


An exploratory analysis of monetary incentives' role in the carbon performance of Brazilian companies


Uma análise exploratória do papel dos incentivos monetários no desempenho de carbono de empresas brasileiras

Un análisis exploratorio del papel de los incentivos monetarios en las emisiones de carbono de empresas brasileñas

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Abstract

There is plenty of information about mechanisms that can motivate companies' voluntary reduction of greenhouse gas (GHG) emissions. However, there needs to be more investigation of the effects that fixed and non-fixed monetary incentives could bring to executives (who make decisions on these issues). We analyzed 31 B3-listed companies that disclosed emissions inventories (GHGs) between 2012 and 2019. We conducted an exploratory analysis using a documental analysis of non-financial disclosures and a two-stage dynamic panel (GMM-SYS) to control for potential endogeneity problems. The results are robust and suggest the effectiveness of these monetary incentives to reduce GHG emissions. Our main results are i) A positive and contemporary relationship exists between monetary incentives and carbon emission reductions. ii) The variables ROA and Total Assets showed a positive and significant relationship with emissions so the larger and more profitable the firm the higher the emissions; iii) Despite ineffective GHG environmental laws, Brazilian companies seem to offer incentives to reduce carbon emissions voluntarily. Our results are relevant especially for regulators and shareholders, as they provide subsidies for emissions control in developing countries like Brazil and align interests.

Keywords: Carbon Performance; Executive Compensation; Carbon Emissions; Brazil

Resumo

Há muitas informações sobre mecanismos capazes de motivar a redução voluntária de emissões de gases de efeito estufa (GEE) pelas empresas. Entretanto, há uma lacuna na investigação dos efeitos que incentivos monetários fixos e não fixos aos executivos (que tomam decisões sobre estas questões) poderiam ocasionar. Foram analisadas 31 empresas listadas na B3 que divulgaram inventários de emissões (GEE) entre 2012 e 2019. Conduzimos uma análise exploratória, com o uso análise documental de divulgações não financeiras e um painel dinâmico de duas fases (GMM-SYS) para controlar potenciais problemas de endogeneidade. Os resultados são robustos e sugerem a eficácia desses incentivos monetários na redução das emissões de GEE. Nossos principais resultados são: i) Existe uma relação positiva e contemporânea entre incentivos monetários e reduções de emissões de carbono. ii) O ROA e Ativo Total apresentaram relação positiva e significativa com as emissões assim quanto maior e mais lucrativa a empresa, maiores são as emissões; iii) Apesar das leis ambientais ineficientes sobre GEE, as empresas brasileiras parecem oferecer voluntariamente incentivos para reduzir as emissões de carbono. Nossos resultados são relevantes especialmente para reguladores e acionistas, pois fornecem subsídios para o controle de emissões em países em desenvolvimento como o Brasil e alinham interesses.

Palavras-chave: Desempenho do Carbono; Incentivos Monetários; Emissões de Carbono; Brasil

Resumen

Existe mucha información sobre los mecanismos capaces de motivar la reducción voluntaria de las emisiones de gases de efecto invernadero (GEI) por parte de las empresas. Sin embargo, existe una brecha en la investigación de los efectos que podrían provocar los incentivos monetarios fijos y no fijos a los ejecutivos (que toman las decisiones relativas a estos asuntos). Analizamos 31 empresas que cotizan en B3 y que divulgaron inventarios de emisiones (GEI) entre 2012 y 2019. Se realizó un análisis exploratorio mediante una revisión documental de la información no financiera y un panel dinámico de dos etapas (GMM-SYS) para controlar los posibles problemas de endogeneidad. Los resultados son robustos y sugieren la eficacia de estos incentivos monetarios para reducir las emisiones de GEI. Nuestros principales resultados son: i) Existe una relación positiva y contemporánea entre los incentivos monetarios y las reducciones de las emisiones de carbono. ii) Las variables ROA y Activos Totales mostraron una relación positiva y significativa con las emisiones, de modo que cuanto más grande y rentable es la empresa, mayores son las emisiones; iii) A pesar de la ineficacia de las leyes medioambientales sobre GEI, las empresas brasileñas parecen ofrecer voluntariamente incentivos para reducir las emisiones de carbono. Nuestros resultados son relevantes especialmente para los reguladores y los accionistas, ya que proporcionan subvenciones para el control de las emisiones en países en desarrollo como Brasil y alinean los intereses.

Palabras clave: Desempeño del carbono; Remuneración de los ejecutivos; Emisiones de carbono; Brasil

1 Introduction

Climate change requires not only government action but also the mobilization of the whole society. The private sector is responsible for Brazil's eco-efficient advancement in sectors with more significant environmental impact (Marcovitch, 2014; Marcon et al., 2017). Hence, the company's challenge involves both the management of the short and long-term interests within their economic and financial objectives as well as the concept of sustainable development, and risks management and opportunities from this process (Cordeiro & Sarkis, 2008).

For companies and investors, it can be something promising, considering that companies worldwide are increasingly being pressured to improve their environmental performance, minimizing potential risks and, at the same time, taking advantage of this process (Hoffman 2005; Eccles et al., 2012; Matsumura et al., 2014; Haque & Ntim, 2020).

To cope with these emerging pressures, some firms worldwide seek different ways of internalizing sustainable goals in their daily business. One is through employee engagement by providing monetary and non-monetary incentives (Cordeiro & Sarkis, 2008; Eccles et al., 2012; Cruz et al., 2017; Haque & Ntim, 2020).

Understanding the role of monetary incentives to managers (responsible for defining the organizations' sustainability strategies) is crucial for organizations. This way, companies could develop effective mechanisms to meet sustainability goals and, thus, enjoy the benefits resulting from these choices (Cordeiro & Sarkis, 2008; Ritz, 2020).

The agency theory shows that incentives tend to align the interests between the agent and principal to the extent that they are used efficiently to converge the agent's efforts to satisfy the principal's interests while also pursuing their interests (Jensen & Meckling, 1976; Cordeiro & Sarkis, 2008; Aguiar & Pimentel, 2017). Thus, incentive-based strategies can be considered a vital governance mechanism that can improve the firm's socio-environmental performance based on the alignment of actors' short- and long-term interests (Haque & Ntim, 2020).

However, the role of employee incentives on firms' social and environmental performance is divergent or inconclusive. Therefore, this relationship is still unclear, especially in emerging economies. Previous research has shown that sustainability targets as carbon performance have long-term nature (Alvarez, 2012) and tend to be more tied to non-fixed incentives, as the risks of poor performance would affect the interests of both the company and the agents (Freeman et al., 2004; Jamali, 2008). In Brazil, for instance, research such as Dalmácio et al. (2009) and Anjos (2016) showed that most executive compensation used to be fixed and not motivational in nature. In other words, risks were not shared, considering that they did not vary according to the results achieved.

Hence, the interests related to environmental objectives (long-term) seemed to concern only companies and shareholders without affecting the interests of agents (short-term) unless it is already incorporated in the agreed fixed compensation (Guimarães, Peixoto & Carvalho, 2017). The existing empirical literature indicates a positive relationship between executive compensation and sustainable business practices (Cordeiro & Sarkis, 2008; Prates, 2019; Haque & Ntim, 2020). Thus, the study argues that monetary incentives may serve as a key determinant influencing firms' sustainable practices.

From the agency theory perspective, executive compensation formulas are designed to align both economic and short-term interests and those of the long-term (Haque, 2017; Haque & Ntim, 2020). These formulas are disclosed on the firm's Reference Forms (RF) through the CVM website. In addition, alternative

channels such as Sustainability Index (ISE) questionnaires (from the Brazilian stock market) and CDP questionnaires are also sources of information regarding sustainability goals and strategies. Nowadays, most companies that use these disclosure channels claim to offer incentives to their executives to meet environmental targets (Cruz et al., 2017).

However, details such as percentages or specific GHG emission reduction targets are yet to be disclosed, given the restriction of the form of disclosure required by the CVM so far. However, one can note proactive actions, growth, and positive results regarding the efficient business strategies of these private companies (Marcovitch, 2014; Cruz et al., 2017).

In this sense, it is relevant to identify the role that monetary incentives play in meeting emission reduction targets, even if companies are not fully transparent about the composition of the compensation formulas for their executives. Therefore, considering the conflict between the risk inherent in voluntary carbon emissions disclosure, and the increasing pressure from shareholders to assess and communicate both the risks and opportunities related to climate change, we state the research question: Is there any influence of executive monetary incentives on carbon performance in Brazilian companies?

Our research is exploratory, and its design encompasses a documental analysis, descriptive statistics, and a two-step dynamic panel data estimation method (GMM-SYS) to control for potential endogeneity problems. Furthermore, we examine this relationship in a segregated way, considering a different monetary incentive in each model: fixed, non-fixed, and total executive compensation as explanatory variables of firms' current carbon performance.

Only a few studies in the reviewed literature have attempted to make a correlated analysis to the one this research proposes to do (Cordeiro & Sarkis, 2008; Eccles et al., 2012; Haque & Ntim, 2020). The originality of the research is that it investigates companies in the Brazilian market to identify if the monetary incentives granted to executives of companies environmentally committed to sustainable development could contribute to the reduction of GHG emissions. Our analysis focuses on Brazil, which has yet to be investigated from a perspective on climate change and carbon performance.

The Brazilian scenario differs from other countries. The environmental law¹ that deals with carbon emissions at the national level is considered inefficient, lenient, and without inspection or punishment concerning GHG (greenhouse gas emissions). This factor hinders the achievement of optimal environmental performance (Marcovitch, 2014).

In addition, we used a Brazilian emissions inventory database that contributes to establishing sectoral benchmarks related to climate issues. This information can be applied in reports of initiatives such as the Carbon Disclosure Project (CDP), the Bovespa Corporate Sustainability Index (ISE), and the Global Reporting Initiative (GRI).

The results are primarily of interest to shareholders concerned with climate and environmental issues and regulators. In the literature, it contributes by promoting greater depth and discussion of the impacts of monetary incentives to executives on the alignment of interests and their effects on the sustainability and long-term goals of Brazilian companies, as measured by the analysis of the organizations' carbon performance.

2 Literature Review

The identification of the manager's motivation to control and disclose information about GHG emissions can be analyzed from two perspectives: intrinsic motivation (non-monetary) and extrinsic motivation (monetary). Cash bonuses can mainly represent monetary incentives, and non-monetary incentives can be, for example, public recognition usually in awards (Anjos, 2016; Aguiar & Pimentel, 2017).

Growing social awareness of the effects of climate change and the real possibility of regulatory and legislative action provide reasons for companies to limit carbon emissions voluntarily. To achieve better environmental and carbon performance, many companies offer executives incentives to adapt to current requirements (Eccles et al., 2012; Haque & Ntim, 2020; Ritz, 2020).

Previous international research has provided evidence that managers perceive disclosure of carbon emissions information as a competitive advantage capable of aligning interests within firms, even at market penalty risk (Matsumura et al., 2014; Saka & Oshika, 2014). Thus, the choice to disclose carbon emissions control would be a competitive advantage in terms of Market Value, suggesting that the capital market incorporates this non-financial information into asset pricing.

Griffin et al. (2017) found that while all firms are automatically penalized for their carbon emissions regardless of whether they disclose them. Firms that do not disclose their emissions face a double penalty from the market. Matsumura et al. (2014) analyzed the effects of firm value on the act of voluntarily disclosing carbon emissions using propensity score matching and robust logistic regression. The average market value of firms that report their carbon emissions is about \$2.3 billion higher than those that do not.

Therefore, it is logical for executives to weigh the costs and benefits of both monitoring and disclosing carbon emissions. However, the scientific literature presents some contradictory results about the effects of monetary incentives on carbon performance.

Eccles et al. (2012) analyzed whether intrinsic (non-monetary) and extrinsic incentives (monetary)

are effective in terms of reducing carbon emissions in companies. They show that those companies that said they offer monetary incentives for environmental performance have higher carbon emissions when compared to companies that claimed not to offer such incentives. The authors used a logit model and monetary incentives consisted of the voluntary responses from companies to the CDP questionnaire. In addition, companies that stated to provide non-monetary incentives had lower carbon emissions when compared to companies that said they did not.

Despite considering several countries in the analysis, Brazil's participation in Eccles et al. (2012) research was less than 4% of the total sample, reinforcing the importance of further investigation of Brazilian companies. The authors used a logit model and the proxy used for monetary incentives consisted of a dichotomous variable (yes=1 and no=0) based on companies' voluntary responses to the CDP questionnaire as to whether or not they claimed to provide these incentives.

Our research, as Eccles et al. (2012), finds it plausible to investigate the proposed relationship from information from data voluntarily disclosed by firms. However, we deepen their strategy for four main reasons. First, we analyze a longer period focusing on investigating deeply the Brazilian context. Second, we use absolute and real executive compensation data. Third, we include the response to the CDP as an explanatory variable and as a proxy for corporate carbon awareness. Finally, we consider the potential problem of endogeneity in the relationship between incentives and emissions.

Gopalan et al. (2014) provided empirical evidence that compensation duration is related to the time horizon of managers' decisions: the longer the compensation duration, the better the firm long-term indicators. Hence, non-fixed compensation linked to long-term performance could effectively motivate sustainability goals.

Regarding the temporally paradoxical relation between monetary incentives to executives and environmental performance, Cordeiro and Sarkis (2008) conducted an exploratory analysis of 207 American companies in 1996. Their results showed a significant relationship only in companies that explicitly reported providing such incentives. Unlike this research, the authors analyzed executive compensation as a dependent variable, where the emission index was an explanatory variable. However, this implicitly emphasizes the potential endogeneity problem in the analyzed relationship.

Haque and Ntim (2020) analyzed 494 European countries from 2002 to 2016. The results indicated that executive compensation positively affects long-term carbon performance but found no effect on contemporary carbon performance. In addition, there was a positive association between carbon performance and market value. Our research differs from that of Haque and Ntim (2020) since the authors tested hypotheses in two different scenarios in which there were companies with compensation explicitly oriented to carbon performance and others that were not. However, even though they did not find a significant relationship between companies with non-oriented compensation and carbon emissions, the authors hypothesized a possible direct relationship. Therefore, we sought to test this relationship with the instruments we have for Brazil.

Considering the potential problem of endogeneity in the relationship between monetary incentives and carbon performance, our model extends the methodological and theoretical approach conducted by Cordeiro and Sarkis (2008) for US companies and follows the methodological approach of Haque and Ntim (2020) for European countries.

We consider a longitudinal research strategy through panel data GMM-SYS to analyze the proposed relationship taking into account the potential endogeneity problems given that monetary incentives can influence the achievement of better carbon performances and that companies most concerned with reducing their emissions also can better remunerate their executives for meeting sustainability goals.

Additionally, different from the previous research, we use GEE emissions in tons in relation to the net operating revenue of each firm. We intend to consider how each firm depends on GHG emissions to operate. This ratio can offer a closer look at each firm emissions dependency. Cordeiro and Sarkis (2008) emphasized that the proxy they used for emissions was an important limitation of their findings.

Based on this debate exposed, the influence of monetary incentives on carbon performance is yet to be clarified in the literature. However, as organizational performance is due to both exogenous and endogenous factors (individual performance), the agent's choice of actions will be due to its motivation, considering that it acts rationally to maximize its utility.

Therefore, our three research hypotheses are grounded on the agency theory, since executive compensation would act as an incentive mechanism capable of aligning interests within companies (Cordeiro & Sarkis, 2008; Guimarães, Peixoto & Carvalho, 2017; Aguiar & Pimentel, 2017). Thus, monetary incentives can serve as a stimulus for achieving short- and long-term goals, influencing companies' sustainable practices, such as reducing emissions.

When it comes to Brazilian companies, there is no detailed data on the relationship between executive compensation contracts and possible targets for reductions in carbon emissions or others involving the environmental dimension. However, through other communication channels such as Institutional Reports, the CDP and/or ISE questionnaires, Brazilian companies (that disclose or choose to answer them) say that they financially encourage their executives to meet environmental sustainability targets.

Cruz et al.'s (2017) findings reinforce our arguments. They conducted a content analysis on ISE

company questionnaires from 2011 to 2014 (for most companies in our sample). They found that most ISE companies say that they provide monetary incentives to high-level employees for achieving sustainability goals, such as reducing emissions.

Objectively, we have the following context: it is not known which part of the compensation (fixed, non-fixed, or both) is linked to the contract signed between the companies and their executives regarding the fulfillment of emission reduction targets. However, it is known that such incentives exist. Thus, we want to test whether, in Brazil, there is an inversely proportional relationship between total compensation and emissions reductions.

In line with this assumption and based on the literature, executives' motivation to achieve their short- and long-term sustainability goals would occur to the extent that there are clauses in their employment contracts linked to these goals achievement as part of their job duties. (Cordeiro & Sarkis, 2008; Eccles et al., 2012; Haque & Ntim, 2020). Thus, we propose our first research hypothesis:

H1: There is a negative relationship between monetary incentives (total compensation) and carbon emissions in Brazilian companies.

We now consider the possibility that the companies in our sample believe that variable financial incentives would be a more efficient and faster way to stimulate their executives to achieve the stipulated sustainability targets. In other words, the executive would only be entitled to non-fixed compensation if he or she met the stipulated targets.

This idea is supported in the literature from countries where this practice is the most common (Freeman et al., 2004; Jamali, 2008; Alvarez, 2012; Gopalan et al., 2014; Haque & Ntim, 2020). Thus, this type of monetary incentive would be more effective in encouraging executives to meet sustainability and emissions reduction targets (Guimarães, Peixoto & Carvalho, 2017).

In this sense, our second hypothesis seeks to deepen the understanding of the specific role of non-fixed monetary incentives in the carbon performance of firms in Brazil. Previous research in Brazil has shown that some large Brazilian companies are quite committed to achieving sustainability goals despite the ineffectiveness of environmental regulation and the long-term horizon (Marcovitch, 2014; Marcon et al., 2017; Prates et al., 2022). Thus, it is pressing to test a second hypothesis:

H2: There is a negative relationship between non-fixed compensation and carbon emissions in Brazilian companies.

The third hypothesis considers, in addition to the aspects already presented, the peculiarity of the Brazilian scenario regarding executive compensation. In this scenario, the incentive is granted mainly through fixed remuneration. Hypothetically, Brazilian companies consider it sufficient to pay their executives predominantly fixed salaries, and this would motivate them to fulfill the company's goals as part of their executives' daily duties.

From this perspective, meeting the emissions reduction targets is only one of many activities stipulated in the employment contract. The executive would be compensated for all these activities in aggregate and would not necessarily earn extra if he fulfilled his daily activities.

In this case, executives would not participate in sharing business risks (such as image and reputation risks due to poor environmental performance) with the company and shareholders. However, executives would only be interested in achieving emissions reduction targets, if they had compensation geared toward meeting sustainability targets or with the imminent risk of losing their jobs (Cordeiro & Sarkis, 2008; Haque & Ntim, 2020).

In this sense, the third hypothesis seeks to understand whether fixed incentives, in particular, could stimulate executives to achieve emissions reduction targets. This evidence could reveal indications of the possibility of pre-directed contracts for meeting these targets:

H3: There is a negative relationship between fixed compensation and carbon emissions in Brazilian companies.

3 Methodological Procedures

To investigate whether there is any influence of monetary incentives to executives on carbon performance in Brazilian companies sampled we adopted a longitudinal analysis strategy that covers a time horizon of eight years. Additionally, for the empirical analyses, we perform estimations using GMM-SYS panel data regressions.

We consider it the adequate strategy for solving our research problem, once it analyzes the sample individuals over time, considering their variations, and heterogeneity, and controlling for potential endogeneity problems (Hill et al., 2021). It is exploratory research as the phenomenon investigated still needs addressing. In addition, it is also descriptive and empirical research with a quantitative approach (Saunders, Lewis, & Thornhill, 2016).

3.1 Sample data

The sample contains 31 companies from various sectors, listed on the B3 (Brazilian Stock Exchange) and that had executive compensation and GHG emissions inventory data available jointly. Thus, the period analyzed was from 2012 to 2019 because it contains the largest availability of data available for the analysis - Brazilian GHG Protocol Program - FGV (2021).

The GHG Protocol is a program developed by the World Resources Institute (WRI) in partnership with the World Business Council for Sustainable Development (WBSCD) and adapted to the national context to provide a way to produce an inventory of carbon emissions (GHG). It is about conducting emission inventories, with defined goals and deadlines, aiming at the continuous improvement of GHG reduction actions.

The sample also has 12 from 17 sectors with the highest environmental impact, according to Arent et al. (2015) classification. The representativeness of each segment in the final sample is described in percentages in Table 1.

Table 1
Final sample data by sector segment from 2012 to 2019

Segment	Company	Number of companies
Water and Sanitation	Sanepar	01
Processed foods	JBS / BRF	02
Cyclical Consumption - Trade	Lojas Americanas / Lojas Renner / Natura	03
Non-cyclical consumption - Trade	Cia Brasileira de Distribuição	01
Construction	MRV	01
Electric Energy	EDP Energias do Brasil / Furnas Centrais elétricas / CPFL Energia / Cemig / AES Brasil / CESP	06
Processing Industry - Machinery	Whirlpool	01
Mining	Vale	01
Oil, Gas and Biofuels	Petrobras / Ultrapar / Raizen Energia	03
Paper and Pulp	Fibria / Klabin / Suzano	03
Chemicals and Petrochemicals	Braskem	01
Health	Hypera / Fleury	02
Telecommunications	Telefônica Brasil / Tim / Oi	03
Transport	VRG Linhas Aéreas / Ecorodovias / CCR	03
Total companies		31

Source: Authors' elaboration (2021)

The largest most expressive participation in the sample comes from the Electric Power sector (19.4%). On the other hand, Cyclical Trade, Pulp and Paper, Telecommunications, Transportation and Oil, Gas, and Biofuels segments participate with 9.7% each in the total sample. The remaining 32% includes Processed Food (6.45%), Health (6.44%), Non-Cyclical Trade (3.2%), Water and Sanitation (3.2%), Construction (3.2%), Manufacturing (3.2%), Mining (3.2%), and Chemicals and Petrochemicals (3.2%).

3.2 Variables and period of analysis

The research data were extracted from secondary, public, and digital sources. The annual executive remuneration data were collected from item 13.2 of the Reference Form from each company on the Securities and Exchange Commission of Brazil – CVM (2021) website. In addition, we hand-collected annual data on GHG emissions by emission scopes: 1, 2, and 3 from the platform developed by the Brazilian GHG Protocol Program (FGV, 2021).

We also collected data from CDP respondent companies directly from the program's platform (CDP, 2020), using the filter by country, year, and theme: "Climate Change." Finally, we collected Total Assets, Market to Book (MKB), and ROA (Return on assets) financial data from the Economática® database (Economática, 2021).

We conducted a documental analysis, reading management reports, reference forms, and questionnaires from the ISE and CDP of all the companies in the sample. The purpose was to identify whether the companies reported offered any incentives to executives for meeting sustainability and carbon reduction targets. We verified that although they report commitment to sustainability and climate change targets, details such as percentages or specific GHG emission reduction targets are not yet disclosed.

The research covers eight years presenting the greatest availability of CO₂ emission data on the FGV platform. Even so, we noticed the absence of emissions data for some companies such as Petrobras (with missing information from 2012 to 2015), Hypera (with no information from 2012 to 2014), MRV, and VALE (with missing information for 2012 and 2017).

In addition, all executive compensation, total assets, and net operating revenues were updated to the

2019 price level by the IPCA (Extended Consumer Price Index) to minimize temporal influences on the quantitative data collected.

Firms that did not report the total number of scopes were also automatically disregarded from the initial database (31 companies * 8 years = 248 observations). Ultimately, we reached a small and unbalanced panel data with 180 observations.

Due to the exploratory nature of this research, we identified the variables that would be appropriate for the proposed empirical analysis. Table 2 shows the variables we used and some of the related studies that contributed in some way to this research.

The dependent variable is Dcarb, measured in tons of GHG emissions relative to net operating revenue; it is used as a proxy for firm carbon intensity. Following previous literature, it can indicate how much a firm's business model depends on GHG emissions. Thus, relative GHG emissions allow comparing the relative carbon performance and carbon exposure of firms of different sizes and industries (Jung, Herbohn & Clarkson (2014). The second variable is the Dcarb lagged one year. We expect its relationship with Dcarb to be positive, according to Haque and Ntim's (2020) findings.

As monetary incentive variables, we used three measures of executive compensation: the fixed compensation natural logarithm (Rfmed), non-fixed compensation (RNF), and total compensation (RT). The expected relationship is negative for RNF and RT and can contribute to emission reductions (Haque & Ntim, 2020).

For Rfmed, we also expect a negative relationship since the investigated companies claim to provide incentives for meeting environmental targets (Guimarães, Peixoto & Carvalho, 2017). Thus, even if the remuneration of Brazilian executives used to be mainly through fixed remuneration, it is acceptable that sustainability targets may be embedded in these fixed remunerations (Dalmácio et al., 2009; Anjos, 2016).

Table 2

Research Variables and expected relationship as a function of carbon performance

Variable	Description	Revised Literature	Expected Relationship
Dcarb _{it}	Total carbon emissions per net operating revenue at the end of the fiscal year of firm i in year t. (in thousands of tons per year; per millions of reais)	King and Lenox (2001); Eccles et al. (2012); Matsumura et al. (2014); Griffin et al. (2017); Lewandowski (2017); Haque & Ntim (2020)	Not applicable
Dcarb _{i,t-1}	Total carbon emissions per net operating revenue at the end of the previous year of firm i in year t-1 (measured by thousands of tons per year; per millions of reais)	Matsumura et al. (2014); Lewandowski (2017); Haque & Ntim (2020)	Positive
Rfmed _{it}	Average annual fixed remuneration of the statutory management of firm i in year t. (per millions of reais)	Eccles et al. (2012); Vasconcelos & Monte (2013); Gopalan et al. (2014); Anjos (2016); Haque & Ntim (2020)	Negative
RNF _{it}	Average annual non-fixed remuneration of the statutory management of firm i in year t. (per millions of reais)	Eccles et al. (2012); Vasconcelos and Monte (2013); Gopalan et al. (2014); Anjos (2016); Aguiar and Pimentel (2017); Haque & Ntim (2020)	Negative
RT _{it}	The average annual remuneration of the statutory board of management of firm i in year t (per millions of reais)	Anjos (2016); Aguiar and Pimentel (2017); Haque & Ntim (2020)	Negative
CDP _{it}	Carbon Awareness: dummy variable that assumes equal to 1 if a company i answered the CDP in year t, and zero otherwise.	He, Tang & Wang (2013); Jung, Herbohn & Clarkson (2014); Griffin et al. (2017)	Negative
ROA _{it}	100 x Profit before financial expenses and income tax plus depreciation and amortization per total assets at the end of the fiscal year of firm i in year t.	Haque & Ntim (2020)	Positive
MKB _{it}	100 x Market value (the number of shares outstanding multiplied by the company's price per common share) divided by (company's equity) at the end of the fiscal year in year t.	Haque & Ntim (2020)	Negative
Total_Assets _{it}	Firm size (firm's total assets) at the end of the fiscal year of firm i in year t (in millions of reais).	Eccles et al. (2012); Alvarez (2012), Matsumura et al. (2014); Haque & Ntim (2020)	Positive

Source: Authors' elaboration (2021).

The dichotomous variable CDP intends to capture companies' awareness of the risks associated with carbon emissions. In this sense, a company that decides to answer the CDP questionnaire signals to

the market a greater awareness of the risks and business opportunities arising from carbon emissions and climate change (He et al., 2013; Jung et al., 2014). Thus, the expected relationship for this variable concerning Dcarb is negative.

The analysis also counts on control variables, such as ROA, MKB, and Total Assets, from 2012 to 2019. At this point, we emphasize that our sample consists of big companies from different sectors with relevant environmental impacts.

The Market-to-book (MKB) is a proxy for a firm's growth opportunity. Thus, the more expressive the growth opportunity, the greater the need to improve firms' environmental performance to obtain resources. Therefore, we expect a negative relationship between this variable with carbon performance (Dhaliwal et al., 2011).

The total assets and ROA variables, used in previous studies to control for company size (production capacity) and profitability, are expected to interact positively with emissions (Haque & Ntim, 2020). Table 3 shows the variable's descriptive statistics.

Table 3
Summary data

Variable	Obs	Mean	Std. Dev.	CV	Median	Min	Max
Ano	235	2016	2.30	0.00	2016	2012	2019
Dcarb _t	180	0.09	0.15	1.56	0.02	0.00	0.72
DCarb _{t-1}	161	0.10	0.15	1.55	0.02	0.00	0.72
Rfmed	233	2,087,474	1,450,924	0.70	1,754,713	297,951.95	9,415,327
RNF	233	2,945,459	3,318,432	1.13	2,297,191	-	23,328,038
RT	233	5,032,933	4,337,752	0.86	4,046,033	549,132.03	28,875,596
ROA	233	12.30	5.04	0.41	11.86	1.10	30.69
MKB	233	2.92	3.17	1.09	1.71	0.11	19.92
Total_Assets	233	80,710,480	182,069,413	2.26	31,195,472	3,348,559	
CDP	233	0.65	0.48	0.74	1	0	R\$ 1.00

Note. CV: coefficient of variance. For variables definitions see Table 2.

The variable DCarb ranges from almost 0.00 thousand tons per year per million reais to 0.72. The companies that presented values closer to 0.72 are the ones that pollute the most per unit of net operational revenue. This variable hardly varied from year to year in most companies showing that any temporal effects are small. The effect of individual companies is much more relevant since the sample contains highly polluting companies and companies that pollute comparatively much less. Regarding inter-firm oscillations, this effect was readily incorporated into the estimated models.

Due to the considerable heterogeneity among the sample companies, we control for the high dispersion in the executive's compensation and total assets variables by estimating models with the natural logarithm of these variables. Return on Assets (ROA), expressed in relative percentage form, showed values from 1.10% to 30.69% profitability and the total earning capacity of assets within an organization.

Regarding the MKB, the data information shows that, on average, the company's market-to-book is greater than 2.92 times the value recorded in its equity. It is also worth mentioning the CDP variable which, when stratified by years, suffered an increase in the mean number of responding companies over the years. In 2012, for example, only 06 companies (24% of the total) responded to the CDP. In 2019, that figure jumped to 25 companies or 81%.

3.3 Generalized method of moments (GMM)

The methodology applied in this study consisted of estimating three different econometric models using a systemic GMM (GMM-SYS) proposed by Blundell and Bond (1998). Blundell and Bond's (1998) model is an improvement of Arellano and Bond's (1991) version of GMM differences (GMM-Diff). Moreover, it incorporates the assumption that the first differences of the instrumental variables are uncorrelated with the errors. This additional restriction allows more instrumental variables to be included, consequently improving the estimation efficiency.

Another feature of these estimators is that GMM-SYS uses moment conditions to estimate the parameters consistently and efficiently in one or two steps. The two stages estimator is asymptotically more efficient than the one stage. So, in this work, we choose the panel estimation by two stages of the GMM-Sys approach. Furthermore, we also applied the correction proposed by Windmeijer (2005) to the variance matrix to treat heteroscedasticity and properly obtain corrected estimates of standard errors, even in finite samples.

Thus, we built a data panel to serve as a basis for estimating our three econometric models:

$$DCarb_{it} = \delta_0 + \delta_1 DCarb_{i,t-1} + \delta_2 Ln(Rfmed_{it}) + \delta_3 ROA_{it} + \delta_4 MKB_{it} + \delta_5 Ln(Total_Assets_{it}) + \delta_6 CDP_{it} + \varepsilon_{it} \tag{1}$$

$$DCarb_{it} = \delta_0 + \delta_1 DCarb_{i,t-1} + \delta_2 Ln(RNF_{it}) + \delta_3 ROA_{it} + \delta_4 MKB_{it} + \delta_5 Ln(Total_Assets_{it}) + \delta_6 CDP_{it} + \varepsilon_{it} \tag{2}$$

$$DCarb_{it} = \delta_0 + \delta_1 DCarb_{i,t-1} + \delta_2 Ln(RT_{it}) + \delta_3 ROA_{it} + \delta_4 MKB_{it} + \delta_5 Ln(Total_Assets_{it}) + \delta_6 CDP_{it} + \varepsilon_{it} \tag{3}$$

Among the independent variables (Table 2), no one showed high linear correlations (Table 4). So, there is no multicollinearity. We considered the dependent variable lagged at one year and the executive's remuneration of each model as endogenous, i.e., they are correlated with the error in each of the following models, so they were chosen to be the instrumental variables.

Table 4
Matrix of linear correlations between the explanatory variables

Variable	DCarb _{t-1}	Rfmed	RNF	RT	ROA	MKB	Total_Assets	CDP
DCarb _{t-1}	1.00							
Ln(Rfmed)	-0.33	1.00						
Ln(RNF)	-0.29	0.59	1.00					
Ln(RT)	-0.30	0.85	0.86	1.00				
ROA	0.04	-0.04	0.17	0.14	1.00			
MKB	-0.10	0.15	0.34	0.29	0.50	1.00		
Ln(Total_Assets)	0.09	0.43	0.24	0.32	-0.24	-0.26	1.00	
CDP	-0.04	0.18	0.19	0.09	0.12	0.26	0.17	1.00

Note. For variables definitions see Table 2.

4 Result Analysis and Discussion

Before showing our results, we must emphasize that we applied several tests to check whether our methodology is robust and the best choice for our analysis.

First, for the estimates to be consistent, there must be strict exogeneity of the regressors, so we apply the first Wooldridge difference test to our three models. The null hypothesis is that there is no serial correlation in the Fixed Effect (FE) model errors, implying that the regressors are strictly exogenous. If the null hypothesis is rejected, one can conclude that the GMM model is better than the FE. Since the null hypothesis was rejected with less than 0.05 significance in all three models, we can infer that the GMM model is more appropriate than the FE model because it handles the problem of independent endogenous variables well.

Second, we must show that among the possible GMM methods, the GMM-SYS is the appropriate approach. This method considers the endogeneity problems, does not depend on external instruments, and explains the dynamic relationship by including the lags of dependent variables as regressors. In addition, the estimators have lower bias and higher efficiency than others. In this sense, GMM-SYS allows more instrumental variables to be introduced than other GMM estimators, the variables are valid instruments, and the error is not serially correlated (Hill et al., 2021).

However, to identify whether GMM-SYS was eligible, we applied the Fisher test of panel data. This test is used to check whether series are stationary, which has the null hypothesis that all panels contain a unit root. The alternative hypothesis is that at least one panel is stationary. Since the condition of the systemic GMM is that the series is stationary, we expect to reject Ho from the unit root test. Therefore, we applied the Fisher test for all regressors and rejected Ho. After that, we use the GMM-SYS approach in the 2-stage version, with the Windmeijer (2005) correction, which aims to reduce bias problems in calculating standard errors in finite samples.

Once the best approach was chosen, Table (5) presents all three estimated models. We observe that the amount of carbon emitted in t-1 is positive and directly proportional to year t, with less than 1% statistical significance. This result highlights the significant persistence of this variable over time. It allows us

to conclude that the carbon performance currently evidenced by firms is significantly and positively influenced by their past emissions (in this case, by the previous year), corroborating the conclusions of Haque and Ntim (2020). This evidence means that the higher the carbon emission in the previous year (t-1), the higher the emission will be in the following year (t). In all three estimations, the sign remained positive, as expected.

Table 5

Carbon Performance Sensitivity to Contemporary Executive Compensation - 2012 to 2019

Independent Variables	MODEL 1	MODEL 2	MODEL 3
DCarb _{t-1}	0.9300225*** (0.0436402)	0.4160215*** (0.1211149)	0.9429092*** (0.0529359)
Ln(Rfmed)	-0.0343472** (0.0127493)	-	-
Ln(RNF)	-	-0.0213614*** (0.0071182)	-
Ln(RT)	-	-	-0.0235395** (0.010252)
ROA	0.0048174** (0.0017463)	0.0031255 (0.0030231)	0.0028899** (0.0013684)
MKB	-0.0018069 (0.0017683)	-0.0013322 (0.0056444)	0.0007904 (0.0024724)
Ln(Total_Assets)	0.0148968*** (0.0050335)	0.0267127 (0.0224739)	0.0119559** (0.0059211)
CDP	-0.0062497 (0.0105887)	-0.00789 (0.202871)	-0.0051318 (0.0065925)
VIF maximum	1,43	1.45	1.47
F (6, 27)	463.08***	19.49***	140.96***
Ar(1)	-1,42 (0.156)	-1.53 (0.126)	-1.42 (0.155)
Ar(2)	-0.88 (0.377)	-0.63 (0.529)	-0.76 (0.448)
Hansen's J	4.09 (8; 0.849)	21.92 (25; 0.640)	25.43 (31; 0.748)
DIFF-Hansen	2.24 (4; 0.692)	1.46 (4; 0.833)	2.20 (4; 0.700)
N. of Observations	180	180	180
N. of Groups	28	28	28
N. of Instruments	15	32	38

Notes: Robust standards errors in brackets. ***p<0.01, **p<0.05, *p<0.1. Standard errors were obtained using data pooled by a firm, in a manner robust to any forms of heteroscedasticity and/or autocorrelation. Values greater than 10 for the variance inflation factor (VIF) statistic indicate multicollinearity problems in the regressors. Hansen's J-statistic test is a robust version of Sargan's overidentification test. The Ar (1) and Ar (2) statistics refer to the first and second-order autocorrelation tests. For the autocorrelation tests, the test statistics Ar (1) and Ar (2) are reported and, in brackets, the corresponding observed significance level. For the Hansen and DIFF-Hansen test, the test statistic and, in parentheses, the number of degrees of freedom and its observed significance level, respectively, are reported. We use the routine `xtabond2` in STATA 13 software to perform the GMM-Sys estimations and necessary tests.

The results also show that fixed, non-fixed, and total compensation seems to influence the companies' carbon performance, in all models. Moreover, the relationship is negative and significant (at significance levels lesser than 5%), meaning that the higher the compensation, the lower the total carbon emission and, therefore, the better the firms' carbon performance (Freeman et al., 2004; Jamali, 2008).

Overall, the three forms of compensation show that monetary incentives could have been used effectively to reduce carbon emissions in the analyzed companies. This result partially corroborates the findings of Haque and Ntim (2020). One might think that rather than implementing substantial carbon reduction initiatives linked to the production process that requires more resources but significantly improves carbon performance, companies may be opting for motivating environmental management, seeking to increase their efficiency in the eyes of stakeholders and improving their carbon performance.

However, our results are divergent from Eccles et al. (2012), in which monetary incentives were ineffective in motivating executives. The divergences may be due to two main reasons: i) analysis period. Fixed remuneration was a significant portion of total executive compensation in Brazil in the period investigated by Eccles (2012) (from 2007-2010). However, our descriptive statistics showed that executive compensation is no longer focused on the fixed portion; ii) the author's sample included a small portion of Brazilian companies (less than 4%). In our research sample with data from Brazil, the phenomenon deepens further.

The MKB and CDP control variables were not statistically significant in any of the proposed models. In this sense, it may not be relevant in influencing the carbon performance of the analyzed companies. The

ROA variable, on the other hand, was significant in models 1 and 3 at a significance level of $p < 0.05$ and presented the expected sign (Haque & Ntim, 2020). In other words, the higher the financial performance of companies, the higher their carbon emissions will be. This fact may be due to increased production.

The firm size, measured by Total assets, proved statistically significant in models 1 and 3 ($p\text{-level} < 0.05$ in both). Additionally, the sign in both was positive, in line with what was expected, since the larger the firm, the more extensive its production capacity and the higher its emissions tend to be (Haque & Ntim, 2020).

Thus, the relationship explained by the three models regarding monetary incentives and carbon emissions could contribute to the alignment of interests between agent and principal in Brazilian companies, corroborating Hopwood et al. (2010), Delmas et al. (2015) and Haque and Ntim (2020) findings.

Therefore, we found no evidence to reject our three research hypotheses (*H1: There is a negative relationship between monetary incentives and carbon emissions in Brazilian companies; H2: There is a negative relationship between non-fixed remuneration and carbon emissions in Brazilian companies and H3: There is a negative relationship between fixed remuneration and carbon emissions in Brazilian companies*).

Concerning the diagnostic analyses to assess the robustness of the results reported at the end of Table 5, all point in favor of the identification hypotheses. The autocorrelation tests AR (1) and AR (2), which measure the first-order autocorrelations in the differences, are negative and non-significant. That is, there was no first-order autocorrelation and no 2nd-order autocorrelation after the two stages of GMM systemic estimation.

Furthermore, for the estimation, it was not possible to reject Hansen's J-test null hypothesis. That means the instruments used are not correlated with the errors and can be used in the model. The DIF-Hansen test did not reject the null hypothesis, validating the additional restrictions required by systemic GMM. Therefore, the Systemic GMM estimation is an appropriate choice for our analyses.

5 Concluding Remarks

The results show that the Brazilian companies analyzed have been providing monetary incentives to their executives to achieve emissions reduction targets, despite the need for more transparency regarding the disclosure of details of these incentives (such as percentages) in the Reference Form established by the CVM.

Our empirical analysis showed that monetary incentives could play an essential role in motivating executives to achieve sustainability goals, in this research measured by carbon performance. Furthermore, the results revealed the existence of a contemporary relationship between compensation and carbon emissions. Thus, the higher the fixed, non-fixed, or total monetary incentives, the greater the emissions reduction and the better the carbon performance.

Even though managers are evaluated based on their previous organizational management, the results for carbon performance analysis show statistical significance for the contemporary relationship between the variables of interest (remuneration and emissions performance). Therefore they can contribute to aligning interests in Brazilian firms analyzed. Besides, it makes sense once the current emissions depend directly on the emissions in the previous year, where executives were already being remunerated. However, we must reemphasize that our results are restricted to the sample investigated and cannot be generalized.

On the other hand, the fact that companies are not transparent about the incentives provided to executives may be covering up a disclosure focused on greenwashing. In this sense, the fact that the CVM does not open specific spaces for such reports in the FRs may encourage the use of a gap for socio-environmental performance management.

The discovery of a link between executives' compensation and carbon performance still leaves the question of why disclosures of these incentives are still not transparent. We speculate that it could be due to the form of disclosure required by the CVM in filling the FR until now. Managers may be concerned about litigation due to environmental violations or with sanctions from investors, including socially responsible funds. By taking advantage of this loophole in disclosure regulation, they show an environmental concern with meeting managed sustainability goals.

Alternatively, our results may suggest that compensation contracts could already include sustainability goals at the time of their establishment. In light of CVM's current requirements regarding the disclosure of compensation data (which are sensitive), there is no express requirement to disclose details of socio-environmental incentives. Thus, companies and managers can choose to keep part of their remuneration confidential without implying an infraction of regulation.

It is worth noting that CVM regulation began in 2009 and involved considerable reluctance on the part of some companies regarding the opening of managers' remuneration formulas (Prates et al., 2021), which favors the argument of keeping as much information as possible in secrecy.

The variables ROA and Total Assets showed a positive and significant relationship with emissions in models 1 and 3, so the more profitable and larger the company the higher the emissions. This relationship is expected since the productive capacity and effective production tend to be higher in these companies with this profile.

Our results can offer scientific and practical contributions. For the literature, we provide evidence of the alignment of interests between agent and principal regarding fulfilling long-term sustainability goals. Furthermore, our results extend Haque and Ntim's (2020) findings by showing a contemporary relationship between monetary incentives and emissions reductions for Brazilian companies. These findings are relevant given the heterogeneity between the European and Brazilian markets.

As for social and practical contributions, our results show that despite the current weak environmental regulation concerning emission reduction, these Brazilian companies demonstrate concern with sustainability issues, precisely climate change matters. Furthermore, our results corroborate Marcovitch (2014) by showing that private companies are acting proactively in dealing with environmental risks by using mechanisms to reduce GHG emissions through executive compensation formulas. These results are also helpful for regulators and investors concerned with environmental issues.

The main limitations of the research lie in the small sample size (31 companies) and the period of analysis (only 08 years). The delimitation of the sample occurred precisely because of the short existing period of joint data availability - of GHG emissions inventories and executive compensation. It should be noted that in Brazil, only in 2009 did information regarding executive compensation become mandatory for listed companies, and so far, it is still few and restricted. These limitations make it difficult to generalize the results. In addition, the disclosure of GHG inventories is voluntary. As a result, for some years, it was not available for some companies whose activities have a relevant impact on research, such as Petrobras.

Another important limitation of our work is that our remuneration measure does not expressly contemplate emission reduction-oriented contracts. In this sense, our result may or may not reflect the actual practice of an incentive to meet such targets. In this case, future studies may offer new insights by conducting in-depth case studies and interviews with various stakeholders (managers, shareholders, and regulators) about their views on this relationship.

It is worth highlighting that Brazilian companies still do not systematically disclose their environmental liabilities or total investments in sustainable development. This fact hinders a standardization that would allow comparison between different companies. Furthermore, the questionnaire the companies answer to be included in the ISE (B3 Sustainability Index), or the CDP is still relatively superficial. Therefore, no financial information can be extracted on the degree of environmental investment in any sustainability dimension. In this sense, our findings could also contribute to the identification of climate or carbon risks.

Perhaps, a qualitative approach, through questionnaires or structured interviews, could contribute to understanding the relationships that may or may not influence executives to achieve sustainability goals. Since it is not known, a priori, what kind of financial incentive is stipulated in the employment contracts in Brazilian companies about sustainability targets, such investigations could be elucidative enough for us to test two groups of companies: one group with companies with sustainable targets stipulated in the contracts; and another one with companies without sustainable targets stipulated in the contracts. Thus, we could have further evidence that incentives provided to executives influence carbon reductions.

We encourage future research to delve deeper into what influences companies' carbon emissions behavior. There is also a great need for more systematic research and assessments of the costs and benefits resulting from voluntary GHG reductions. Therefore, a causal analysis of the strategies used, including monetary and non-monetary incentives to achieve long-term financial and carbon performance, can be of great value in understanding this issue.

References

- Aguiar, A. B. D., & Pimentel, R. C. (2017). Remuneração de executivos e desempenho no mercado brasileiro: relações contemporâneas e defasadas. *Revista de Administração Contemporânea*, 21(4), 545-568. <https://doi.org/10.1590/1982-7849rac2017160228>
- Alvarez, I. G. (2012). Impact of CO2 emission variation on firm performance. *Business Strategy and the Environment*, 21(7), 435-454. <https://doi.org/10.1002/bse.1729>
- Anjos, L. C. M. D. (2016). *Relações entre eficiência técnica das organizações e remuneração a executivos à luz dos impactos da motivação e sensibilidade da remuneração ao desempenho*. Tese de Doutorado, UnB, UFPB, UFRN, João Pessoa, Brasil.
- Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies*, 58(2), 277-297. <https://doi.org/10.2307/2297968>
- Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of econometrics*, 68(1), 29-51. [https://doi.org/10.1016/0304-4076\(94\)01642-D](https://doi.org/10.1016/0304-4076(94)01642-D)
- Arent, D. J., Tol, R. S., Faust, E., Hella, J. P., Kumar, S., Strzepek, K. M., & Xu, H. (2015). Key economic

sectors and services. *Climate Change 2014 Impacts, Adaptation and Vulnerability: Part A: Global and Sectoral Aspects*, 659-708. <https://doi.org/10.1017/cbo9781107415379.015>

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1), 115-143 DOI: <https://doi.org/10.1920/WP.IFS.1995.9517>

Brasil. Lei nº 12.187 de 29 de dezembro de 2009. *Establishes the National Policy on Climate Change - PNMC and makes other provisions.* http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/l12187.htm

B3 (2018). Brasil, Bolsa, Balcão. http://www.b3.com.br/pt_br/market-data-e-indices/indices/indices-de-sustentabilidade/indice-carbono-eficiente-ico2.htm

CDP (2020). Carbon Disclosure Project. <https://www.cdp.net/pt>

Cordeiro, J. J., & Sarkis, J. (2008). Does explicit contracting effectively link CEO compensation to environmental performance?. *Business Strategy and the Environment*, 17(5), 304-317. <https://doi.org/10.1002/bse.621>

Cruz, T. S., Gomes, S. M. S., Oliveira, N. C., & Oliveira, N. S. (2017). Estratégias de enfrentamento às mudanças climáticas: um estudo com as empresas listadas no Índice de Sustentabilidade Empresarial da B3. *Revista de Administração da Universidade Federal de Santa Maria*, 10, 149-166. <https://doi.org/10.5902/1983465927257>

CVM (2021). Securities and Exchange Commission of Brazil. *Business Reference Form.* <https://cvmweb.cvm.gov.br/SWB/Sistemas/SCW/CPublica/CiaAb/FormBuscaCiaAb.aspx?TipoConsulta=c/>

Dhaliwal, D. S., Li, O. Z., Tsang, A., & Yang, Y. G. (2011). Voluntary nonfinancial disclosure and the cost of equity capital: The initiation of corporate social responsibility reporting. *The Accounting Review*, 86(1), 59-100. <https://doi.org/10.2308/accr.00000005>

Dalmácio, F. Z., Rezende, A. J., & Slomski, V. (2009). Análise setorial das medidas de performance utilizadas nos contratos de remuneração dos gestores. *Revista Universo Contábil*, 5(3), 6-23. <http://dx.doi.org/10.4270/ruc.20095>

Delmas, M. A., Nairn-Birch, N., & Lim, J. (2015). Dynamics of environmental and financial performance: The case of greenhouse gas emissions. *Organization & Environment*, 28(4), 374-393. <https://doi.org/10.1177/1086026615620238>

Eccles, R. G., Ioannou, I., Li, S. X., & Serafeim, G. (2012). Pay for environmental performance: The effect of incentive provision on carbon emissions. *Harvard Business School Working Paper*, No. 13-043, November 2012 <https://dash.harvard.edu/handle/1/10018989>

Economática. Financial Database. (2021). Economática, São Paulo, Brasil.

FGV. Fundação Getúlio Vargas (2021) - *GHG Protocol Brasil - Registro Público de Emissões.* <http://www.registropublicodeemissoes.com.br/>

Freeman, R. E., Wicks, A. C., & Parmar, B. (2004). Stakeholder theory and “the corporate objective revisited”. *Organization Science*, 15(3), 364-369. <https://doi.org/10.1287/orsc.1040.0066>

Gopalan, R., Milbourn, T., Song, F., & Thakor, A. V. (2014). Duration of executive compensation: Duration of executive compensation. *The Journal of Finance*, 69(6), 2777-2817. <https://doi.org/10.1111/jofi.12085>

Guimarães, T. M., Peixoto, F. M., & Carvalho, L. (2017). Sustentabilidade empresarial e governança corporativa: uma análise da relação do ISE da BM&FBOVESPA com a compensação dos gestores de empresas brasileiras. *Revista de Educação e Pesquisa em Contabilidade (repec)*, 11(2). <http://dx.doi.org/10.17524/repec.v11i2.1418>

Griffin, P.A., Lont, D.H. and Sun, E.Y. (2017), “The Relevance to Investors of Greenhouse Gas Emission Disclosures”, *Contemporary Accounting Research*, 34(2), . 1265-1297. <https://doi.org/10.1111/1911->

[3846.12298](#)

- Haque, F., & Ntim, C. G. (2020). Executive compensation, sustainable compensation policy, carbon performance, and market value. *British Journal of Management*, 31(3), 525-546. <https://doi.org/10.1111/1467-8551.12395>
- He, Y., Tang, Q., & Wang, K. (2013). Carbon disclosure, carbon performance, and cost of capital. *China Journal of Accounting Studies*, 1(3-4), 190-220. <https://doi.org/10.1080/21697221.2014.855976>
- Hill, A. D., Johnson, S. G., Greco, L. M., O'Boyle, E. H., & Walter, S. L. (2021). Endogeneity: A review and agenda for the methodology-practice divide affecting micro and macro research. *Journal of Management*, 47(1), 105-143. <https://doi.org/10.1177/0149206320960533>
- Hoffman, A. J. (2005). Climate change strategy: The business logic behind voluntary greenhouse gas reductions. *California Management Review*, 47(3), 21-46. <https://doi.org/10.2307/41166305>
- Hopwood, A. G., Unerman, J., & Fries, J. (Orgs.). (2010). *Accounting for sustainability: Practical insights*. London; Washington, DC: Earthscan.
- Jamali, D. (2008). A stakeholder approach to corporate social responsibility: A fresh perspective into theory and practice. *Journal of Business Ethics*, 82(1), 213-231. <https://doi.org/10.1007/s10551-007-9572-4>
- Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs, and ownership structure. *Journal of Financial Economics*, 3(4), 305-360. [https://doi.org/10.1016/0304-405X\(76\)90026-X](https://doi.org/10.1016/0304-405X(76)90026-X)
- Jung, J., Herbohn, K., & Clarkson, P. (2014). The impact of a firm's carbon risk profile on the cost of debt capital: Evidence from Australian firms. *University of Queensland*. <https://doi.org/10.1007/s10551-016-3207-6>
- King, A. A., & Lenox, M. J. (2001). Does it really pay to be green? An empirical study of firm environmental and financial performance: an empirical study of firm environmental and financial performance. *Journal of Industrial Ecology*, 5(1), 105-116. <https://doi.org/10.1162/108819801753358526>
- Lewandowski, S. (2017). Corporate carbon and financial performance: The role of emission reductions: corporate carbon and financial performance. *Business Strategy and the Environment*, 26(8), 1196-1211. <https://doi.org/10.1002/bse.1978>
- Marcon, A., de Medeiros, J. F., & Ribeiro, J. L. D. (2017). Innovation and environmentally sustainable economy: Identifying the best practices developed by multinationals in Brazil. *Journal of Cleaner Production*, 160, 83-97. <https://doi.org/10.1016/j.jclepro.2017.02.101>
- Marcovitch, J. (2014). *As empresas e a legislação verde no Brasil. A Redução de Emissões de Gases de Efeito Estufa e a Legislação Brasileira*, 2.
- Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2014). Firm-value effects of carbon emissions and carbon disclosures. *The Accounting Review*, 89(2), 695-724. <https://doi.org/10.2308/accr-50629>
- Prates, J. C. R. (2019). *Desempenho de carbono e remuneração de executivos: evidências sobre o mercado brasileiro*. Dissertação de Mestrado em Ciências Contábeis, Universidade Federal de Pernambuco. Recife, Brasil.
- Prates, J. C. R., Porto, W. S., de Freitas, M. A. L., & dos Anjos, L. C. M. (2021). Reações do mercado acionário frente à regulação da remuneração dos executivos: Uma investigação sobre o setor bancário nacional e internacional listado na [b] 3. *Revista Eletrônica de Negócios Internacionais: Internext*, 16(3), 252-270. <https://doi.org/10.18568/internext.v16i3.609>
- Prates, J. C. R., Magalhães, A. S., Prates, T. M., & Avelino, B. C. (2022). How Different and How Alike? Cluster Analysis Applied to Greenhouse Gas Emissions Inventory Data from Companies Listed on the Brazilian Stock Exchange. *Environmental and Social Management Journal*, 16(2), e02924-e02924. <https://doi.org/10.24857/rgsa.v16n2-005>

- Ritz, R. (2020). Climate targets, executive compensation, and corporate strategy. *Cambridge Working Papers in Economics 2098*, Faculty of Economics, University of Cambridge. <https://doi.org/10.17863/CAM.62311>
- Saka, C., & Oshika, T. (2014). Disclosure effects, carbon emissions and corporate value. *Sustainability Accounting, Management and Policy Journal*, 5(1), 22-45. <https://doi.org/10.1108/SAMPJ-09-2012-0030>
- Saunders, M., Lewis, P., & Thornhill, A. (2016). *Research methods for business students*. Pearson education.
- Vasconcelos, A. F., & do Monte, P. A. (2013). A remuneração de executivos e o desempenho financeiro das empresas brasileiras. *Registro Contábil*, 4(1), 1-18.
- Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics*, 126(1), 25-51. <https://doi.org/10.1016/j.jeconom.2004.02.005>

NOTES

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Conception and preparation of the manuscript: J. C. R. Prates, A. M. R. Cabral

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DATASET

The dataset that supports the results of this study is not publicly available.

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CONSENT TO USE IMAGE

Does not apply.

APPROVAL OF THE RESEARCH ETHICS COMMITTEE

Does not apply.

CONFLICT OF INTERESTS

Does not apply.

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ⁱ For Brazil, Federal Law No. 12.187 encourages the voluntary reduction of GEE emissions until the year 2020 with the institution of the inventory of GEE emissions, as an operating system of the National Policy on Climate Change (PNMC) (Brasil, 2009).