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### ► To cite this version:

Emmanuelle Fromont, Thi Le Hoa Vo, Gulliver Lux. Investors' valuation of corporate CO2 emissions: the impact of the COVID-19 crisis. *Bankers, Markets and Investors*, 2023, 172-173 March-June 2023, pp.15-22. hal-04139934

**HAL Id: hal-04139934**

**<https://hal.science/hal-04139934v1>**

Submitted on 23 Jun 2023

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**Investors' valuation of corporate CO2 emissions: the impact of the COVID-19 crisis**

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# **Investors' valuation of corporate CO2 emissions: the impact of the COVID-19 crisis**

## **Abstract**

This study examines the impact of the COVID-19 crisis on the valuation of CO2 emissions by investors. Using the sample constituted by large French companies (SBF 120) having published their carbon emissions from 2016 to 2021, we show that investors are sensitive to firms' carbon emissions and value them negatively over the period. The results nevertheless highlight that the relationship is non-linear and would depend on their carbon footprint. We also demonstrate that under the pressure of the COVID-19 crisis, investors penalize more heavily high polluting firms while their valuation of low polluting firms does not seem to be impacted by the crisis. Therefore, our findings suggest that it is important for firms, especially high-emitting firms, to continue to reduce their carbon emissions in order to earn and maintain investors' confidence after the crisis. Our managerial contribution emphasizes the confirmation that the COVID-19 shock could be a good opportunity for both firm and investor to pursue their clean technologies development and investment to deal with climate change. Furthermore, regarding this last point, our results also invite reflection on the nature of political action in the area of environmental preservation by companies, particularly concerning the role of individuals' eco-anxiety on their expectations of companies' environmental behavior.

## **Keywords**

COVID-19 crisis, CO2 emissions, investors' valuation, activity sector, polluting firm.

### 1. Introduction

Worldwide CO2 emissions have been steadily increasing since the beginning of the industrial era (IPCC, 2022) with the exception of certain periods of crisis (e.g., financial crisis in 2008 and COVID-19 crisis in 2020 and 2021). During the COVID-19 period, countries took measures to curb the spread of the virus that resulted in the sudden cessation of a significant amount of economic activity (Nguyen and al., 2021), leading to a decrease in energy consumption (Smith et al., 2021) particularly related to industrial and manufacturing activities, but also to transportation (McKibbin and Fernando 2020). Nguyen and al., (2021) report that “the first quarter of 2020 experienced a 3.8% (150 Mtoe) drop in global energy demand leading

to an over 5% (−341.4 Mt CO<sub>2</sub>) decline in CO<sub>2</sub> emissions relative to the first quarter of 2019 (...). The decreases in CO<sub>2</sub> emissions from the power sector varied among major countries and regions. Specifically, larger decreases were seen in the U.S. (7.6%, 66.3 Mt CO<sub>2</sub>), India (12.7%, 83.6 Mt CO<sub>2</sub>), and EU27 & UK (19.3%, 98.5 Mt CO<sub>2</sub>) compared to smaller changes observed in China (1.4%, 31.3 Mt CO<sub>2</sub>)". More generally, Liu Z. and al. (2020), report a global decrease of 7.8% in CO<sub>2</sub> emissions in the first quarter of 2020 (compared to 2019) due to the decrease in fossil fuel consumption. For the same period, the decrease is estimated at 12.1% in Europe (Andreoni 2021). Despite these positive results to fight against global warming, the corporate emission reductions still appear to be very low compared to the 70% emission reduction target set by the IPCC 2022 to keep the rise in temperature to 1.5 degrees by 2050. Consequently, the efforts to be made by companies in view of their weight in global emissions, remain still significant, especially since the covid-19 crisis did not favor the reduction of our reliance on fossil fuels because of decreases in clean energy investment due to economic slowdown.

Nowadays, companies have to endeavor to align their activities with stakeholders' expectations, regulatory requirements and public pressure regarding pollution reduction. This can be supported by the theory of legitimacy, suggesting that the environmental commitments of companies enable to legitimize the activities and ensure their development when they meet the expectations of stakeholders and society (Ren et al. 2020). In this context, disclosures of carbon emissions information and their effect on financial performance of companies remain of particular interest. Many scholars have investigated the associations between corporate greenhouse gas emissions and the market value of companies during periods of economic and financial stability. Several studies suggest that, in this context, investors tend to penalize CO<sub>2</sub> emissions produced by companies with a more pronounced effect on the largest CO<sub>2</sub> emitters (Aggarwal and Dow 2015; Clarkson and al. 2015). Shareholders reward companies with an ethical behavior by profiting from positive effects on their reputation and their financial performance over the long run (Aggarwal and Dow, 2015). However, the evaluation of environmental risk could have changed with the COVID-19 crisis (Ferreruela and Mallor, 2021) since the pandemic has led to an increase in CSR considerations of society and governments (Bae and al. 2021). Bortolotti and Fotak (2020) states that, although investors tend to focus more on day-to-day cash management issues than innovation funding in the short term, economic shocks would influence positively their demand for advanced technologies and green investments over the long term.

Therefore, the objective of this study is to investigate the impact of the COVID-19 crisis on investors' valuation of CO<sub>2</sub> emissions. Particularly, we aim to address two main questions: (1)

Do investors consider information on carbon emissions published by companies in their valuation? (2) Did the COVID-19 crisis influence this valuation? To answer these questions, we estimated the effect of Scopes 1 and 2 published by large French companies on their financial performance (measured by Tobin's Q) from 2016 to 2021, the period including the COVID-19 crisis (N = 546). To assess how a high environmental risk associated with the largest emitters can influence our results, the estimations are implemented by differentiating firms according to their degree of pollution.

Our study highlights two main results. First, we find that investors sanction corporate carbon emissions, particularly high polluting firms, suggesting that this information is useful to refine their estimate of a firm's future cash flows. Furthermore, our results show that the COVID-19 crisis has amplified the negative effect of CO<sub>2</sub> emissions on financial performance of companies. While participating knowledge on investors' sensitivity to corporate environmental information, this research contributes to the literature on investors' behavior in a context of crisis, suggesting that they tend to change the way they value available environmental information when uncertainty increases due to a severe economic shock. From a managerial point of view, it contributes to making companies, especially the largest emitters, aware that the absence of ambitious environmental policies to reduce CO<sub>2</sub> emissions can lead to a rapid decrease in their market value in the event of another shock affecting investors' risk perceptions.

The paper is presented as follows: after presenting the theoretical framework and our proposed research hypotheses (2.), the research methodology will be outlined (3.) before developing the results (4.) and discussing them (5.).

## 2. Valuation of CO<sub>2</sub> emissions by investors

### *2.1. Valuation of CO<sub>2</sub> emission volumes and sectors*

In their quest for financial performance, companies need to align with the environmental expectations and concerns of investors. This necessity is supported by the theory of legitimacy, suggesting that companies' environmental engagements must fulfill expectations of stakeholders and society in order to legitimize their activities and ensure their development (Doshi et al. 2013; Ren et al. 2020). This can also be justified by results of many studies, suggesting that corporate carbon emissions represent a material risk for investors (Krueger and al., 2020) which influence their decision-making (Bose and al., 2021) and would have a negative effect on the market value of companies (Clarckson and al. 2015; Bush and Hoffman

2011). According Aggarwal and Dow (2015), a higher exposure to carbon emissions would impact negatively the market value of companies which could nevertheless be improved by expenditures to mitigate them. Thus, Galama and al. (2021) underline that firms might enhance their financial performance through efficiency development aimed at reducing CO<sub>2</sub> emissions. According to Delmas and al. (2015) and Rokhmawati and al. (2015), the corporate financial performance, measured by the Tobin's Q, would thus be positively influenced by their decreased GHG emissions. Hence, while making investments in proactive environmental strategies may be expensive in the short term due to its negative effects on ROA, they would nevertheless generate a better financial performance over the long term by increasing the market value of the company.

However, this valuation could depend on the environmental sensitivity of the company's sector. Chapple and al. (2013) suggest that the discount for each ton of CO<sub>2</sub> emitted would be higher for the largest emitters. Similarly, Griffin and al. (2017) show that carbon emissions impacted stronger the market value of the largest S&P500 issuers between 2006 and 2012 because of their higher environmental risk. Thus, the market would punish strongly major CO<sub>2</sub> emitters and reward companies which are acting to slow down global warming. While finding a negative impact of carbon emissions on credit ratings of US companies, Saffiullah et al. (2021) show that high-emitting companies face higher cash flow uncertainty. Khandelwal et al. (2022) also confirm in their study that companies in high-pollution industries are more sensitive to emissions-related risks, financial risks or future cash flow uncertainty.

Hence, it is likely that, during the recent period, the investors penalized carbon emissions of companies, particularly those of high polluting companies since the climate challenges continue to grow. This leads us to formulate the following hypothesis:

H1: Carbon emissions of companies negatively influence their financial performance, especially for the highest polluting ones.

## *2.2.Valuation of CO<sub>2</sub> emissions, sectors and the COVID-19 crisis*

Many researches suggest that corporate carbon emissions are negatively associated with the financial performance of companies. However, these studies do not allow assessing the changes in investors' sensitivity to CO<sub>2</sub> emissions due to world global crisis such as the COVID-19 crisis. Yet, results could be quite different compared to periods with a relatively stable economic and financial environment. Indeed, Bae and al. (2021) highlight that the pandemic has led to an increase in CSR considerations of markets participants and governments since environmental

issues have become one of the main concerns of the post-crisis economic recovery plans. Jacob and Nerlinger (2021) find that in crisis period, high-emitting stocks face higher risk levels than in normal time. The authors demonstrate that carbon-intensive stocks may have losses not only during the crisis time but also in the recovery period. According to Bortolotti and Fotak (2020), the corporate innovations generated by COVID-19 crisis would follow the same trend as after 2008 financial crisis since companies need to meet an increase in requirements of investors concerning the decrease in the CO<sub>2</sub> emissions. This increase in investors' environmental demands during the COVID crisis is also supported by works dealing with the anxiety and eco-anxiety of individuals and investors (Garel et Petit-Romec, 2021; Selmi et al., 2021; Vakoch et Mickey, 2022). Thus, Selmi et al (2021) show how anxiety related to COVID-19 leads individuals and companies to seek a better balance between environmental, social and economic priorities and thus to change their behavior. Therefore, the COVID-19 crisis would have influenced the valuation of companies' CSR activities (Batrancea 2021). So, Albuquerque and al. (2020) highlight that firms with higher environmental and social performance would have displayed a better financial performance during the COVID-19 crisis. Based on the literature suggesting an increase in market participants for environmental considerations in the covid-19 crisis, we therefore propose the following hypothesis:

H2: The COVID-19 crisis influenced valuation of companies' CO<sub>2</sub> emissions by investors

### 3. Research methodology

#### *3.1. The Sample*

The sample consists of financial and environmental data published by large French companies listed on the SBF 120 index from 2016 to 2021. Only companies that communicated their direct and indirect CO<sub>2</sub> emissions (Scope 1 and Scope 2) were included in the sample, leading to 546 data sets. All financial and environmental information was extracted from the Bloomberg database. By requiring the publication of the CO<sub>2</sub> emissions by listed companies, the French legislative framework (Grenelle, 2012) is conducive to the construction of a representative sample of large French companies. Moreover, the mandatory certification of this report by an independent third-party organization (Decree 2012-557) makes it possible to limit the influence of biases related to the perceived quality of environmental data. The influence of the COVID-19 crisis on the valuation of CO<sub>2</sub> emissions is evaluated over the application period of the state of emergency enacted in France from the first quarter 2020 to December 2021. The sample is

composed of polluting sectors (Transport, Waste Treatment, Energy, Chemicals, Materials and Heavy Industries - N = 204) and less sensitive, so-called low-polluting sectors (N = 342).

As shown in Table 1, the number of French companies that published their Scopes increases over the period, regardless of the sensitivity of their activity sector. At the same time, this growth in environmental transparency is combined with a constant decrease in average CO<sub>2</sub> emission volumes, especially over the COVID-19 period (Fig. 1).

Table 1. Distribution of observations over the study period

		Low Polluting	Highly Polluting	Total
Before the COVID-19 Crisis	2016	52	31	352
	2017	53	32	
	2018	56	34	
	2019	59	35	
COVID-19 period	2020	61	36	194
	2021	61	36	
<i>Total</i>		342	204	546

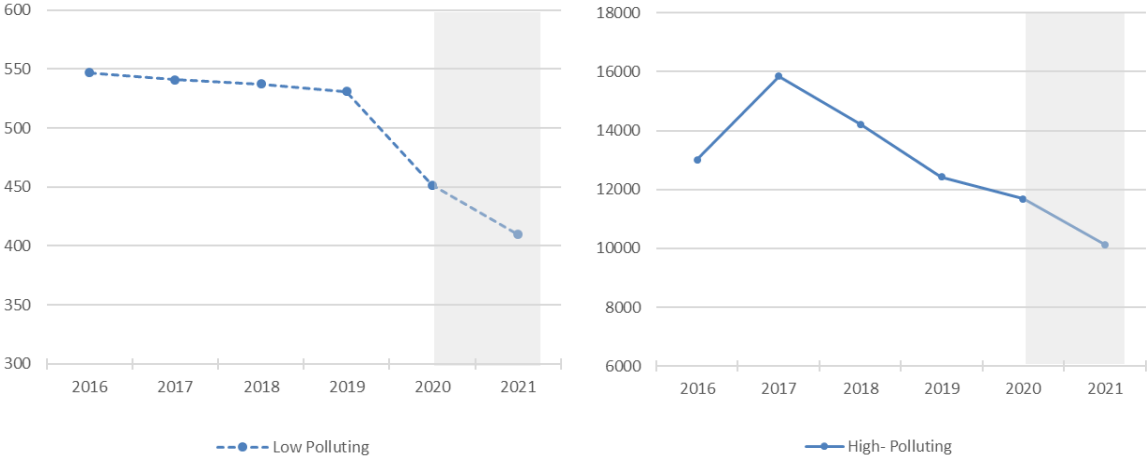


Fig. 1. Evolution in the average CO<sub>2</sub> emissions published by the sample from 2016 to 2021 (in tonnes)

### 3.2. Research Model

The impact of CO<sub>2</sub> emissions on investors’ valuations was estimated using a six-factor model. It is the final result of a *Partial Least Squares (PLS)* regression containing only significant variables with a VIP score (Variable Importance in Projection) greater than 1 and ensuring the minimization of prediction error of the model at the 10% risk threshold. While avoiding the



problem of non-normality of distributions, the use of the PLS regression method allows the combination of collinear variables (Hair and al. 2022) without introducing bias in estimated coefficients. In this way, it is possible to study the effect of the COVID-19 crisis on the valuation of CO<sub>2</sub> emissions by including an interaction factor.

The model's equation is as follows:

$$Tobin\ Q_{i,t} = \beta_0 + \beta_1 Vol.CO2_{it} + \beta_2 Vol.CO2_{it} * Crisis_{it} + \beta_3 Crisis_{it} + \beta_4 ROA + \beta_5 Leverage_{it} + \beta_6 Size_{it} + e_{it} \quad (1)$$

Proxy for the company's financial performance, the dependent variable *Tobin Q* is calculated by dividing the market value of the assets at the end of year *t* (Market capitalization + liabilities) by their replacement value (book value of assets in the year *t-1*). Used in many studies on CSR reporting (Lee and al. 2015, Radhouane and al. 2019), this measure reflects how investors perceive the future economic performance of a company based on available information.

The sensitivity of investors to corporate CO<sub>2</sub> emissions is studied with two independent variables. While the variable *Vol.CO<sub>2</sub><sub>it</sub>* enables the measurement of the influence of information on CO<sub>2</sub> emissions published by the company *i* in year *t* (in natural logarithm), the interaction variable *Vol.CO<sub>2</sub><sub>it</sub> \* Crisis<sub>it</sub>* is used to assess the potential marginal effect of the COVID-19 crisis on the valuation of this environmental information by the investor. Therefore, a significant  $\beta_2$  would mean that the crisis has increased or mitigated the effects of CO<sub>2</sub> emissions. The COVID-19 crisis corresponds to the application period of the COVID-19 state of emergency in France that is identified by the dummy variable *Crisis*, coded 1 for the observations in 2020 and 2021 and 0 otherwise. Finally, the last three variables reflect the influence of financial information on financial performance. While the variable *ROA<sub>it</sub>* measures the return of economic assets, the variables *Leverage<sub>it</sub>* and *Size<sub>it</sub>* represent respectively the firm's risk (total debt divided to total assets) and the natural logarithm of total assets used to capture the potential influence of size on investors' sensitivity to environmental information (Griffin and al. 2017).

To evaluate if the highest environmental risk associated with the largest emitters modified investors' valuation, we split the initial sample into four sub-samples according to firms' CO<sub>2</sub> emissions (quartiles). In this way, we investigate whether the valuation of each unit of CO<sub>2</sub> depends on the volume of emissions produced by firms, which could reveal the existence of a non-linearity in the relationship. This choice can also be justified from the descriptive statistics presented in Table 2. Since the distributions of *Tobin-Q Ratio* are significantly different for the

firms with the lowest emissions (first quartile) and the highest emissions (fourth quartile), investors' valuation could depend on the amount of carbon emissions.

Table 2. Main descriptive statistics for the lowest and the highest emitters

	1st Quartile (N = 136)					4th Quartile (N = 136)					Test of difference			
	Mean	St. Dev.	Min	Med.	Max	Mean	St. Dev.	Min	Med.	Max	t-test		Mann-Whitney (U stand.)	
Tobin-Q Ratio	1.77	1.28	0.83	1.23	8.38	1.17	0.26	0.76	1.11	2.47	5.33	***	3.920	***
Vol. CO <sub>2</sub> (ln)	2.15	0.96	-0.92	2.30	3.32	8.60	1.53	6.89	7.92	12.17	-41.62	***	-14.256	***
Vol. CO <sub>2</sub> * Crisis	0.70	1.16	-0.92	0.00	3.27	2.63	4.08	0.00	0.00	12.11	-5.26	***	-1.841	*
Crisis	0.35	0.48	0.00	0.00	1.00	0.30	0.46	0.00	0.00	1.00	0.90		0.902	
ROA	0.05	0.07	-0.10	0.04	0.55	0.02	0.04	-0.19	0.02	0.17	4.52	***	4.601	***
Leverage	0.16	0.22	-0.49	0.14	0.71	0.15	0.11	-0.14	0.15	0.35	0.56		-0.641	
Size	8.99	1.49	5.85	8.76	13.18	10.61	1.06	8.37	10.65	12.63	-10.14	***	-9.196	***

The first (fourth) quartile corresponds to the 25% of companies with the lowest (highest) CO<sub>2</sub> emissions. \*\*\*, \*\*, \* means that the coefficient is significant at the 1%, 5% and 10% level respectively.

#### 4. Results

Table 3 reports the results of the PLS regressions for different levels of CO<sub>2</sub> emissions over the period 2016-2021.

Table 3. PLS regression results for different levels of CO<sub>2</sub> emissions (standardized coefficients)

	Levels of CO <sub>2</sub> Emissions			
	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Vol. CO <sub>2</sub> (Ln)	-0.099 *	-0.131 *	-0.161 **	-0.143 ***
Vol. CO <sub>2</sub> (Ln) * Crisis	-0.031	-0.030	-0.048	-0.071 **
Crisis	0.038	0.063	-0.031	-0.061
ROA	0.409 ***	0.416 ***	0.378 ***	0.308 ***
Leverage	-0.262 ***	-0.193 ***	-0.072 *	-0.108 *
Size	-0.228 ***	-0.241 ***	-0.180 ***	-0.230 ***
% of DModX > Dcrit (X) à 90%	7.35%	3.65%	8.03%	6.62%
% of DModY > Dcrit (Y) à 90%	8.09%	7.30%	5.84%	8.82%
N	136	137	137	136
Number of components	1	1	1	1
R <sup>2</sup> Y Cum	37.1%	38.1%	33.0%	35.8%
R <sup>2</sup> X Cum	34.8%	22.8%	23.6%	25.5%

The first (fourth) quartile corresponds to the 25% of companies with the lowest (highest) CO<sub>2</sub> emissions. A threshold value for  $Q^2$  of 0.0975 was set to allow the addition of a new PLS component (Tenenhaus 1998). The risk threshold for the quality of models is set at 10% for the exogenous variables (% of DModX > DcritX) as well as for the endogenous variable (DModY > DcritY). \*\*\*, \*\*, \* mean that the coefficient is significant for thresholds of 1%, 5% and 10%, respectively.

Since the *Vol. CO<sub>2</sub>* coefficients are significant for all quartiles, the results reveal that the carbon emissions would have negatively influenced the Tobin-Q ratio of firms over the study period. This suggests that investors would sanction carbon emissions of all companies and not just the largest emitters. Thus, whatever their choice in terms of environmental risk exposure, such information appears to be useful for investors to refine their estimate of a firm's future cash flows. The comparison of the *Vol. CO<sub>2</sub>* coefficients between the quartiles nevertheless shows that the relationship is non-linear. For example, the penalty applied per unit of CO<sub>2</sub> emissions is higher for the largest emitters (-0.143) than for the companies with the lowest volumes of emissions (-0.099). While confirming the H1 hypothesis, the results highlight that the valuation of each unit of CO<sub>2</sub> produced by firms would depend on their carbon footprint.

The coefficients of the interaction variable complete the analysis by assessing how the COVID-19 crisis influenced the valuation of CO<sub>2</sub> emissions by investors. We note that the effect of the COVID-19 crisis was not homogeneous on the four sub-samples. The marginal effect of CO<sub>2</sub>

emissions ( $\frac{\partial Y}{\partial Vol.CO_2}$ ) indicates that the crisis would have increased the penalty applied to the largest emitters since  $|\beta_1 + \beta_2| = 0.214 > |\beta_1| = 0.143$  for the 4<sup>th</sup> quartile. In contrast, investors interested in smaller emitters would not have changed their valuation of emissions during the COVID-19 crisis as the  $\beta_2$  is not significant for the three first quartiles. This result tends to validate H2, suggesting that the highest environmental risk associated with the largest emitters, modified investors' valuation when facing the COVID-19 crisis.

As a robustness check, we re-implement the estimations from two alternative sub-samples separating the high-polluting sectors (Transport, Waste Treatment, Energy, Chemicals, Materials and Heavy Industries – N = 204) and the low-polluting sectors (N = 342). In this way, we test whether this difference in investors' sensitivity is also observed when firms are classified according to the environmental sensitivity of their sector and not just the quantity of their emissions.

Table 4. PLS regression results according to the pollution level of the sectors (standardized coefficients)

	Low Polluting		High Polluting	
Vol. CO <sub>2</sub> (Ln)	-0.053	*	-0.243	***
Vol. CO <sub>2</sub> (Ln) * Crisis	-0.027		-0.055	***
Crisis	0.003		0.044	
ROA	0.358	***	0.310	***
Leverage	-0.193	***	-0.163	***
Size	-0.173	***	-0.240	***
<hr/>				
% of DModX > Dcrit (X) à 90%	8.77%		5.39%	
% of DModY > Dcrit (Y) à 90%	8.48%		7.35%	
<hr/>				
N	342		204	
Number of components	1		1	
R <sup>2</sup> Y Cum	26.5%		52.7%	
R <sup>2</sup> X Cum	25.1%		38.5%	

*The High Polluting sample consists of the sectors perceived as the largest emitters (Transport, Waste Treatment, Energy, Chemicals, Materials and Heavy Industries) and the Low Polluting sample includes companies in less sensitive sectors. A threshold value for Q<sup>2</sup> of 0.0975 was set to allow the addition of a new PLS component (Tenenhaus 1998). The risk threshold for the quality of models is set at 10% for the exogenous variables (% of DModX > DcritX) as well as for the endogenous variable (DModY > DcritY). \*\*\*, \*\*, \* mean that the coefficient is significant for thresholds of 1%, 5% and 10%, respectively.*

While confirming the negative effect of CO<sub>2</sub> emissions on firms' valuation, the results in Table 4 support the idea that this relationship would depend on the company's environmental risk since the penalty applied per unit of CO<sub>2</sub> emissions is higher for polluting sectors.

Furthermore, they confirm that the crisis has increased the negative impact of CO<sub>2</sub> emissions on financial performance of polluting firms, as  $\beta_1 + \beta_2$  (- 0.298) is higher than  $\beta_1$  (-0.243). In contrast, investors interested in less polluting sectors would not have changed their valuation of emissions during the COVID-19 crisis because the  $\beta_2$  is not significant for a risk threshold of 10%<sup>1</sup>.

## 5. Discussion and Conclusion

This research allows us to better understand the effects of carbon emissions on investors' valuation, especially in a crisis context. Using data of large French companies having published their Scopes 1 and 2 between 2016 and 2021, we show that the investors value negatively the volume of corporate carbon emissions for all activity sectors, and more heavily for high-emitting sectors. We also demonstrate that under the effects of COVID-19, this penalization would also have increased for polluting companies. Therefore, our work contributes to the growing research streams that focus on the relationship between environmental performance and financial performance, and more specifically in a context of crisis.

Our results first confirm findings from previous studies on the negative impact of CO<sub>2</sub> emissions on the firm's financial performance (Aggarwal and Dow 2015; Clarkson and al. 2015; Aggarwal and Dow, 2015). While attesting that investors consider carbon emissions as a material risk for investors (Krueger and al. 2020), our outcomes are in line with Bose and al. (2021) showing that investors penalize companies with high carbon emissions. This also attests the results of In and al. (2019), suggesting that investors with a portfolio including long position on firms with low carbon emissions and short position on stocks with high emissions, generates positive abnormal returns.

Secondly, our study demonstrates that, under the pressure of the COVID-19 crisis, investors penalize more heavily polluting firms. For investors who choose to move towards less polluting sectors, their valuation of emissions does not change with the COVID-19 crisis. This non-linearity points out that investors tend to sanction companies with poor environmental performance and reward companies with greater environmental responsibility. These results confirm the statement of Garel and Petit-Romec (2021) that *“Even though the COVID-19 crisis was not primarily caused by environmental issues or climate change, it may still have led*

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<sup>1</sup> We consider that this additional penalty during the COVID crisis cannot be due to the stronger correction in the market value of “Value stocks” generally observed during crises. Indeed, the sub-sample of polluting sectors for which a negative effect of the interaction factor was captured by the model shows a slight decrease in the proportion of “Value” Stocks (Tobin Q < 1), whereas the latter increased from 17% before the crisis to 25% during the crisis in the low-polluting sectors for which no significant effect was identified.

*investors to reassess the importance of environmental responsibility*". Particularly, the authors show that companies with a superior environmental score can get higher stock returns during the COVID-19 shock. Therefore, our findings shed light on the fact that investors' environmental concerns are not weakened by the crisis but rather reinforced to the extent that investors continue to support companies with responsible strategies on environmental issues. This incentivizes companies of both polluting and low polluting sectors to keep up their initiatives and strategies of environmental preservation. So, our finding contradicts Bae and al. (2021), suggesting that there is no evidence of any change in the valuation of CSR activities by the market during the COVID-19 crisis.

Thirdly, our study provides some managerial implications for a firm's deciders and investors. In fact, it is important for firms, especially high-emitting firms to continue to reduce their carbon emissions in order to earn and maintain investors' confidence after the crisis. This latter can cause some difficulties due to economic troubles but could be a good opportunity for both firm and investor to maintain their clean technologies development and investment thanks to potential markets of new technologies. The crisis helps us better recognize the concerns of the renewable energy investment and its important role in green transition and the fight to limit the negative consequences of climate change.

Finally, our study opens up a debate on political action for businesses with regard to environmental protection. COVID-19 has led individuals not only to question further environmental issues (Garel and Petit-Romec, 2021) but also to a significant level of anxiety and eco-anxiety among individuals (Selmi et al., 2021). These effects of COVID19 stem (at least in part) from a relatively anxiety-provoking political and media discourse (Vakoch and Mickey, 2022) on the topic over the past two years. However, our study shows that during the COVID-19 period, investors penalize the most polluting companies more heavily. Thus, our results contribute to the reflection raised by Selmi et al (2021) that "*the rising COVID-19 related anxiety brings the link between environmental sustainability and societal resilience to the fore, thereby leading societies to seek a better balance in the environmental, social and economic priorities*". In other words, our findings contribute to support the fact that individuals' anxiety could be a determinant of their environmental expectations (Vakoch and Mickey, 2022) as well as of their investment behavior (Selmi et al., 2021) and raise a question to which we call for future developments in behavioral finance: in order to lead firms to a better respect for the environment, is it more effective to develop a policy action that evolves investors' eco-anxiety or a policy action that endorses (ou puts forward) incentives or regulatory obligations on firms?

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