An empirical analysis: Did green supply chain management alleviate the effects of COVID-19?

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Abstract
Supply chain management played a central role during the COVID-19 crisis, as the outbreak of the pandemic disrupted the majority of all global supply chains. This paper tests whether companies that use green supply chain management (GSCM) practices benefited from a buffer effect in the context of COVID-19. Our empirical analysis, conducted on a sample of U.S. companies, shows that GSCM companies experienced less negative abnormal stock returns during the crisis. This result contributes to the literature on financial impact of GSCM, finding that GSCM is perceived as an effective risk management tool and can serve as an effective drug against COVID-19 crisis. Our paper also contributes to the business debate on the role of green supply chains in the post-COVID19 world.

KEYWORDS
capital markets, coronavirus disease, COVID-19, event study, green supply chain management, GSCM, stakeholder theory

1 | INTRODUCTION

In March of 2020 the World Health Organization (WHO) declared the 2019 novel coronavirus outbreak, known as COVID-19, a pandemic. The infectious disease, which was responsible for more than one million deaths and over 45 million cases within six months of the declaration, created a worldwide health catastrophe. The global health crisis quickly led to a global economic and financial crisis. After the S&P 500 experienced record heights in mid-February, the pandemic caused the US market to experience the largest 1-week decline since the 2008 financial crisis.

According to recent surveys,¹ among the Fortune 1000 companies, 16% and 94% have tier-1 and tier-2 suppliers, respectively, in Wuhan, China. Supply chains play a central role in economic growth and stability; therefore, the consequences of COVID-19 disrupted the majority of all global supply chains (Majumdar et al., 2020). According to Smith (2020), at least 5 million companies around the world have tier-2 suppliers located in the Wuhan region. Given such dramatic and extreme disruption, even the best combinations of traditional supply chain risk management strategies such as agility, flexibility, and surplus inventory have demonstrated to be insufficient to cope with this particular global pandemic.

This paper focuses on a specific feature of supply chains—the extent to which they are environmentally sustainable. Green Supply Chain Management (GSCM) refers to the selection of suppliers or sourcing partners by using environmental criteria (ISO 14000, energy consumption, etc.). GSCM (Sarkis et al., 2011) encompasses every level of the supply chain, from product concept to distribution. Core strategies include reduction of fuel emissions, curtail and eliminate waste, lower energy use, utilize renewable materials and ethical sourcing.

We investigate the association between the adoption of GSCM practices and abnormal returns during COVID-19 outbreak, to test whether companies adopting GSCM experienced less negative returns during the market collapse. In other words, we aim at empirically testing whether investors considered GSCM companies better able to respond to the crisis (resilience) and/or to generate more value in the post-COVID19 economy.

Our study contributes to the prior literature on GSCM as well as to Stakeholder Theory (Freeman, 1984). According to
Although global supply chains are increasingly more significant for value creation, which is the primary aim of any business entity, academic literature has not reached a consensus on the effectiveness of GSCM. Building on prior studies, we identify two opposing views about the role of GSCM during COVID-19 that we define as follows: “GSCM as an ineffective placebo against COVID-19” and “GSCM as an effective drug against COVID-19”. We use the event study methodology to calculate abnormal returns (AR) of U.S. companies during the COVID-19 outbreak. Following prior studies (Albuquerque et al., 2020; Borusyak & Jaravel, 2017; Castro-Iragorri, 2019), we employ the diff-in-diff methodology, and find a positive and significant relation between GSCM and abnormal returns in the post-COVID period. These results support the “GSCM as an effective drug against COVID-19” literature.

We also perform a robustness analysis by testing whether the positive effect of GSCM on abnormal returns after COVID is more substantial for companies operating in environmentally sensitive industries, namely, tobacco, mining, food, and beverage. We find that the “buffer effect” of GSCM is not influenced by whether companies operate in environmentally sensitive industries. On the contrary, the effect is similar for environmentally sensitive and non-environmentally sensitive companies. While this result seems to be counter-intuitive, it may help to better understand the nature of GSCM to investors.

Our study contributes to the academic literature and provides relevant insights to companies as well. Previous studies did not reach a consensus on the effectiveness of GSCM. While some theoretical arguments and empirical results suggest that GSCM is effective (Barratt & Oke, 2007; Danso et al., 2019; Rao & Holt, 2005; Sen, 2009; Zhu & Sarkis, 2004), others do not (Amankwah-Amoah & Syllias, 2020; Jorgensen & Wilcoxen, 1990; King & Lenox, 2001; Seuring, 2001; Van Hoek, 1999). We find support for the effectiveness of GSCM, and we show that GSCM is a driver of business value and not a cost center (Wilkerson, 2005).

From the perspective of companies, we provide some empirical evidence about the role of supply chains in the post-COVID world. Claire Lund, Head of Environmental Sustainability at GlaxoSmithKline (GSK), said: “There’s going to be a post-COVID world that looks at the supply chain differently: How do we partner? How do we become a bit more agile? What are we going to do to be part of the supporting networks and frameworks that will help that continue? And this isn’t just an intervention that disappears after a bit of time ...”. Our research contributes to this relevant debate because recent events indicate that COVID-19 will continue to impact the global economy through additional outbreaks. Moreover, it is likely that this pandemic, as well as potential future pandemics, will affect the world business commerce for the foreseeable future. Therefore, pandemic risk management is of paramount importance to companies worldwide.

2 | BACKGROUND AND HYPOTHESIS DEVELOPMENT

2.1 | GSCM

GSCM has its roots in both the environmental management and supply chain management literature, and it aims at addressing the influence and relationships between supply-chain management and the natural environment (Srivastava, 2007). GSCM requires the integration and coordination of business processes (such as purchasing, manufacturing, marketing, and logistics) and strategy alignment throughout the supply chain to satisfy the final customer of the supply chain (Green et al., 2008; Cohen & Roussel, 2005; Ho et al., 2002; Sarkis et al., 2010).

Generally, firms adopting green business practices (GBPs) place emphasis on reducing pollution, curtailing and eliminating waste, lowering energy use, utilizing renewable materials, and incorporating and installing resource conservation measures to ensure that the product/service can be delivered in an environmentally sustainable manner (Amankwah-Amoah, 2020; Hendiani et al., 2020). According to Van Hoek (1999), there are three approaches to GSCM, namely, reactive (companies commit minimal resources to environmental management, label products that are recyclable and use “end of pipe” initiatives to lower their environmental products); proactive (companies start to pre-empt new environmental laws by realizing a modest resources commitment to initiate the recycling of products and designing green products); and value-seeking (companies integrate environmental activities such as green purchasing and ISO implementation as strategic initiatives into their business strategy).

The three different approaches to GSCM derive from motivations to implement specific practices. Liu et al. (2012) found that clients’ and competitors’ pressures are the main reasons to adopt GSCM practices, while regulatory pressure has a slightly positive influence. Although the findings of Thun and Müller (2010) reinforce a market driven adoption of GSCM, their research also suggests that the fulfillment of legal regulations and environmental protection still demonstrates satisfactory results for GSCM adoption with little effect on the company’s competitive advantage. These findings can be reconciled by results such as Liu et al. (2020) and Malviya et al. (2018) that showed the impact of strategy on the success of implementation process of GSCM.

On this matter, Feng et al. (2018) and Laari et al. (2018) presented findings that GSCM does not directly create financial performance, since GSCM focuses on creating resource and operational efficiency and that may or may not translate into profitability and market share. Therefore, both papers identified a positive result in environmental performance but not necessarily in financial performance. Interestingly, Feng et al. (2018), again highlighting the strategic aspect of GSCM by pointing out that financial performance can be identified when internal and external GSCM practices are implemented as an integral strategy.

However, research on GSCM remains inconclusive. Although studies propose client pressure as the main driver of GSCM practices (Chavez et al., 2016; Liu et al., 2012, 2020; Thun & Müller, 2010), Zhu et al. (2017) findings call for regulations and policies to promote practices, such as GSCM, among small and medium-sized manufacturers.
Also, given the complexity of identifying the financial effect of GSCM, some authors investigate factors that may facilitate the effectiveness of GSCM, like the adoption of customer-centric GSCM (Chavez et al., 2016), complimentary effects of Environmental Management Systems (Darnall et al., 2008), and the mediation effect of strategic orientation and the motivation to adopt GSCM (Liu et al., 2020).

2.2 Previous literature on the effectiveness of GSCM

Previous studies do not reach a consensus about the effectiveness of GSCM in terms of its ability to foster financial performance. Since there are theoretical arguments, both supporting and opposing GSCM effectiveness, the existence of a relation between GSCM practices and financial performance is an empirical question.

Some authors argue that GSCM practices are not effective. Among those, Van Hoek (1999) argues that GSCM practices may be a burden to competitive advantage. Jorgensen and Wilcoxen (1990) share the same concern: firms may lose competitive advantage due to increased costs from the implementation of environmental sustainability guidelines. Similarly, King and Lenox (2001) do not find a strong and conclusive link between GSCM practices and financial performance, and they call for further empirical investigation. Seuring (2001) questions whether the adoption of GSCM results in a win-win situation for multiple parties or whether there are environmental and economic tradeoffs for the supply chain partners.

Conversely, other studies find that GSCM does yield financial benefits. This argument is based on the Stakeholder Theory (Freeman, 2010). According to this theory, companies produce externalities that affect many parties (stakeholders) which are both internal and external to the firm. Externalities often cause stakeholders to increase pressures on companies to reduce negative impacts and increase positive ones (see Sarkis et al., 2011). The theory predicts that taking care of stakeholder expectations (doing good) will lead to better performance (doing well). In other words, companies that have better stakeholder performance will also be able to deliver better financial performance and to generate value in the long run. More specifically, according to Sen (2009) and Barratt and Oke (2007), companies can gain competitive advantage by being the first to adopt environmental sustainability and implement GSCM practices. Among the empirical studies, Zhu and Sarkis (2004) empirically test the relation between GSCM and economic performance in the Chinese context, and they find a positive relation. Similarly, Rao and Holt (2005) find that greening the different phases of the supply chain leads to an integrated green supply chain, which ultimately leads to competitiveness and economic performance.

2.3 GSCM as an ineffective placebo against COVID-19

Building on previous GSCM literature, one could argue that GSCM may fail to protect companies against the negative effects of COVID-19, just like an ineffective placebo does not protect from the disease. There are three main arguments that would support the existence of an insignificant relation between GSCM practices and abnormal returns during the outbreak of COVID-19.

First, prior research indicates that GSCM does not yield a preferential treatment by investors in an unchanging state, normal course of business activity (Jorgensen & Wilcoxen, 1990; King & Lenox, 2001; Seuring 2001; Van Hoek, 1999). Hence, GSCM would likely be ineffective during the COVID-19 pandemic.

Second, regardless of GSCM effectiveness, companies may be expected to abandon green supply chain investments as a consequence of the COVID-19 crisis. According to Amankwah-Amoah (2020), although firms increasingly adopt environmental initiatives, these are often jettisoned as soon as they are confronted by new and difficult to predict challenges. In other words, the authors question whether organizations can maintain momentum when the financial resources are under severe strain (such as in the case of COVID-19), and they hypothesize the existence of major challenges in maintaining momentum for environmentally sustainable practices especially in times of crisis.

Following this perspective, GSCM will be ineffective not because of its ineffectiveness per se, but because companies are expected to constrain their investments in green supply chain practices. If this is the case, previous sustainability (and GSCM) performance before COVID-19 crisis is not predictive of companies' performance after the crisis. On the contrary, investors may construe responses to COVID-19 that harm the environmental performance of the supply chain as necessary for corporate survival and the absence of these efforts as detrimental to the long term success of a corporation in a competitive market.

The third argument for the ineffectiveness of GSCM is based on the fact that COVID-19 is not an environmental but rather a social and health crisis. This may significantly change the priorities of companies from environmental to social sustainability. According to “The 2020 global risks report” by the World Economic Forum, the risk of infectious diseases was not mentioned by global players among the top five risks. Investors may perceive that this is likely to change after COVID-19, as the social and health concerns become more important than the environmental dimension.

Additionally, Bae et al. (2021) documented that during the period of the market crash (February 18–March 20), they could not identify a significant effect of CSR on stock return. The main conclusion of their study offers that pre-crisis CSR was not effective in protecting shareholder wealth after the crisis, which, although not related to GSCM, represents initial evidence of lack of economic impact of CSR practices during a pandemic situation.

2.4 GSCM as an effective drug against COVID-19

Building on Stakeholder Theory, one may argue that GSCM will protect companies against the negative effects of COVID-19, as an effective drug protects from the disease. Stakeholder Theory predicts that firm’s commitment to its stakeholders (including the environment, suppliers, and customers) will be understood as a strategic resource expected to
lead to a competitive advantage (Freeman, 2010). Considering demand during COVID-19, He and Harris (2020) identified that the ethical dimension of consumption became more salient during the pandemic, and a shift to more responsible and prosocial consumption is expected. Qiu et al. (2021) also highlighted that companies that engage in CSR practices may generate faster stock returns during a period of crises. Their findings supported the argument that CSR investment usually rewards slowly but constantly over a long-term period.

More specifically, investors may consider companies committed to GSCM are better able to respond quickly to a crisis by adapting their supply chain and avoiding costly production halts and securing the supply of imported materials. Anecdotal evidence also shows that the disruption of supply chains severely impacted the ability of companies to create value in the short run. Consistent with Rao and Holt (2005), who argue that GSCM will empower better knowledge of the supply chain, investors may believe that companies that invested in the green supply chain will also be able to limit the short term adverse effects of COVID-19. While GSCM may allow companies to better respond to the COVID-19 crisis in the short term, it may also have significant long-term benefits. Investors may believe sustainability to have an even more important role in the post-COVID 19 world.

GSCM is an essential component of sustainability, and it may signal to investors the ability to create value in the long run. The inclusive efforts underlying GSCM help to make organizations more attentive in determining and responding to environmental demands of consumers and other stakeholders (Danso et al., 2019). Stakeholders’ inclusion or engagement across a range of functional areas, including product design and manufacturing, has often been a key pillar in environmental sustainability practices of businesses (Durugbo & Amankwah-Amoah, 2019). Similarly, GSCM can help firms penetrate new market segments whilst enhancing their reputation (Konadu et al., 2020) and attracting top talent (Agyabeng-Mensah et al., 2020).

This positive effect of GSCM might be even more relevant in the post-COVID19 world, because of the ever more central role of sustainability.

2.5 | Hypothesis

By relying on previous literature, we identify arguments both supporting (GSCM as an effective drug) and opposing (GSCM as an ineffective placebo) the existence of a relation between GSCM practices and stock returns.

We propose the following hypothesis, stated in the null form:

H: GSCM practices do not have any significant impact on firms’ abnormal stock returns during COVID-19 outbreak.

3 | RESEARCH DESIGN

In order to address our research questions, we adopt an archival approach. This section discusses the sample and data selection and the econometric models employed.

3.1 | Sample and data selection

Our sample includes all publicly listed US companies, that have total assets higher than 100 million Dollars and positive total equity, available in Refinitiv–Thomson Reuter Database, formerly known as Eikon Thomson Reuters Database.

Refinitiv is one of the most well-known ESG databases; it covers the information of companies that represent over 70% of global market capitalization, controlling more than 450 metrics of Environmental, Social and Governance aspects (Refinitiv, 2020). Investors and other users can have a comprehensive understanding of ESG performance of the companies and analyze specific components of each dimension, such as Green Supply Chain Management (Benlemlih et al., 2018; Cheng et al., 2014; Fasan et al., 2016).

The control group is formed by companies that apply Green Supply Chain Management. We retrieve this information from the category Environmental Supply Chain Management described as “Does the company use environmental criteria (ISO 14000, energy consumption, etc.) in the selection process of its suppliers or sourcing partners? - data can also be on existing suppliers who were selected using some environmental criteria” (Refinitiv, 2020). GSCM presents companies that implement Green Supply Chain Management, operationalized by a dummy variable equal to 1 when the company has GSCM, and 0 otherwise.

The control group is formed by all US companies in the sample that did not implement any practices of Green Supply Chain Management, according to Refinitiv database. Data of daily stock return and accounting data for 2019 and 2020 are obtained from Refinitiv database as well. The Daily Total Return incorporates the daily price change and any relevant dividends for the same day (Refinitiv, 2020).

In order to calculate abnormal returns, we adopted the Market Model. The model is the most used to explore the unexpected variation of stock price surrounding an event (Godfrey et al., 2009; He et al., 2020; Mio & Fasan, 2012). Additionally, it is the best measure for “security price performance”, when compared to other methodologies such as the Constant Mean Return Model (Brown & Warner, 1980). Following the procedures of Campbell et al. (1998) and Godfrey et al. (2009), we regress the stock returns of the companies in our sample with the stock return of the market that is retrieved from French Library Database in the estimation window (January 1 to December 31, 2019) to determine the expected return of the stock.

$$R_{it} = \alpha + \beta R_{mt} + \epsilon_{it}$$

The abnormal stock return represents the error of the equation. The difference between the expected return considering $\alpha$ that represents the average return for the firm keeping market movements stable and $\beta$ that indicates that stock's performance relative to the market (Godfrey et al., 2009; Mio & Fasan, 2012).

$$AR_{it} = R_{it} - (\alpha + \beta R_{mt})$$
We used data from 2019 as the estimate window of the returns of the companies. Daily return data are gathered from 3377 firms to estimate the CAPM parameters, it summed 825,711 observations from January 1 to December 31, 2019.

The main tests considered daily return data from January 1 to March 31, 2020, resulting in 195,310 observations (from 3,377 firms) after excluding observations with missing values.

Our variable Post_COVID represent our event window and includes all the one-day Abnormal Returns belonging to the event window. Post_COVID have value 1 for the period between February 24 and March 31 and 0 otherwise. We follow previous literature (Albuquerque et al., 2020; Ramelli & Wagner, 2020), and we consider February 24 the start of “fever” period, because it is the day in which more awareness of COVID19 negative consequences arose. It is the day after Italy placed the north regions under strict lockdown (Albuquerque et al., 2020; Ramelli & Wagner, 2020).

Controls variables include the following: Tobin’s q, Size, Leverage, Return on Asset, Market to Book and Cash. See Appendix A for further details.

3.2  |  Model specification

We perform a difference-in-differences analysis, regressing abnormal returns on the interaction between Green Supply Chain Management (GSCM) and a dummy variable with value 1 for the post-COVID 19 period (COVID). The regression model used is represented as follows:

\[
\text{Abnormal Returns}_{it} = \beta_1 \text{GSCM}_{it} + \beta_2 \text{COVID}_{it} + \beta_3 \text{GSCM} \times \text{COVID}_{it} + \sum \beta_j \text{Controls}_{it} + \epsilon_{it} \quad (1)
\]

Diff-in-diff model: impact of GSCM on abnormal returns

4  |  DESCRIPTIVE STATISTICS

The means, standard deviation, minimum and maximum of the variables included in the model are presented in Table 1, for the 3,377 firms, that comprise 195,310 observations. GSCM, the dummy variable indicating if the company uses GSCM practices has mean equal to 0.205, indicating that 20.5% of the sample firms adopted GSCM practices.

Our correlation analysis shows that there is a positive and statistically significant relationship between GSCM and abnormal returns, as presented in Table 2. Additionally, many control variables also show a statistically significant relationship with the dependent variable (Abnormal Returns), specially size which showed a correlation of 0.403.

5  |  EMPIRICAL RESULTS

5.1  |  Main effect of GSCM

The purpose of the paper is to investigate the role played by GSCM on the abnormal returns observed in the Post Covid period. To start our analysis we test if GSCM influences abnormal return independently from the COVID-19 setting. We regress GSCM on Daily Abnormal Return, controlling for tobin’s-Q, size, leverage, ROA, market to book and cash. The results are presented in Table 3.

The results show a consistent positive significant coefficient for GSCM in both variation we performed. Model 1 presents the result for pooled regression, clustered by company while Model 2 repeats the tests but for panel data, to strengthen the control of companies fixed effects. The results are similar in both models. Companies that

### Table 1: Descriptive statistics

| VARIABLES | (1) Mean | (2) Std | (3) Min | (4) Max |
|-----------|---------|--------|--------|--------|
| GSCM      | 0.205   | 0.403  | 0.000  | 1.000  |
| AB_RET    | 0.004   | 2.741  | −11.324| 11.245 |
| TOBINS    | 2.761   | 3.574  | 0.610  | 21.680 |
| SIZE      | 7.451   | 1.941  | 2.630  | 12.370 |
| LEV       | 0.555   | 0.256  | 0.010  | 0.960  |
| ROA       | −0.032  | 0.217  | −1.120 | 0.300  |
| MTB       | 5.845   | 11.577 | 0.260  | 80.460 |
| CASH      | 0.172   | 0.253  | 0.000  | 0.970  |

### Table 2: Correlation matrix—Pearson

|         | GSCM   | AB_RET | TOBINS | SIZE   | LEV    | ROA   | MTB   | CASH  |
|---------|--------|--------|--------|--------|--------|-------|-------|-------|
| GSCM    | 1      |        |        |        |        |       |       |       |
| AB_RET  | 0.021***| 1      |        |        |        |       |       |       |
| TOBINS  | −0.064***| −0.022***| 1      |        |        |       |       |       |
| SIZE    | 0.403***| 0.014***| −0.391***| 1     |        |       |       |       |
| LEV     | 0.142***| 0.011***| −0.214***| 0.504***| 1     |       |       |       |
| ROA     | 0.171***| −0.011***| −0.341***| 0.450***| 0.121***| 1     |       |       |
| MTB     | 0.001   | −0.016***| 0.736***| −0.239***| 0.088***| −0.257***| 1     |       |
| CASH    | −0.141***| −0.001 | 0.482***| −0.517***| −0.400***| −0.569***| 0.306***| 1     |

*p < 0.05. **p < 0.01. ***p < 0.001.
use GSCM present higher levels of daily abnormal returns throughout the whole period covered by our sample. The GSCM coefficient is approximately 0.14%. Additionally, we re-estimate (not tabulated) the two models only considering observations before February 24. The analysis of the whole period (January to March) and the period before instills confidence that the result is not driven by the effect of COVID-19 crisis. When analyzing the period from January until February 24, the positive significant relationship is maintained, with a slightly lower coefficient, 0.08%.

This higher effect in the period that encompasses the COVID outbreak may suggest that the positive relationship between GSCM and abnormal returns is even more pronounced during the pandemic crisis. The diff-in-diff model, presented in Table 4, further investigate this empirical question.

In order to test the hypothesis that GSCM practices do not have any significant impact on firms' abnormal stock returns during COVID-19 outbreak, we present in Table 4, the results of the Diff-and-Diff presented in Equation 1. For robustness we present two models in which Model 1 control for companies fixed effects, and Model 2 also control for company value, size, leverage, ROA, Market-to-book and cash.

When we interact GSCM and Post_Covid, we obtain a variable that represents the effect of GSCM on Abnormal Returns after COVID outbreak. More specifically, following the diff-in-diff methodology, the interaction GSCM * POST_Covid represents the difference in Abnormal Returns of GSCM companies from the pre COVID to the post COVID period, net of the difference in Abnormal Returns of non-GSCM companies from the pre COVID to the post COVID period. While Castro-Iragorri (2019) presents difference-in-difference as a modern tool for event studies, Borusyak and Jaravel (2017) highlight that difference-in-difference estimators are commonly used tools for estimating causal effects of treatments in event studies.
The variable shows a positive, significant and consistent result in all three models. It indicates that companies adopting GSCM practices showed higher abnormal returns than their non-GSCM counterparts. Stock of GSCM companies performed better in the period February 24 through March 31 compared to stocks of non GSCM companies, and the economic effect is noteworthy. While, in general, the daily abnormal stock return of companies was 0.05% lower in the epidemic period compared to the pre-COVID period, companies that adopted GSCM showed an abnormal return of 0.21% higher than other companies. Therefore, their stock had a much better outcome than non GSCM companies.

The variable Post_Covid is negative and significant, consistently with the expectation of stock prices dropping due to the negative effects of COVID-19, which led to a sudden stop of economic activity. The negative effect is significant at 1% level controlling for companies fixed effects (model 1) and also company value, size, leverage, ROA, Market-to-book, and cash (model 2).

GSCM shows significance but the effect varies according to the model. In model 1 GSCM is negatively significant at 1% level, indicating higher abnormal return for companies adopting GSCM over time. This significance disappears when controlling for companies fixed effects. When adding other controls it shows 1% significance, but negative. Such result seems to indicate that, unconditionally, GSCM play some role in abnormal return but the effect is not clear.

To make sure that the event window is not driving the results, we re-estimated the tests considering the start of the epidemic crisis in March 11, 2020, when World Health Organization (WHO) declared pandemic situation. As presented in Table 5 the main results are consistent those presented in the prior analyses. Negative significant effect, showing the large effect of the pandemic in the US Stock Market. Considering the WHO as the date of analysis we see a positive relationship of GSCM with abnormal return and reenforces the positive relationship of the interaction, showing that companies that adopt GSCM fared better during the pandemic.

To check for the robustness of the result, we repeated all the analysis using panel data, and in this way controlling for firm specific characteristics. The result (not tabulated) corroborates the results found in the pooled regressions: negative effect of Post_Covid and positive relationship of the interaction.

We further investigated the role of social and environmental sensitive industries in explaining our results. The broader definition includes the following industries: Automobiles & Auto Parts, Electronic Equipment & Parts, Semiconductors & Semiconductor Equipment, Metals & Mining, Machinery, Tools, Heavy Vehicles, Trains & Ships, Aerospace & Defense and Food & Tobacco. The stricter definition only considers the following industries to be environmentally sensitive: Food & Tobacco and Machinery, Tools, Heavy Vehicles, Trains & Ships.

The results, not tabulated, indicate that the inclusion of sensitive industries and interactions with Post_Covid, GSCM and multiple interactions with the two did not substantially change the results presented earlier. Therefore, GSCM continues to be positively and significantly related to abnormal returns. While this result appears to be counter-intuitive, the interaction between an environmentally sensitive industry and GSCM does not indicate significance in any of the models. This may suggest that GSCM is inherently value added, signaling sustainable management and therefore increasing the expectations of a positive performance above and beyond the environmental dimension. Future studies may further explore this point, relying on a qualitative methodology based on case studies.

### 6 | DISCUSSION AND FINAL REMARKS

Supply chains received much attention during the outbreak of COVID-19 as disruptions did cause significant damages to companies. In this scenario, Green Supply Chain Management may have played a

| VARIABLES     | (1) AB_RET | (2) AB_RET |
|---------------|------------|------------|
| POST_WHO      | -0.1540*** (0.0240) | -0.1540*** (0.0240) |
| GSCM          | 0.0635*** (0.0119)  | 0.0209 (0.0144) |
| GSCM_POST_WHO | 0.1130** (0.0473)  | 0.1130** (0.0473) |
| Tobin's q     | -0.0207*** (0.0035) | 0.0020*** (0.0045) |
| Size          | 0.0202*** (0.0045)  | 0.0805*** (0.0326) |
| Lev           | 0.0805*** (0.0326)  | 0.0805*** (0.0326) |
| ROA           | -0.3510*** (0.0488) | -0.3510*** (0.0488) |
| MTB           | -0.0020** (0.0010)  | -0.0099 (0.0476) |
| Cash          | 0.0086 (0.0488)     | 0.0086 (0.0488) |
| Constant      | 0.1390*** (0.0380)  | 0.0086 (0.0488) |
| Observations  | 195,310            | 195,310 |
| R-squared     | 0.003               | 0.005 |
| Industry FE   | YES                 | YES |
significant role, allowing companies to respond more quickly to the crisis by adapting their supply chain and avoiding costly production halts and securing the supply of imported materials.

This expectation is not obvious, and it requires to be empirically tested. On the one hand, some studies advocate that GSCM companies sacrifice competitive advantage due to increased costs from the implementation of GSCM (Seuring, 2001; Van Hoek, 1999). We define this view “GSCM as an ineffective placebo against COVID-19”. On the other hand, some papers suggested that investors perceive GSCM as a signal of the ability of companies to be resilient in the short term and to create value in the long run (Danso et al., 2019). We define this view “GSCM as an effective drug against COVID-19”. Considering this tension in previous studies, we hypothesized and tested whether GSCM practices have any significant impact on firms’ abnormal stock returns during COVID-19 outbreak.

Our empirical analysis is performed on a sample of US companies. We gather data on the extent of the implementation of GSCM and we employ the difference-in-differences methodology. Consistently with the results by Zhu and Sarkis (2004) and Rao and Holt (2005), we find empirical evidence of a robust positive relationship between abnormal returns and GSCM. This means that GSCM did in fact play a significant role during the COVID-19 crisis and in how investors evaluated the ability of companies to generate value during and after the crisis.

In order to test the robustness of our results, we test whether the positive effect of GSCM on abnormal returns after COVID is stronger for companies operating in environmentally sensitive industries. We find that the “buffer effect” of GSCM is not influenced by whether companies operate in environmentally sensitive industries. On the contrary, the effect is similar for environmentally sensitive and non-environmentally sensitive companies. While this result seems counter-intuitive, it may help shed some light on the nature of GSCM to investors. More specifically, it is consistent with the notion that GSCM, although to a limited extent, does provide a positive signal to the market through the existence of knowledgeable and capable management.

Previous literature reviewed above suggests that GSCM may benefit companies in the context of COVID-19 because of long-term benefits (engagement with stakeholders and ability to develop new products, in the context of a business environment which is even more sensitive to sustainable and environmental issues, after COVID19) and/or because of short-term benefits (the ability of the company to be resilient during the crisis and to avoid negative effects). Our results seem to suggest—but this point requires further research—that investors were more interested in the short-term ability of companies to be resilient rather than to the environmental performance of companies.

In the short-term, both environmentally sensitive and non-environmentally sensitive industries would benefit from higher supply chain resilience and less supply chain disruptions. Conversely, it is reasonable to expect that the long-term benefit of GSCM would be more prominent for environmentally sensitive industries, under the condition that environmental sustainability will play a more prominent role in the post-COVID world.

This study contributes to the academic literature on GSCM, as previous studies did not reach a consensus on the effectiveness of GSCM. While some theoretical arguments and empirical results suggest that GSCM is effective (Barratt & Oke, 2007; Danso et al., 2019; Rao & Holt, 2005; Sen, 2009; Zhu & Sarkis, 2004), others do not (Amankwah-Amoah & Syllias, 2020; Jørgensen & Wilcoxen, 1990; King & Lenox, 2001; Seuring, 2001; Van Hoek, 1999). We find support for the effectiveness of GSCM, and we demonstrate that GSCM is a driver of business value and not a cost center (Wilkerson, 2005).

Companies may as benefit from our analysis as the effect of COVID-19 and other future inevitable pandemics will have a long lasting impact on the global economy. Companies may wish to consider the results of this paper in order to reexamine the role of supply chains in the post-COVID world.

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ENDNOTES

1 See Dun & Bradstreet white paper “The Worldwide Business Impact of the Coronavirus”, available at https://www.dnb.com/perspectives/supply-chain/coronavirus-business-impact.html (accessed November 1st 2020).
2 https://www.weforum.org/reports/the-global-risks-report-2020

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## Table A1  Variables definition and sources

| Variables | Definition | Source |
|-----------|------------|--------|
| **Dependent variable:** | | |
| AB_RET | The daily Abnormal return is the difference between daily return of a stock and the CAPM beta times the daily return of the market, expressed as a percentage. The CAPM beta is estimated by using daily returns from 2019. Information was retrieved from Thomson Reuters Eikon (Refinitiv). | |
| **Main Variables of Interest:** | | |
| GSCM | Is equal to 1 if a company have Green Supply Chain Management and 0 otherwise Information was retrieved from Thomson Reuters Eikon (Refinitiv). | |
| Post_COVID | Is equal to 1 in the period between February 24 to March 31 and 0 in the period before (Albuquerque et al., 2020; Ramelli & Wagner, 2020) | |
| Post_WHO | Is equal to 1 in the period between the March 11 to 31 and 0 in the period before WHO (2020) | |
| **Firm-level Controls:** | | |
| Tobins’ q | Book value of assets minus the book value of equity plus the market value of equity, all divided by book value of assets in period t | |
| Size | Is the natural logarithm of total assets for each company in period t | |
| Leverage | Is the ratio of liabilities and total assets in period t Information was retrieved from Thomson Reuters Eikon (Refinitiv). | |
| ROA | Is the return on asset composed of the ratio of net income in period t over the total assets in period t | |
| MTB | Market-to-book ratio (market value/book value) denoting company tangibility in period t. | |
| CASH | Cash holdings over book assets in period t. | |