sectors of the economy, and the challenge to understand the damage distribution, appropriate pricing of the risks generated and mitigation strategies on financing. Among other areas for future research, the authors highlight the need to understand the impact of climate change on disinvestments, signalizing that carbon-intensive companies in the energy sector, for example, may become new “sin stocks” as the Tabacco companies did decades before. In this regard, both investors and companies should consider climate change's effects on financing.

Although a great part of the discussion on CSR and climate change relates to risks, it is important to highlight that there are also opportunities. Larry Fink in his letters mention the reallocation of capital on more sustainable business (BLACKROCK, 2020, 2021) and the Global Sustainable Investment Alliance defines sustainable investments as also embracing approaches that would drive money to sustainable business, such as positive and best-in-class screening, themed investing and shareholder action, among others (GLOBAL SUSTAINABLE INVESTMENT ALLIANCE, 2018).

Under the sustainable investments approach the sustainability indexes appeared as another opportunity for corporations. Both CSR and Climate performance are being increasingly used as criteria to compose asset portfolios and indexes, such as the Down Jones Sustainability Index (DJSI, 2021) Family, focusing on sustainability as a whole but incorporating climate change as one of the metrics, and the STOXX Global Climate Leaders (2021), an index focusing exclusively on corporate climate performance. Both risks and opportunities associated with CSR and Climate Change only reinforce the need for a deeper understanding of the management of climate-related issues that would affect firms' finance.

2.3 Corporate Social Responsibility (CSR) and Corporate Finance Performance (CFP)

With the growth of sustainable investment products and the more integrated use of CSR performance into stakeholders' decision-making process, it became progressively important to understand how CSR affects CFP. Several empirical studies have been published in the last few decades aiming to evaluate how the performance of different CSR dimensions relates to the performance of different financial aspects. And despite the advances, one of the main questions remains, whether a positive CSR performance has a positive, negative, or neutral effect on the CFP. The answer to that is probably much more complex and depends on a series of determinants, including the metrics and measurements used as a proxy for both CSR and financial performance.

Several metrics have been used in the CSR-CFP studies to represent the finance dimension. A literature review carried out by Benlemlih (2017) described the main financial elements studied as those related to firm value, reputation, diminishment of information asymmetry, capital and debt cost, capital structure, equity cost, WACC, credit access, and price, among others. Through a deep dive into the impacts of CSR on information asymmetry, cost of debt and equity capital, and the capital structure, Benlemlih (2017) finds a negative relationship between information asymmetry and a lower equity cost.

Alshehhi, Nobanee and Nilesh (2018) through the revision of 132 top-tier journals found that 78% of the reported a positive CSR-CFP relationship, although several divergent views were led by differences in methodologies and measurement. One of the main divergencies identified was the different proxies for corporate financial measures, especially the use of accounting versus market-based metrics. According to Alshehhi, Nobanee and Nilesh (2018), it is possible to notice that accounting metrics are more traditional and still dominates the literature, however, market-based metrics are becoming increasingly utilized, and suggests that the use of both measures are complementary and can offer additional insights on how CSR relates to CFP.

The same author also observes that variations in results can also be attributed to firm sizes, industry and the CSR component evaluated. A similar result was detected by Margolis, Elfenbein and Walsh (2009) when evaluating more than 200 studies on the topic. The authors noted that the lack of consensus could derive from the different timeframes observed, the markets studied, model choice, control variables, and the measures chosen as CSR and CFP proxies.

The most comprehensive literature review found on the CSR-CFP relationship was from Friede, Busch and Bassen in 2015, which analyzed more than 2 thousand individual empirical studies and concluded that 90% of them showed a non-negative result, with the majority reporting positive findings. Although the ESG impact on CFP proved consistent over time, the authors also found variations between portfolio and non-portfolio studies, asset class, regions, and, more importantly, the categories of E, S, or G criteria utilized.

Among the corporate finance dimensions, the most present in the literature are those related to profitability and market performance, but the other two dimensions are scarce in the literature: liquidity and growth (TRUMPP; GUENTHER, 2017). We were able to identify only a few studies connecting CSR and liquidity, which also indicated mixed results. Bertrand, Guyot and Lapointe (2014) find a positive and significant relationship between Vigeo’s ESG rating and stock liquidity for listed companies in Europe. Subramaniam, Samuel and Mahenthiran (2016) build their CSR-CFP theory from the link in the literature between information asymmetry and liquidity and found as a result that greater levels of CSR disclosure lead to higher liquidity. Chang *et al.* (2019), however, explores a different causal effect and the results indicated that high stock liquidity negatively affects CSR ratings in the short-term, discouraging CSR long-term practices.

Maybe even more challenging than the variation on financial performance criteria, it is the divergency in the criteria choose to represent each aspect of the ESG and their final combination as a CSR performance metric. Berg, Koelbel and Rigobon (2020) in their working paper called “Aggregated Confusion: The divergence of ESG Rating” compare five of the most prominent ESG ratings in the market and found a correlation of only 0,61, which is attributed to the differences in the scope and set of criteria selected for each dimension, different assessment methodologies for the ESG categories and distinct weighing of the scoring methodology. The first aspect, differences in the scope, alone explains more than 50 percent of the variation.

Still looking at the ESG rating market, Escrig-Olmedo, Muñoz-Torres and Fernández-Izquierdo (2010) evaluates six different sustainability indices from ESG agencies and showed a lack of standardization on the methodologies due to differences in the positive evaluation criteria, the exclusionary criteria, the use of international standards, and scoring systems, among others. All these differences likewise led to disagreement on the final results and recommendations of the ESG agencies.

Gillian, Koch and Starks (2021) add to the discussion the influence of country and industry characteristics on CSR practices and, more importantly, that within the existing literature the direction of the causality is not always explicitly. In this sense, the authors understand that both directions are plausible and present the mechanisms presents in the literature for CSR to influence CFP and the opposite. In the first case, it would happen through two channels: CSR increasing shareholder value, for example, when costumers buy more from a responsible firm and it increases cashflow, and/or CSR increasing shareholder utility, that would occur when shareholders value responsible firms. Under the other alternative, companies with greater value and better financial performance would have more resources to invest in CSR activities and performance. In any case, the theory supports a positive relation between CSR and CFP.

Under the same line of discussion, Scholtens (2008) studies the "Granger causation" to understand the causal direction on the CSR-CFP relationship on a sample of 289 firms in the US, from 1994 to 2004, using the KLD multidimensional ESG score as a CSR proxy. The results indicated that financial performance could be preceding overall, but the direction sometimes varied for specific themes. More recently, Lungu, Caraiani and Dascălu (2020), investigated the bidirectional CSR-CFP effect on the energy industry worldwide for 2016 and 2017, using the Thomson Reuters ESG database, and found a bidirectional relationship between profitability and market-based performance. Although it is an extremely relevant discussion and inherent challenge on the field, the causality and bidirectionally between CSR-CFP will not be addressed in this work, which will focus initially on relationships and correlations.

Another recent debate in the field related to the "shape" of the relationship. The concept is not new, Brammer and Milligton (2008) while analyzing the CSR-CFP relationship for a charity component, built the theory an argument as to why CSR could imprint neutral, positive-negative, or curvilinear effect. They propose that CSR could also have a U-shaped or an inverted U-shaped relationship with CFP. In the first case, improving sustainability practices led to a better relationship with stakeholders and financial benefits until it goes beyond optimum and starts to be associated with a declining CFP. In the second case, low and high-performance firms differentiate themselves from those in the middle, and the competitive advanced lead to better CFP.

Although it is still not common in the literature, other authors also tested non-linear relationships for other CSR dimensions. Nollet, Filis and Mitrokostas (2016) utilize the

Bloomberg multidimensional ESG database to test CSR-CFP and found an overall U-shaped relationship, with the caveat that the existence of this relationship would vary depending on the sub-component evaluated. Other studies also evaluated the presence of this relationship using climate components as a CSR metric and found similar results (GARCIA-SANCHEZ; PRADO-LORENZO, 2012; TRUMPP; GUENTHER, 2017), to be better explored in the next section.

With this complexity, the results identified for one dimension cannot be automatically transferred to explain other relationships. Therefore, it is critical to disaggregate the ESG criteria utilized to explain the CSR-CFP relationship and understand the influence of each aspect on both accounting and market-based financial metrics. This disaggregation will allow all the stakeholders to make a better and more informed decision and enable a conscious optimization of the CSR-CFP relationship.

2.4 Corporate Climate Performance (CCP) and Corporate Finance Performance (CFP)

The great part of the existing work exploring the relationship between corporate climate performance and corporate financial performance date from the past two decades and focus mainly on the effects of corporate policy transparency and carbon efficiency (GALLEGO-ALVAREZ; GARCIA-SANCHEZ; VIEIRA, 2014; ZIEGLER; BUSCH; HOFMANN, 2011). More recently the studies have deepened their analysis into the different aspects of corporate performance on managing climate-related issues, including for instance governance, targets, emissions reduction initiatives, and competitivity (DAMERT; PAUL; BAUMGARTHER, 2017). Likewise, the relationship between CSR-CFP, one of the most challenging aspects of CCP-CFP is understanding how the different proxies for climate change management can influence the various aspects of CFP.

Ziegler, Busch and Hofmann (2011), evaluated the impacts of CCP on the stock performance of American and European markets using it as proxies for CCP climate disclosure, climate impacts, and emissions reduction measures. The authors found a slightly positive relationship between the stock performance and climate disclosure and emissions reduction measures, but no link with climate impact. Notably, they also found a strong positive relationship for the energy sector and related that geography was a relevant influencing factor due to each region's climate policies and institutional environment.

Busch and Hoffmann (2011), that used as CCP proxy emissions intensity per unit of revenue to test its effects on companies' return on asset (ROA), return on equity (ROE), and Tobin's Q. The results showed a positive link between emissions intensity and CFP, but a negative correlation between the managerial efforts directed to the CCP and the CFP. An additional contribution of this paper is the differentiation of outcome-based measures, such as carbon intensity, from process-based measurements, such as management approaches. Interestingly, the authors already found that different CCP components might have different effects on CFP.

Expanding the same approach above, Garcia-Sanchez and Prado-Lorenzo (2012), included an even wider variety of CCP components extracted from the CDP database, including governance, corporate climate policy, disclosure, emissions accounting, emissions reduction and management of opportunities, and their relation with companies' return on assets (ROA) and Price-to-Book value (P/B). Their goal was to understand the impacts on a firm's financial accounting and market value. One of the interesting aspects tested by this paper is the potential non-linearity of the CCP-CFP relationship, to assess if the relationship is linear, positive or negative, or a curve. The results showed an inverse-linear effect on firm performance.

The most traditional line of study in the literature, however, focuses specifically on climate impact measured by carbon emissions intensity per unit of revenue, in line with

Gallego-Alvarez, Garcia-Sanchez and Viera (2014). The authors center the study on carbon emission intensity and CFP, using return on sales, assets, and equity (ROS, ROA, and ROE), only for carbon-intense industries around the world and looking into the effect of economic crises. The authors identified that during crises the link between CCP and CFP is bigger, probably because companies with high CSR performance have a better relationship with their stakeholders and become more resilient during a crisis.

Based on a similar approach to Garcia-Sanchez and Prado-Lorenzo (2012), Damert, Paul and Baumgarther (2017) also expanded the metrics considered for CCP and analyzed the CCP-CFP on the steel, cement, and automotive, known as carbon-intense sectors. The CCP proxies were governance, emissions reduction initiatives, and carbon efficiency, and the CFP returned on assets and equity (ROA and ROE). They found a positive correlation between emissions reduction initiatives, any significative relation for carbon efficiency, and mixed results on governance. The results for governance were highly influenced by company size and geography. These results are in line with previous suggestions, indicating that different CCP elements can have different types of interaction with CFP, adding to it the potential influence of other firm factors, such as size and origin.

Complementing previous studies, Trumpp and Guenther (2017) explored more explicitly the possibility of a non-linear relation between CCP and CFP, using as proxies for CCP carbon efficiency per unit of revenue and CFP return on assets (ROA) and total shareholder return (TSR), for the manufacturing and services sector. They have found a non-linear, U-shaped relationship between CCP and profitability for both sectors evaluated, and between CCP and market performance only for industries. These results indicate that the type of relationship depends on the level of CCP, with a negative relation for companies with low CCP and a positive relation for high CCP. Another provocative contribution is the indication that market-based metrics effects may vary more widely depending on the sector exposition, in comparison with profitability metrics that tend to have more consistent influence, regardless of the sector.

The most prominent contribution of this study, however, is the theoretical framework discussion on the non-linearity of CSR aspects and CFP. With the understanding that CSR-CFP might be too complex to have a simple linear explanation (positive, negative, or neutral), the authors explore alternatives that would explain why other results in the literature may seem contradictory at first. They propose the possibility for a “U-shaped” relationship as evidence of the “too-much-of-a-good-thing” (TMGT) effect, and an inverted “U-Shaped” form as an indication of the “too-little-of-a-good-thing” (TLGT). Both approaches combine positive and negative relations. The first (TMGT) is related to diminishing marginal returns, which implies a positive relation initially and becomes negative after an optimum. The second (TLGT), explains why good performance may lead to negative results if there are below a certain threshold (PIERCE; AGUINIS, 2013; TRUMPP; GUENTHER, 2017).

The vast majority of the studies found on CCP-CFP relationship (Appendix A) explores profitability as the financial performance metric, mainly through return on assets (ROA) and equity (ROE), a smaller proportion includes market-based metrics, such as Tobin’s Q and Price-to-book (P/B), and no study on CCP-CFP was found for liquidity. According to Trumpp and Guenther (2017), the theoretical foundation is missing for CCP effects on liquidity and growth. An additional challenge also faced by the present work related to discrepancies in data frequency between CCP and market liquidity.

When it relates to the results, it is possible to observe that outcome-based measures, such as carbon intensity and GHG emissions, tend to be consistent in comparison with processed-based measures, such as governance and strategy. Equivalent to the studies for de CSR-CFP relationship, the results for the CCP-CFP also seem to be dependent on the chosen proxies for climate management performance, companies’ size, sector, and geography. This study contributes to the literature by deepening the analysis on CCP-CPF through the use of one of the biggest and most acknowledged corporate climate performance ratings in the world as a proxy for CCP and the use of a comprehensive database with a broad geographical and temporal outreach, which will allow proper incorporation of heterogeneity aspects.

3 DATA AND METHODOLOGY

3.1 Corporate Climate Data

CDP, former Carbon Disclosure Project, is the biggest environmental disclosure platform, with almost 10 thousand disclosing organizations in 2020 (CDP, 2020a) and a top-ranked ESG rating on quality and usefulness according to the Rate the Raters consecutively from 2012 to 2019 (SUSTAINABILITY, 2019). After collecting data from organizations, CDP runs a comprehensive and robust scoring methodology on companies' response and assign a score based on their climate management performance. The scoring aims to provide a roadmap to companies on environmental best practices and by developing the scoring methodology over time CDP can reflect the changes in the market of what is considered best practices each year, thus incentivizing companies' behavior to improve constantly (CDP, 2020b).

The climate change scoring methodology is designed to apply to all companies, even those in different geographies and sectors, allowing cross-regional and sectorial comparison on climate-related performance. CDP scoring methodology is based on four consecutive levels, or score bands, that represent organizations' progress on environmental performance that goes from D-, minimum score to A, the maximum score representing the leadership level (CDP, 2020b). In this study, we used CDP's climate change score for all public companies disclosing to CDP from 2010 to 2020. Additionally, for the CDP score to be read as a numerical variable in the econometrical model, we created a new variable on Stata called "CDP Rank" that represents the conversion of CDP's alphabetic score into a numerical rank, from 1 to 8, being 1 the less mature level and 8 the most advanced one.

Because CDP Score is an ordinal metric that was transformed into a numeric rank, additional tests were necessary to confirm whether we could use the CDP score as a continuous variable. The tests performed were the Likelihood Ratio Chi-Square Test and the Wald Test (WILLIAMS, 2020), indicating that CDP Score had a similar behavior and scale, in comparison with the other variables and control, as the CDP Score converted into the described numerical rank, confirming it could be used as a continuous variable.

Besides CDP score as a climate management performance variable, we also used carbon intensity to allow comparability with previous studies (BUSCH; HOFFMANN, 2011; BUSCH et al, 2020; TRUMPP; GUENTHER, 2017) and collaborate with the existing literature by expanding the timeframe and number of firm-years included in similar studies. The carbon intensity variable was calculated by the sum of GHG reported by companies through the CDP questionnaire, for direct emissions (scope 1) and indirect emissions (scope 2). The total emissions were then divided per the annual revenue in US dollars, as a proxy for sales, and it was then multiplied by minus one (-1) to obtain the carbon intensity (BUSCH *et al*., 2020; TRUMPP; GUENTHER, 2017). In this study, we also used the natural logarithm to normalize more extremes values.

The main difference in this study between both climate metrics is that the CDP score offers an integrated and comprehensive evaluation of climate performance as a whole, including climate governance, business strategy, risk management, targets, and metrics, whereas carbon intensity alone is only one of the metrics utilized to measure climate impact. In this sense the CDP score measures corporate climate performance in a more complete approach, going beyond carbon impact. Additionally, this study is the first one in the literature to use CDP Score as a metric for climate performance with such a broad temporal and geographical outreach, which makes this work unique.

All the metrics for corporate climate performance were extracted from CDP’s database. More information can be found in Table 1.

3.2 Corporate Finance Data

All Corporate finance data were accessed directly from the S&P Capital IQ database. Because CDP has data of thousands of companies from a wide range of geographies and sectors, and this study accessed a wide timeframe, S&P Capital IQ demonstrated to be one of the best options due to its broad coverage. Firms' ISIN code from the CDP database was used as the main identifier to match CDP data with S&P Capital IQ's database.

Three different corporate finance dimensions were used: profitability, firm value, and liquidity. For profitability, we utilized the return on assets (ROA) because it measures the efficiency of assets on producing income, organizational capacity, and short-term return (BUSCH *et al*., 2020; BUSCH; HOFFMAN, 2011; TRUMPP; GUENTHER, 2017). As a metric for firm value, we adopted the price-to-book (P/B), because as a market-based indicator it can translate external and internal factors affecting firms' value, including the reputational perception of the firm by its stakeholders', it also coincides with Tobin's Q and it is automatically generated by Capital IQ's database (BLOCK, 1995; BUSCH; HOFFMANN, 2011; GARCIA-SANCHEZ; PRADO-LORENZO, 2012; NEZLOBIN; RAJAN; REICHELSTAIN, 2016). On market liquidity, we used the quoted spread because it is a low-frequency estimator of the bid-ask spread and it is suitable for long time horizons (LE; GREGORIOU, 2020).

Some of these metrics were automatically calculated by Capital IQ, and for others only extracted the components required to calculate the indicators ourselves. Additional information can be found in Table 1.

3.3 Econometric Model

The applied methodology consisted of estimating an unbalanced panel with fixed effects (Wooldridge, 2009). This econometric model was chosen because it's a common approach also applied by other studies on the field, including by Trumpp and Guenther (2017), and allows us to test how different CCP affects CFP, while also testing for non-linearity as discussed previously. This model was also tested for random and fixed effects through the Hausman Test and for heteroscedasticity, following Wooldridge (2009). The final generic model can be written as follows:

$$\textit{Linear model (M1): } CFP_{it} = \beta_0 + \beta_1\, CCP_{it} + \beta_3\, R\&D_{it} + \beta_4\, CAPIN_{it} + \beta_5\, LEV_{it} + \beta_6\, GRO_{it} + \beta_7\, CF_{it} + \beta_8\, SIZE_{it} + \lambda_t + \alpha_i + \mathcal{E}_{it} \quad (1)$$

$$\textit{Non-linear model (M2): } CFP_{it} = \beta_0 + \beta_1\, CCP_{it} + \beta_2\, (CCP_{it})^2 + \beta_3\, R\&D_{it} + \beta_4\, CAPIN_{it} + \beta_5\, LEV_{it} + \beta_6\, GRO_{it} + \beta_7\, CF_{it} + \beta_8\, SIZE_{it} + \lambda_t + \alpha_i + \mathcal{E}_{it} \quad (2)$$

In the model, the corporate finance performance (CFP_{it}) metrics are the dependent variables, the independent variable of interest is the corporate climate performance (CCP_{it}), followed by the control variables, year fixed-effects to account for time effects that affect all companies, the firm fixed-effects, represented by α_i, and an error term, represented by $\mathcal{E}_{it}$. Subscripts $_i$ and $_t$ indicate firms and years, respectively. Through the firm fixed-effects, any time-invariant firm characteristics of the firm are accounted in the model, for instance, geographical region, country, sector, and industry. All the dependent, independent, and control variables are described in Table 1. The difference between the linear and the non-linear model is the addition of the quadratic term for the CCP metric, as proposed by Brammer and Millington (2008) and applied by Trumpp and Guenther (2017) in a similar study.

To mitigate endogeneity concerns, a general limitation on the field, we used several control variables. The control variables were chosen based on their likelihood to determine the dependent variable and the frequency they were used by other relevant CCP-CFP studies on the field. The control variables utilized were research and development intensity, capital intensity, leverage, growth, cash flow, and size, and their expected influence on the CFP is described in Table 1. Especially when running the model for the liquidity measure, we also used return on assets (ROA) and price-to-book (P/B) as control variables (CHANG *et al.*, 2019).

A complementary measure on avoiding endogeneity, which also supports casual inferences, would be to use time-lagged measures for CCP. Because CDP's data and the score are naturally lagged in one year, we consider that the chosen CCP variables are already lagged in one year. (BUSCH *et al*., 2020; TRUMPP; GUENTHER, 2017). We recognize that endogeneity, along with casual and bidirectionality, is an inherent challenge in this field and additional tests and studies could be developed, however, this work will focus initially on relationships and correlations.

To run robustness checks two dummies were created to count for countries' development status and carbon-intensive sectors. The most recent United Nations classification on level of countries' development was used to separate "developed countries", indicated by 1, from "developing countries, indicated with 0 (UNITED NATIONS, 2020). The carbon-intensive sectors were divided using the S&P Capital IQ industry classification, which is The Global Industry Classification Standard (GICS). From which, the energy, industry, materials, and utility sectors received an overall classification as carbon-intensive sectors, indicated by a 1, and the other sectors were signalized with a 0. These dummies were only utilized during the robustness checks and the classification for countries' development categories can be found in the Appendix.

Table 1 – Variable definitions used in this study.

Category	Variable	Definition	Source	Reference
Corporate Financial Metrics (CFP)	**Return on Assets (ROA)**	Net income divided per total assets.	Automatically calculated by S&P Capital IQ.	Bush and Hoffman (2011); Bush *et al*. (2020); Trumpp and Guenther (2017).
	Price to Book (P/B)	Firm's market value per share divided by its book value per share.	Automatically calculated by S&P Capital IQ.	Block (1995); Garcia-Sanchez and Prado-Lorenzo (2012); Nezlobin, Rajan and Reichelstain (2016).
	Quoted Spread	Sum of the daily closing spread divided by trading days.	Calculated by the authors based on raw data from S&P Capital IQ.	Le and Gregoriou (2020).
Climate Metrics (CCP)	**CDP Score**	CDP's alphabetic score is converted into a numerical rank, from 1 to 8, on Stata.	CDP database	CDP (2020b).
	Carbon Intensity	Negative of total emissions, divided by revenue in US dollars. The total emissions are calculated by the sum of direct (scope 1) and indirect (scope 2) greenhouse gas emissions (GHG) disclosed by the company through CDP. It can be positive or negative.	CDP database	Trumpp and Guenther (2017).
Control variables	**R&D**	Research and development intensity is measured as R&D expenses divided by sales. R&D intensity represents the innovation capability from knowledge enhancement. It expected a long-term positive effect on CFP metrics.	Calculated by the authors based on raw data from S&P Capital IQ.	Trumpp and Guenther (2017)
	CAPIN	Capital intensity is measured as capital expenditures divided by beginning-of-the-year total assets. It can affect positively and negatively the CFP.	Calculated by the authors based on raw data from S&P Capital IQ.	Bush *et al*. (2020); Trumpp and Guenther (2017)
	LEV	Leverage is measured as total debt divided by total assets. Leverage can be described as the financing risk gathered from a high level of debt. It is expected a negative influence on CFP.	Calculated by the authors based on raw data from S&P Capital IQ.	Busch and Hoffmann (2011); Bush *et al*. (2020); Garcia-Sanchez and Prado-Lorenzo (2012); Trumpp and Guenther (2017).
	GRO	Growth is measured as change in total assets divided by beginning-of-period total assets. A positive effect is expected on CFP.	Calculated by the authors based on raw data from S&P Capital IQ.	Bush *et al*. (2020); Trumpp and Guenther (2017).
	CF	Cash flow return on sales is measured as net cash flow divided by sales. It is expected a positive relation with CFP.	Calculated by the authors based on raw data from S&P Capital IQ.	Trumpp and Guenther (2017).
	SIZE	The company size is measured by the natural logarithm of total assets. It can affect the CFP positively.	Calculated by the authors based on raw data from S&P Capital IQ.	Busch and Hoffmann (2011); Bush *et al*. (2020); Garcia-Sanchez and Prado-Lorenzo (2012); Trumpp and Guenther (2017).

Source: the author.

3.4 Sample

The final sample contains a total of 17,191 firm-years observations. By its nature, as an unbalanced panel, the firm observations per year are not always the same, but across all years the sample contains 2,148 unique companies that appear at least 4 of the 11 years observed. As displayed in Appendix B, the firms' distribution per region is mostly concentrated in Europe (39%), United Stated and Canada (25%), and Asia Pacific (27%). Across sectors, the samples are relatively well balanced, with the most represented sectors being Industrials (22%), Materials (14%), Consumers Discretionary (13%), and Information Technology (11%), respectively.

This sample was formed by the matching of CDP's database with Capital IQ using the ISIN conde as the main identifier. The impossibility to match CDP and Capital IQ database through the ISIN led to considerable dropouts of the sample. Additionally, several data cleaning steps were made to secure a robust analysis. Companies with negative assets and revenue were dropped out of the sample, to avoid firms with financial problems that may have puzzling effects on the CFP. Countries with less than 10 companies across all years were dropped due to the low representativeness, as well as companies that appear less than 4 times across all years. Financial sector firms were also dropped out of the sample because of their unique behavior with the CFP metrics and several of the control variables, such as leverage for instance. And finally, to mitigate the effects of other potential outliers, all variables were winsorized at the lowest and the highest 1st percentile. All these measures allowed the appropriate incorporation of growth and size-related effects (BUSH *et al.*, 2020; TRUMPP; GUENTHER, 2017).

4 RESULTS

4.1 Descriptive Statistics

The descriptive statistics are presented in Table 2. The unbalanced panel counts with 17,191 observations in total, but as is expected, the total observations per variable fluctuate. To produce the descriptive statistics and the bivariate correlation, all observations with at least one missing cell were dropped. The summary of the bivariate correlations among the variables is presented in Table 3. The correlations were calculated to a 95% confidence interval, and all the bivariate correlations for the explanatory variables are below ±0.5, diminishing the risk for multicollinearity while corroborating the choice of the control variables.

Table 2 – Descriptive statistics for the variables defined in the study.

Variable	N	Mean	SD	p50	Max	Min
CDP Score	14,156	4.586	2.102	4.000	8.000	1.000
Carbon Intensity	14,156	7.954	6.259	9.697	19.495	-15.431
ROA	14,156	5.096	3.922	4.388	19.382	-4.651
P/B	14,156	3.051	3.385	1.990	22.341	0.325
Quoted Spread	14,156	-0.022	0.401	0.001	1.619	-1.829
R&D	14,156	0.018	0.044	0.000	0.223	0.000
CAPIN	14,156	0.032	0.039	0.019	0.198	0.000
LEV	14,156	13.045	55.283	0.340	422.910	0.000
GRO	14,156	0.031	0.130	0.033	0.513	-0.428
CF	14,156	0.009	0.086	0.004	0.390	-0.336
SIZE	14,156	8.998	1.410	8.957	12.366	5.667

Notes: The variables are defined in Table 1. Although the model consists of an unbalanced panel, to calculate the descriptive statistics, we disregard all the missing in the sample. This explains the difference between the "n" in the table and the number of observations presented in the sample section.
Source: the author.

Table 3 – Summary of bivariate correlations for the variables defined in the study.

	Variable	1	2	3	4	5	6	7	8	9	10	11
1	CDP Score	**1.000**										
2	Carbon Intensity	0.0857*	**1.000**									
3	ROA	-0.0525*	0.0369*	**1.000**								
4	P/B	0.0412*	0.0877*	0.5455*	**1.000**							
5	Quoted Spread	-0.0103	-0.0246*	-0.0370*	-0.0398*	**1.000**						
6	R&D	0.0323*	0.0519*	0.1039*	0.1454*	-0.0292*	**1.000**					
7	CAPIN	-0.0768*	-0.1323*	0.1088*	0.0788*	-0.011	-0.0931*	**1.000**				
8	LEV	0.0466*	-0.0143	-0.1166*	-0.1117*	0.0052	-0.0385*	-0.1898*	**1.000**			
9	GRO	-0.0054	0.0067	0.2073*	0.1088*	-0.0147	0.0595*	0.0931*	0.0024	**1.000**		
10	CF	0.0171	0.0382*	0.0264*	0.0305*	-0.002	0.0126	-0.0321*	-0.0086	0.1728*	**1.000**	
11	SIZE	0.3185*	-0.0681*	-0.1393*	-0.0613*	-0.0732*	0.0574*	0.0208	0.0480*	0.0378*	0.0076	**1.000**

Notes: This table reports Bravais–Pearson bivariate correlations for the variables defined in this study (1-11). The variables are defined in Table 1. *means p < 0,01.
Source: the author.

4.2 Results considering Profitability (ROA)

The results for profitability indicate a linear and positive relationship between corporate climate performance and return on assets (ROA), for both CDP score as a proxy for climate-related issues management at the firm level and carbon intensity. These results are as expected and show that improvements in climate performance are associated with an increase in profitability. The statistics in Table 4 and Table 5 demonstrate an overall good fit of the empirical model, and for both cases, the linear model has a considerable higher explanatory power, thus we found no evidence of a curvilinear effect for return and CCP. The findings are consistent with the literature since most of the studies evaluated also found a positive and linear relationship between ROA and CCP, and very few works in the field have tested non-linear models.

One of the differences found in comparison with Busch and Hoffmann (2011) is that, while both studies obtained a positive relationship for "outcome-based" measures, such as carbon intensity, in their case they found a negative relationship for "process-based" measures, such as governance among others, and this study found a positive relationship with CDP Score. One of the reasons may be because CDP Score is an integrated evaluation of how companies are managing climate change issues, including "outcome-based" or quantitative indicators on performance. Therefore, it captures a more holistic CCP than "processed-based" metrics alone.

Although our results don't indicate a "U-shape" form for profitability and CCP, as proposed by Trumpp and Guenther (2017), the "U-shape" theory suggests that it is possible to have both negative and positive relations, negative at the beginning of the journey and with the CCP starting to pay off after a certain point. Because profitability is considered a short-term CCP metric (BUSCH *et al.*, 2020), and our study only embraces companies that already voluntarily disclose climate data to CDP, it is possible that the companies in the sample already passed the “turning point” under which CCP starts to payoff. If this theory is correct, our results do not necessarily contradict Trumpp and Guenther (2017) findings.

The robustness test on carbon intensity and ROA indicated that the same positive and linear relationship can be found for all subsets of developed and developing countries, carbon-intensive and non-intensive sectors. However, the analysis for CDP Score and ROA presented different results. The same positive and linear trend can only be found for developed countries and non-intensive sectors. No relationship was found for developing countries. One possible explanation may be because a great part of the samples is formed by companies based in developed countries, and a great part of the representants of the developing words was dropped out of the samples by the data cleaning process described in the methodology section. Another reason could be because companies based in developing countries still do not face the same political and economic incentives necessary to convert good corporate performance on climate management into financial results.

Regarding the intensity of carbon, the carbon-intensive sectors were the only ones that presented a non-linear “U-Shaped” relationship, similar to the results found by Trumpp and Guenther (2017). This can indicate that, for carbon-intensive companies, investments in the management of climate-related issues only pay off after a minimum level of CCP. The small quadratic term indicates that low levels of CCP can have almost linear behavior, whereas the higher the level of CCP the closer it gets to a non-linear form.

It is also worth noticing that all control variables were highly significant, thus helped to control for other firm characteristics (besides CCP) that concomitantly affect CFP, and behaved as expected.

Table 4 – Results for profitability (ROA) and CDP Score as the climate performance metric.

ROA	Reported Data		Developed Countries		Developing Countries		Intensive Sectors		Non-Intensive Sectors	
	M1	M2	M1	M2	M1	M2	M1	M2	M1	M2
CDP	0.043***	-0.022	0.059***	0.003	0.001	-0.075	0.017	-0.182**	0.069***	0.116
	(0.016)	(0.056)	(0.017)	(0.059)	(0.044)	(0.159)	(0.023)	(0.082)	(0.022)	(0.076)
CDP sqr		0.008		0.006		0.009		0.023**		-0.006
		(0.006)		(0.006)		(0.018)		(0.009)		(0.008)
R&D	-45.321***	-45.290***	-44.383***	-44.365***	-50.727***	-50.672***	-26.010***	-25.248***	-47.578***	-47.591***
	(5.740)	(5.731)	(6.049)	(6.044)	(15.267)	(15.234)	(7.988)	(7.952)	(6.344)	(6.351)
CAPIN	17.708***	17.695***	19.394***	19.385***	5.543	5.510	16.088***	16.046***	18.815***	18.823***
	(1.736)	(1.736)	(1.847)	(1.847)	(5.310)	(5.304)	(2.183)	(2.184)	(2.755)	(2.756)
LEV	-0.017***	-0.017***	-0.085***	-0.086***	-0.014***	-0.014***	-0.013***	-0.013***	-0.021***	-0.021***
	(0.004)	(0.004)	(0.011)	(0.011)	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)
GRO	3.332***	3.323***	3.137***	3.130***	4.066***	4.060***	3.770***	3.745***	2.860***	2.866***
	(0.222)	(0.221)	(0.247)	(0.247)	(0.550)	(0.549)	(0.345)	(0.345)	(0.282)	(0.281)
CF	0.534**	0.535**	0.364	0.363	1.497***	1.502***	0.709*	0.706*	0.404	0.403
	(0.243)	(0.243)	(0.269)	(0.269)	(0.534)	(0.534)	(0.405)	(0.404)	(0.290)	(0.291)
SIZE	-1.401***	-1.399***	-1.527***	-1.524***	-0.684*	-0.681*	-1.136***	-1.120***	-1.704***	-1.706***
	(0.168)	(0.168)	(0.184)	(0.184)	(0.414)	(0.414)	(0.210)	(0.210)	(0.256)	(0.256)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Sqr. Overall	0.0163	0.0163	0.0178	0.0178	0.0803	0.081	0.0757	0.077	0.0128	0.0128
Observations	16,418	16,418	13,512	13,512	2,846	2,846	7,909	7,909	8,509	8,509

Notes: Results for the linear and non-linear model on profitability (ROA) as the dependent variable and CDP Score as the independent variable. M1 refers to the linear model and M2 to the non-linear model. Numbers in parentheses are the heteroscedasticity-robust standard errors. *p < 0,10. **p < 0,05. ***p < 0,01.
Source: the author.

Table 5 – Results for profitability (ROA) and Carbon Intensity as the climate performance metric.

ROA	**Reported Data**		**Developed Countries**		**Developing Countries**		**Intensive Sector**		**Non-Intensive Sector**	
	M1	**M2**	**M1**	**M2**	**M1**	**M2**	**M1**	**M2**	**M1**	**M2**
Intensity	**0,172*** **	**0,161*** **	**0,133*** **	**0,123*** **	**0,301*** **	**0,346*** **	**0,109** **	**0,127*** **	**0,214*** **	**0,199*** **
	(0,035)	(0,035)	(0,039)	(0,039)	(0,087)	(0,103)	(0,046)	(0,049)	(0,054)	(0,052)
Intensity sqr		**0,001**		**0,001**		**-0,003**		**-0,001**		**0,003**
		(0,001)		(0,001)		(-0,990)		(0,001)		(0,001)
R&D	**-42,180*** **	**-42,201*** **	**-43,615*** **	**-43,648*** **	**-32,982** **	**-33,030** **	**-26,435*** **	**-26,404*** **	**-43,968*** **	**-43,990*** **
	(5,333)	(5,340)	(5,992)	(6,002)	(14,292)	(14,268)	(8,175)	(8,193)	(5,872)	(5,889)
CAPIN	**17,774*** **	**17,725*** **	**19,388*** **	**19,330*** **	**5,618**	**5,717**	**16,326*** **	**16,362*** **	**18,745*** **	**18,703*** **
	(1,752)	(1,751)	(1,863)	(1,861)	(5,338)	(5,344)	(2,224)	(2,227)	(2,715)	(2,724)
LEV	**-0,017*** **	**-0,017*** **	**-0,081*** **	**-0,081*** **	**-0,014*** **	**-0,014*** **	**-0,013*** **	**-0,013*** **	**-0,020*** **	**-0,020*** **
	(0,004)	(0,004)	(0,011)	(0,011)	(0,004)	(0,004)	(0,005)	(0,005)	(0,006)	(0,006)
GRO	**3,161*** **	**3,165*** **	**3,010*** **	**3,014*** **	**3,847*** **	**3,841*** **	**3,675*** **	**3,671*** **	**2,594*** **	**2,610*** **
	(0,220)	(0,220)	(0,250)	(0,250)	(0,534)	(0,532)	(0,352)	(0,352)	(0,264)	(0,264)
CF	**0,482** **	**0,481** **	**0,233**	**0,232**	**1,643*** **	**1,635*** **	**0,600**	**0,597**	**0,406**	**0,402**
	(0,242)	(0,242)	(0,266)	(0,266)	(0,541)	(0,541)	(0,416)	(0,416)	(0,278)	(0,277)
SIZE	**-1,437*** **	**-1,445*** **	**-1,520*** **	**-1,529*** **	**-0,986** **	**-0,974** **	**-1,083*** **	**-1,078*** **	**-1,806*** **	**-1,828*** **
	(0,170)	(0,170)	(0,188)	(0,188)	(0,409)	(0,408)	(0,211)	(0,211)	(0,258)	(0,256)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Sqr. Overall	0,0217	0,0219	0,0197	0,0199	0,106	0,1066	0,0819	0,082	0,0144	0,015
Observations	15.893	15.893	13.110	13.110	2.728	2.728	7.712	7.712	8.181	8.181

Notes: Results for the linear and non-linear model on profitability (ROA) as the dependent variable and the reverse of Carbon Intensity as the independent variable. M1 refers to the linear model and M2 to the non-linear model. Numbers in parentheses are the heteroscedasticity-robust standard errors. *p < 0,10. **p < 0,05. ***p < 0,01.
Source: the author.

4.3 Results considering Firm Value (P/B)

The results for firm value (P/B) as CFP proxy and CCP indicates an overall good fit of the empirical model and for both CDP Score and Carbon Intensity the non-linear model showed a high explanatory power, but with different directions.

When analyzing the results for firm value and CDP Score, displayed in Table 6, we obtained a significative relationship only for the non-linear model, with the linear term negative and the quadratic term positive, indicating a “U-shape” relationship between firm value and CCP, as proposed by Trumpp and Guenther (2017). Additionally, the small quadratic term indicates that for low carbon intensities the model can behave as a linear model, and as the intensity increases it gets more prominently non-linear. These findings are in line with the literature, especially with Trumpp and Guenther (2017), since very few studies in the field have tested non-linearity. The “U-shape” form found in this study corroborates with the “too-little-of-a-good-thing” (TLGT) theory, under which investments on better climate-related issues management only payoff after a minimum level of CCP.

Our findings for firm value and carbon intensity, available in Table 7, however, show evidence for an “inverted U-shape” form, with both linear and quadratic term positive. These results are more in line with Busch *et al.* (2020), which found a negative relation between market-based metrics and carbon intensity under which the higher the emissions, the higher the firm value. Under the authors' analysis, they suggest that although investors are increasingly reinforcing the need to address climate change and there are several initiatives, like CDP, that pushes companies towards transparency and disclosures, they yet do not utilize efficiently the insights and data from these disclosures to include low-carbon criteria on their investment’s decision and companies’ valuation.

When considering the robustness checks for CDP Score, the same relationship was found for developed countries and carbon-intensive sectors. But none no relationship was found between developing countries and non-intensive sectors, suggesting that developing economies and non-intensive sectors are not exposed enough to market scrutiny for the firm value to reflect its performance on the overall management of climate change issues. For carbon intensity, as an isolated CCP, only developed countries again, and non-intensive sectors showed the same results as the presented for the overall reported data. Unlike Busch *et al.* (2020), we found out a positive and linear relationship with firm value for carbon-intensive sectors. Suggesting that at least for this sector the market recognizes efforts on diminishing carbon intensity.

Table 6 – Results for firm value (P/B) and CDP Score as the climate performance metric.

Price-to-book	Reported Data		Developed Countries		Developing Countries		Intensive Sector		Non-Intensive Sector	
	M1	**M2**	**M1**	**M2**	**M1**	**M2**	**M1**	**M2**	**M1**	**M2**
CDP	**-0.005**	**-0.132****	**0.001**	**-0.114***	**0.014**	**-0.009**	**-0.028**	**-0.275*****	**0.008**	**0.012**
	(0.015)	(0.055)	(0.017)	(0.060)	(0.029)	(0.125)	(0.019)	(0.068)	(0.023)	(0.085)
CDP sqr		**0.015****		**0.013****		**0.003**		**0.029*****		**0.000**
		(0.006)		(0.007)		(0.014)		(0.008)		(0.009)
R&D	**-3.648**	**-3.592**	**-1.382**	**-1.349**	**-13.941****	**-13.926****	**-3.063**	**-2.058**	**-4.191**	**-4.192**
	(2.603)	(2.597)	(2.530)	(2.537)	(6.210)	(6.213)	(7.541)	(7.505)	(2.708)	(2.708)
CAPIN	**6.963*****	**6.920*****	**8.016*****	**7.976*****	**1.471**	**1.466**	**4.933*****	**4.831*****	**10.529*****	**10.530*****
	(1.253)	(1.250)	(1.363)	(1.362)	(3.148)	(3.143)	(1.328)	(1.315)	(2.474)	(2.476)
LEV	**-0.002**	**-0.002**	**-0.010**	**-0.010***	**0.000**	**0.000**	**-0.004***	**-0.004***	**0.001**	**0.001**
	(0.002)	(0.002)	(0.006)	(0.006)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
GRO	**0.932*****	**0.917*****	**0.638*****	**0.625*****	**1.265****	**1.264****	**1.022*****	**0.996*****	**0.795****	**0.796****
	(0.212)	(0.212)	(0.235)	(0.235)	(0.538)	(0.538)	(0.204)	(0.204)	(0.347)	(0.346)
CF	**0.307**	**0.308**	**0.425***	**0.424***	**-0.187**	**-0.185**	**0.512****	**0.507****	**0.118**	**0.118**
	(0.222)	(0.222)	(0.244)	(0.244)	(0.480)	(0.481)	(0.229)	(0.230)	(0.342)	(0.342)
SIZE	**-0.760*****	**-0.753*****	**-0.759*****	**-0.752*****	**-0.811****	**-0.810****	**-0.744*****	**-0.722*****	**-0.917*****	**-0.917*****
	(0.142)	(0.142)	(0.153)	(0.154)	(0.330)	(0.330)	(0.152)	(0.152)	(0.230)	(0.230)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Sqr. Overall	0.0112	0.0116	0.0139	0.0145	0.0855	0.0858	0.0232	0.025	0.0093	0.0093
Observations	15,230	15,230	12,565	12,565	2,612	2,612	7,344	7,344	7,886	7,886

Notes: Results for the linear and non-linear model on firm value (P/B) as the dependent variable and the CDP Score as the independent variable. M1 refers to the linear model and M2 to the non-linear model. Numbers in parentheses are the heteroscedasticity-robust standard errors. *p < 0,10. **p < 0,05. ***p < 0,01.
Source: the author.

Table 7 – Results for firm value (P/B) and Carbon Intensity as the climate performance metric.

Price-to-book	Reported Data		Developed Countries		Developing Countries		Intensive Sector		Non-Intensive Sector	
	M1	M2	M1	M2	M1	M2	M1	M2	M1	M2
Intensity	**0,135*** **	**0,113*** **	**0,137*** **	**0,119*** **	**0,094**	**0,077**	**0,098*** **	**0,084** **	**0,147*** **	**0,132*** **
	(0,025)	(0,025)	(0,028)	(0,027)	(0,058)	(0,064)	(0,032)	(0,033)	(0,037)	(0,036)
Intensity sqr		**0,002*** **		**0,002*** **		**0,001**		**0,001**		**0,004*** **
		(0,001)		(0,001)		(0,002)		(0,001)		(0,001)
R&D	**-2,525**	**-2,593**	**-1,210**	**-1,290**	**-8,228**	**-8,215**	**-0,606**	**-0,645**	**-3,017**	**-3,075**
	(2,462)	(2,451)	(2,644)	(2,630)	(6,062)	(6,067)	(7,788)	(7,761)	(2,488)	(2,478)
CAPIN	**7,200*** **	**7,094*** **	**8,206*** **	**8,102*** **	**1,480**	**1,429**	**4,972*** **	**4,945*** **	**11,334*** **	**11,309*** **
	(1,279)	(1,277)	(1,392)	(1,391)	(3,202)	(3,200)	(1,368)	(1,370)	(2,501)	(2,504)
LEV	**-0,001**	**-0,001**	**-0,010***	**-0,009**	**-0,001**	**-0,001**	**-0,004***	**-0,004***	**0,002**	**0,002**
	(0,002)	(0,002)	(0,006)	(0,006)	(0,001)	(0,001)	(0,002)	(0,002)	(0,002)	(0,002)
GRO	**0,816*** **	**0,823*** **	**0,569** **	**0,578** **	**1,074***	**1,075***	**0,980*** **	**0,982*** **	**0,596***	**0,618***
	(0,212)	(0,212)	(0,234)	(0,234)	(0,555)	(0,555)	(0,210)	(0,210)	(0,344)	(0,343)
CF	**0,282**	**0,279**	**0,362**	**0,356**	**-0,057**	**-0,054**	**0,497** **	**0,497** **	**0,096**	**0,091**
	(0,225)	(0,224)	(0,246)	(0,246)	(0,507)	(0,506)	(0,236)	(0,236)	(0,345)	(0,345)
SIZE	**-0,819*** **	**-0,839*** **	**-0,801*** **	**-0,822*** **	**-0,914** **	**-0,919** **	**-0,738*** **	**-0,743*** **	**-1,014*** **	**-1,041*** **
	(0,145)	(0,145)	(0,155)	(0,154)	(0,359)	(0,363)	(0,155)	(0,155)	(0,237)	(0,237)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Sqr. Overall	0,0198	0,0203	0,021	0,0213	0,0992	0,0989	0,0347	0,0346	0,0113	0,0121
Observation	14.731	14.731	12.182	12.182	2.501	2.501	7.157	7.157	7.574	7.574

Notes: Results for the linear and non-linear model on firm value (P/B) as the dependent variable and the reverse of Carbon Intensity as the independent variable. M1 refers to the linear model and M2 to the non-linear model. Numbers in parentheses are the heteroscedasticity-robust standard errors. *p < .05. **p < .01. ***p < .001.
Source: the author.

4.4 Results considering Liquidity (Quoted Spread)

The results for liquidity (quoted spread) indicate a significative linear relationship for both CDP Score and Carbon Intensity, but also in different directions, being positive for CDP Score and negative for Carbon Intensity. The interpretation is similar to the results obtained for firm value since both price-to-book and stock liquidity have a very strong market component. It could indicate that the market can value more easily aggregated climate management performance, such as the CDP Score, while it still faces difficulty in understanding and incorporating specific data, such as carbon intensity, on its investment decisions and companies' valuation.

The robustness check for the CDP Score presented equal results to the overall data, with exception of the carbon-intensive sectors, for which we find no relationship. One possible explanation is that market liquidity for carbon-intensive sectors is usually related to several other political and economic factors, and overall management of climate issues is not yet captured. As for the robustness check for carbon intensity as CCP, both developed and intensive sectors presented the same relationship, but no relation was found between developing countries and non-intensive sectors.

Additionally, an important challenge faced by this study was to harmonize intrinsically different data frequencies between stock liquidity and CCP. Stock liquidity is often measured and calculated with intraday data, while CSR and CCP data are disclosed to the market usually on an annual basis, and generally with one year lag. In this work we identified stock liquidity indicators that were suitable for low-frequency inference and manipulation, to allow daily trade data per company to be consolidated into one single liquidity data per firm year. The complexity of matching information that flows in different frequencies to back up daily investment decisions might be a complicating factor as to why high stock liquidity is still associated with high carbon intensity.

An interesting observation regarding the liquidity model and results is that, although we used all the control variables also used in other similar studies, most of the control variables do not show a significant p-value, which indicates that further research and theory foundations should be developed to allow for more robust econometric models to be studied. Chang *et al.* (2019) and Subramaniam, Samuel and Mahenthiran (2016), for instance, control for firm size, industry, ROA, market-to-book, and leverage. In our model only size, price-to-book and cash flow were statistically significant depending on the model analyzed.

Table 8 – Results for liquidity (Quoted Spread) and CDP Score as the climate performance metric.

Liquidity (Quoted Spread)	Reported Data		Developed		Developing		Intensive Sector		Non-Intensive Sector	
	M1	**M2**	**M1**	**M2**	**M1**	**M2**	**M1**	**M2**	**M1**	**M2**
CDP	**0.007*** **	**0.011**	**0.006** **	**0.011**	**0.013** **	**-0.001**	**0.004**	**0.006**	**0.010*** **	**0.016***
	(0.002)	(0.007)	(0.003)	(0.007)	(0.006)	(0.022)	(0.004)	(0.010)	(0.003)	(0.010)
CDP sqr		**0.000**		**-0.001**		**0.002**		**0.000**		**-0.001**
		(0.001)		(0.001)		(0.002)		(0.001)		(0.001)
R&D	**-0.050**	**-0.051**	**0.124**	**0.123**	**-1.669** **	**-1.659** **	**0.599**	**0.591**	**-0.063**	**-0.066**
	(0.324)	(0.325)	(0.346)	(0.346)	(0.687)	(0.677)	(1.303)	(1.306)	(0.331)	(0.332)
CAPIN	**-0.123**	**-0.122**	**-0.101**	**-0.099**	**-0.078**	**-0.081**	**-0.270**	**-0.270**	**0.195**	**0.196**
	(0.166)	(0.166)	(0.179)	(0.179)	(0.442)	(0.442)	(0.196)	(0.196)	(0.323)	(0.323)
LEV	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
GRO	**0.032**	**0.032**	**0.066**	**0.066**	**0.015**	**0.014**	**0.025**	**0.025**	**0.037**	**0.038**
	(0.032)	(0.032)	(0.036)	(0.036)	(0.080)	(0.080)	(0.044)	(0.044)	(0.046)	(0.046)
CF	**-0.016**	**-0.016**	**0.034**	**0.034**	**-0.245** **	**-0.244** **	**-0.042**	**-0.042**	**0.001**	**0.001**
	(0.038)	(0.038)	(0.040)	(0.040)	(0.107)	(0.107)	(0.056)	(0.056)	(0.052)	(0.052)
SIZE	**-0.050*** **	**-0.050*** **	**-0.060*** **	**-0.060*** **	**-0.008**	**-0.007**	**-0.043** **	**-0.043** **	**-0.056*** **	**-0.056*** **
	(0.014)	(0.014)	(0.015)	(0.015)	(0.034)	(0.034)	(0.022)	(0.022)	(0.019)	(0.019)
ROA	**-0.001**	**-0.001**	**-0.001**	**-0.001**	**0.005**	**0.005**	**-0.001**	**-0.001**	**0.000**	**0.000**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
P/B	**-0.004** **	**-0.004** **	**-0.003**	**-0.003**	**-0.003**	**-0.003**	**-0.003**	**-0.003**	**-0.005***	**-0.005***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Sqr. Overall	0.0274	0.0273	0.0538	0.0537	0.0309	0.0304	0.0237	0.0237	0.0300	0.0299
Observation	14,638	14,638	12,054	12,054	2,535	2,535	7,072	7,072	7,566	7,566

Notes: Results for the linear and non-linear model on liquidity (Quoted Spread) as the dependent variable and CDP Score as the independent variable. M1 refers to the linear model and M2 to the non-linear model. Numbers in parentheses are the heteroscedasticity-robust standard errors. *p < .05. **p < .01. ***p < .001.
Source: the author.

Table 9 – Results for liquidity (Quoted Spread) and Carbon Intensity as the climate performance metric.

Liquidity (Quoted Spread)	Reported Data		Developed		Developing		Intensive Sector		Non-Intensive Sector	
	M1	M2	M1	M2	M1	M2	M1	M2	M1	M2
Intensity	**-0,011*****	**-0,011*****	**-0,010*****	**-0,011*****	**-0,007**	**-0,011**	**-0,018*****	**-0,011*****	**-0,004**	**-0,004**
	(0,004)	(0,003)	(0,004)	(0,004)	(0,012)	(0,004)	(0,006)	(0,003)	(0,005)	(0,005)
Intensity sqr		**0,000**		**0,000**		**0,000**		**0,000***		**0,000**
		(0,000)		(0,000)		(0,000)		(0,000)		(0,000)
R&D	**-0,008**	**-0,009**	**0,158**	**0,155**	**-1,649****	**0,155****	**0,525**	**-0,009**	**-0,007**	**-0,009**
	(0,339)	(0,339)	(0,367)	(0,367)	(0,728)	(0,367)	(1,375)	(0,339)	(0,344)	(0,344)
CAPIN	**-0,143**	**-0,145**	**-0,119**	**-0,122**	**-0,180**	**-0,122**	**-0,314**	**-0,145**	**0,234**	**0,234**
	(0,173)	(0,173)	(0,186)	(0,186)	(0,456)	(0,186)	(0,204)	(0,173)	(0,335)	(0,335)
LEV	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**	**0,000**
	(0,000)	(0,000)	(0,001)	(0,001)	(0,000)	(0,001)	(0,000)	(0,000)	(0,000)	(0,001)
GRO	**0,029**	**0,029**	**0,063***	**0,064***	**0,013**	**0,064**	**0,030**	**0,029**	**0,028**	**0,029**
	(0,034)	(0,034)	(0,037)	(0,037)	(0,084)	(0,037)	(0,046)	(0,034)	(0,048)	(0,048)
CF	**-0,018**	**-0,018**	**0,036**	**0,036**	**-0,253****	**0,036****	**-0,051**	**-0,018**	**0,004**	**0,004**
	(0,040)	(0,040)	(0,043)	(0,043)	(0,111)	(0,043)	(0,059)	(0,040)	(0,055)	(0,055)
SIZE	**-0,045*****	**-0,045*****	**-0,056*****	**-0,056*****	**0,006**	**-0,056**	**-0,036**	**-0,045**	**-0,052****	**-0,053*****
	(0,015)	(0,015)	(0,016)	(0,016)	(0,036)	(0,016)	(0,023)	(0,015)	(0,020)	(0,020)
ROA	**-0,001**	**-0,001**	**-0,001**	**-0,001**	**0,005**	**-0,001**	**-0,001**	**-0,001**	**0,000**	**-0,001**
	(0,002)	(0,002)	(0,002)	(0,002)	(0,003)	(0,002)	(0,002)	(0,002)	(0,003)	(0,003)
P/B	**-0,003**	**-0,003**	**-0,002**	**-0,002**	**-0,003**	**-0,002**	**-0,002**	**-0,003**	**-0,004***	**-0,004***
	(0,002)	(0,002)	(0,002)	(0,002)	(0,005)	(0,002)	(0,004)	(0,002)	(0,003)	(0,003)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Sqr. Overall	0,0291	0,0291	0,0562	0,056	0,0297	0,0297	0,0267	0,0267	0,0298	0,0295
Observation	14.156	14.156	11.685	11.685	2.426	2.426	6.892	6.892	7.264	7.264

Notes: Results for the linear and non-linear model on liquidity (Quoted Spread) as the dependent variable and the inverse of Carbon Intensity as the independent variable. M1 refers to the linear model and M2 to the non-linear model. Numbers in parentheses are the heteroscedasticity-robust standard errors. *p < .05. **p < .01. ***p < .001.
Source: the author.

5 CONCLUSIONS AND RECOMMENDATIONS

Our study evaluated a sample of 17,191 firm-year observations, between 2010 and 2020, including 2,148 unique firms, through an unbalanced panel with fixed effects, to evaluate the relationship between a good climate-related issues management performance (CCP) and corporate financial performance (CFP). As CFP metrics (dependent variables in the empirical models), we used profitability (ROA), firm value (Price-to-Book), and liquidity (Quoted Spread). As CCP metrics we used CDP Score and Carbon Intensity.

Our results for profitability showed a significant, linear, and positive relationship between ROA and both CDP Score and Carbon Intensity, indicating that improvements in climate performance are associated with an increase in profitability. These findings do not invalidate other non-linear "U-shaped" outcomes, such as proposed by Trumpp and Guenther (2017), because the companies that are already disclosing to CDP may have already passed the "turning point" under which CCP starts to pay off, given that profitability may be considered a short-term CFP.

Regarding firm value, measured by Price-to-book, we found a significative and non-linear relationship, but with different directions for CDP Score and Carbon Intensity. The relationship found for firm value and CDP Score was a "U-Shape", in line with Trumpp and Guenther (2017), indicating that investments on a better climate-related issues management only payoff after a minimum level of CCP. While the opposite was found for firm value and Carbon Intensity, in line with Bush *et al.* (2020), an "inverted U-shape", meaning that higher carbon intensity is linked with higher value. This could suggest that while there are several investors and initiatives promoting climate disclosure and transparency, there is still a gap in the efficient use of these insights and data to include low-carbon criteria on investment decisions and companies' valuation.

The results for liquidity (quoted spread) indicate a significative linear relationship for both CDP Score and Carbon Intensity, but also in different directions, being positive for CDP Score and negative for Carbon Intensity. Alike the results for firm value, it could indicate that the market can value more easily aggregated climate management performance, such as the CDP Score, while it still faces difficulty in understanding and incorporating specific data, such as carbon intensity, on its investment's decisions and companies' valuation. Additionally, in the case of liquidity, the differences in data frequency between stock liquidity and CCP data, and the lack of theoretical foundation and previous study might represent an additional challenge.

Regarding the robustness checks, all the analyses indicated that developing countries tend to behave consistently, regardless of the proxies. While the influence on carbon-intensive sectors depends on the CFP and CCP proxy, reacting more consistently for non-market-based CFP metrics and CDP Score. This might be associated with a bigger maturity of developed markets on integrating firms' ESG and climate performance on their financial analysis. Additionally, accounting-based financial metrics, such as profitability, might benefit more directly from better climate risk management, than market-based proxies. Probably because the latter is influenced by a much more complex set of factors, and the current level maturity of markets on incorporating CCP on firms' market value consistently.

Our results, in practical terms, demonstrate that the market might be aware of the overall relevance of climate management best practices on firms' performance. Still, investors are not able to understand the concrete implications of climate performance specific metrics on their investments, even with the increasing availability of data on the topic. And, despite market value and liquidity might not yet reflect properly improvements on CCP, by implementing better climate risks and opportunities management practices firms can enhance their profitability.

In this context, every stakeholder has its part to play: Companies should continue to disclose their environmental and climate data to their stakeholders, seeking for continued improvement of transparency and data quality; Regulators have an important role in the establishment of clear rules and guidelines to the financial sector on the matter; Investors should pursue constant training and capacity building on how to incorporate specific climate data available on their analysis and decisions; And finally, the academy is crucial on expanding the understanding of how different CCP metrics affects CFP and to make robust recommendations to the market.

This study contributes in 4 different aspects to the existing literature: (1) It utilizes a unique database for its empirical analysis, expanding dramatically the observed timeframe, geographical and sectoral coverage in comparison with other studies in the field. (2) It uses CDP Score as a proxy for integrated corporate climate performance more broadly than any other study and demonstrates statistically significant correlations with corporate financial metrics. (3) it corroborates the complexity in the CSR-CFP relationships that makes it not possible to easily assume linear, non-linear, positive, or negative relations, and that makes each interaction between a specific CSR component and different CFP dimensions unique. (4) There are very few empirical studies on CSR and Liquidity, and none on CCP and Liquidity, which makes this work a pioneer, although we recognize that a lot of the theoretical foundation is still missing.

Several future areas for research are identified, among others: (1) the possibility to expand this research to understand the effects of individual characteristics of the firm, such as region, industry, type of ownership, and others; (2) finding quasi-experiments to identify causal effects of corporate climate performance on financial aspects of the firm, helping to break the endogeneity between CCP and CFP (in particular, simultaneity); (3) expand the understanding on the use of CDP Score as a proxy for corporate climate performance, its effects on other firms dimensions and explore the CDP Score breakdown per category.

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APPENDIX A – SUMMARY TABLE ON CCP AND CFP LITERATURE REVIEW

Paper	Climate Measures	Financial Measures	Sample Size	Timeframe	Geographies	Sectors
Busch and Hoffmann (2011)	Carbon Intensity	ROA ROE Tobin's Q	174	2007	Non-restrict	Non-restrict
Busch *et al*. (2020)	Carbon Intensity	ROA ROE Tobin's Q	4873	2005 - 2014	Non-restrict	Non-restrict
Damert and Baumgartner (2017)	Carbon Governance Carbon Reduction Carbon Competitiveness	ROA ROE	45	2008 and 2013	Non-restrict	Steel, cement, and automotive
Gallego-Alvarez, Garcia-Sanchez and Vieira (2014).	Carbon Intensity	ROA ROE ROS	855	2006 - 2009	Non-restrict	Carbon Intensive sectors
Garcia-Sanchez and Prado-Lorenzo (2012).	CDP Score	ROA Market to book (P/B)	81	2007	Non-restrict	Non-restrict
Trumpp and Guenther (2017).	Carbon Intensity	ROA TSR (Total Shareholder Return)	696	2008 - 2012	Non-restrict	Manufacturing and Services Industries
Ziegler, Busch and Hoffmann (2011).	Climate Disclosure Climate Impact Statement Climate Reduction Measures	Risk-adjusted returns of different stock portfolios (CAPM)	499	2001 - 2006	Europe and the United States of America	Non-restrict

Notes: All the studies in this table utilized the financial metrics as the dependent variable on their model. Only Gallego-Alvarez, Garcia-Sanchez & Vieira (2014) tested the financial metrics as both dependent and independent variables. This note does not apply to Ziegler, Busch & Hoffmann, (2011) because the authors used a Capital Asset Pricing Model (CAPM).
Source: the author.

APPENDIX B – FIRMS DISTRIBUTION ACROSS REGIONS AND SECTORS

	Firms per Year											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Region												**Total firm-years**
Africa	53	68	61	70	59	92	95	97	88	84	76	843
Asia and Pacific	297	374	299	355	398	461	506	496	491	486	499	4662
Europe	499	587	517	548	603	696	685	691	666	651	645	6788
Latin America and Caribbean	43	45	40	47	55	70	79	73	73	70	69	664
United States and Canada	303	353	290	342	340	407	458	454	445	426	416	4234
Sector												**Total**
Communication	73	91	74	81	92	110	105	106	102	103	104	1041
Consumers Discretionary	150	191	158	176	184	232	248	254	240	241	234	2308
Consumers Staples	120	136	123	131	138	152	170	169	166	164	160	1629
Energy	73	89	75	75	93	103	103	95	90	91	87	974
Health Care	80	91	72	86	92	110	109	115	115	110	107	1087
Information Technology	129	164	125	163	162	205	217	202	196	196	205	1964
Industrials	268	320	273	317	337	383	404	403	394	376	377	3852
Materials	166	194	171	189	199	244	267	267	257	240	244	2438
Real State	45	62	63	73	76	88	95	91	91	84	84	852
Utilities	91	89	73	71	82	99	105	109	112	112	103	1046
Total per year	**1195**	**1427**	**1207**	**1362**	**1455**	**1726**	**1823**	**1811**	**1763**	**1717**	**1705**	**17191**

Source: the author.

APPENDIX C – CLASSIFICATION OF DEVELOPED AND DEVELOPING COUNTRIES

Developed Economies		**Developing Economies**		**Economies in Transition**
Australia	New Zealand	Argentina	Mexico	Bosnia-Herzegovina
Austria	Norway	Bahamas	Mongolia	Georgia
Belgium	Poland	Bahrain	Morocco	Kazakhstan
Bulgaria	Portugal	Bermuda	Nigeria	Russia
Canada	Romania	Botswana	Oman	Serbia
Croatia	Slovakia	Brazil	Pakistan	Ukraine
Cyprus	Slovenia	The British Virgin Islands	Panama	
Czech Republic	Spain	Cambodia	Papua New Guinea	
Denmark	Sweden	Cameroon	Peru	
Estonia	Switzerland	Cayman Islands	Philippines	
Finland	United Kingdom	Chile	Qatar	
France	United States	China	Saudi Arabia	
Germany		Colombia	Singapore	
Greece		Egypt	South Africa	
Hungary		Gabon	South Korea	
Iceland		Hong Kong	Sri Lanka	
Ireland		India	Taiwan	
Italy		Indonesia	Thailand	
Japan		Iran	Turkey	
Latvia		Israel	United Arab Emirates	
Lithuania		Kenya	Uruguay	
Luxembourg		Kuwait	Vietnam	
Malta		Malaysia	Zimbabwe	
Netherlands		Mauritius		

Notes: This table presents only the cross-check between countries represented on this sample and the United Nations (2020) classifications. Economies in transition were not utilized in this study.
Source: the author.