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Do green supply chain management practices improve organizational resilience during the COVID-19 crisis? A survival analysis of global firms

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ABSTRACT

This study investigates whether green supply chain management (GSCM) practices help companies to be resilient against the buffer effect in the context of COVID-19. Building on the instrumental version of stakeholder theory, companies implementing GSCM practices should build environmental skills and competitive advantage to cope with a crisis caused by supply chain disruptions. Our survival analysis, conducted on 5,696 firms headquartered in 35 countries, shows clear evidence that GSCM companies’ market prices recover quickly from the shock. Considering mounting pressure on environmental issues, this study documents the new benefits of GSCM for companies confronted with a global financial shock. By applying a large sample, the study has originality and implications for stakeholders, including investors, governments, and policymakers, to push firms to become more eco-friendly and resilient.

1. Introduction

Extreme events like natural disasters, terrorist attacks, and pandemics frequently disrupt the supply chain and paralyze the financial markets. Hamel and Välikangas (2003) stated that “the world is becoming turbulent faster than organizations are becoming resilient”. Soon after naming it COVID-19 on the February 11, the current pandemic caused a severe 1-week decline after mid-February in the US market since the 2008 financial crisis due to the severe supply chains disruption (Fasan et al., 2021).

Besides, firms are under significant pressure from stakeholders to adopt environmentally sustainable practices (Flammer, 2013). Concerning the supply chains, firms are embracing the green supply chain management (hereafter, GSCM) practices by selecting suppliers and sourcing partners fulfilling environmental criteria (for example, ISO 14000, energy consumption, etc.) (Fasan et al., 2021). GSCM refers to a firm’s performance by improving its supply chain management to reduce the use of materials, energy, or water and to find more eco-efficient solutions.

The importance of these issues for firms leads us to question whether GSCM mitigates the negative consequences of the supply chain disruptions caused by COVID-19. Following Staw et al. (1981) and Meyer (1982), researchers have attempted to understand how organizations respond to external threats (Linnenluecke, 2017). Previous studies, for instance, Gittell et al. (2006) and Hamel and Välikangas (2003), focused on how firms adapt their business models in a turbulent environment. Organizational resilience (hereafter, OR), critical for firm success (Richtnérand Löfsten, 2014), is thus gaining more attention in the management literature. Organizational resilience is “the ability of a system to persist despite disruptions and the ability to regenerate and maintain existing organization” (Desjardine et al., 2019; Gunderson and Pritchard, 2002). Resilience is thus referred to as a firm’s ability to adapt to exogenous shocks and quick

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of materials, energy or water, and to find more eco-efficient solutions by improving supply chain management". Environmental data from Refinitiv are reliable and are widely used in academic literature. Refinitiv rates thousands of companies on a scale from 0 (the lowest) to 100; however, we divide the scores by 100 to bring them between 0 and 1. As a robustness check, we also perform the analysis using the specific "environmental supply chain management" information obtained from Refinitiv, also used by Fasan et al. (2021). Based on this, we create a binary variable (GSCMD) that equals 1 if "the firm uses environmental criteria (ISO 14000, energy consumption, etc.) in the selection process of its suppliers or sourcing partners" and 0 otherwise.

2.1.3. Control variables

We also include other variables in the analysis to account for their likely effect on OR in the crisis. Precisely, we have the environmental performance index (EPI) scores developed by Yale University in our study. Other variables such as the firm size (Size) are measured by the firm’s assets divided by the industry average; the book to market value ratio (B/M), debt to assets ratio (D/A), age (Age) calculated by the natural log of firm years from incorporation, historical beta (Beta) to firms local index calculated monthly over five years return, percentage of research & development expenditure to sales (RD), and capital expenditures scaled by total assets (CAPEX). Since research & development expenditure data is scarce, following Fama and French (2002), we include a dummy for RD, denoted by RDD. RDD is equal to 1 if research & development expenditure data is available and 0 otherwise. Besides these financial indicators, we also include a dummy for the firm’s industry and region of the firm’s country.

2.2. Sample

Our initial sample includes 7,576 firms available in the Refinitiv ESG dataset. As summarized in Table 1, the non-availability of necessary variables data reduced our final sample to 5,696 firms from 35 countries; 2,132 firms are headquartered in the USA, followed by China (656) and Japan (417). Though the sample is unbalanced, excluding the USA firms from the sample does not affect our results.

Descriptive statistics and correlation matrix are presented in Table 2. We winsorize the financial data at 1% and 99% levels to mitigate the impact of potential outliers. The time to recovery (OR) does not portray correct information since there are right-censored observations. Therefore, we present the summary statistics of RECOV Pr, which is equal to 1 if a firm is recovered within the 60 days time window and 0 otherwise. The mean RECOV Pr is 0.67, indicating that 67% of firms’ prices were retrieved within the time window. The mean GSCM is 0.39.

Table 1

| Sample selection | N |
|------------------|---|
| Refinitiv ESG data | 7,576 |
| Less: Green Supply Chain Management data unavailable | 24 |
| Less: EPI data of firm observations unavailable | 306 |
| Less: Datastream data is not available | 1,429 |
| Less: less than 20 observations by country | 121 |
| Final sample | 5,696 |

2. Methodology

2.1. Variables

2.1.1. Organizational resilience (OR)

Following DesJardine et al. (2019) and Marsat et al. (2022), we measure OR by the time to recovery of the daily stock prices to the pre-crisis level. We consider the stock prices on February 17, 2020, as the pre-crisis level because after this date stock markets started a decline in the third week of February 2020 (Ding et al., 2021). Following DesJardine et al. (2019) and Marsat et al. (2022), we measure OR in different time windows. To mitigate potential concerns that other variables may drive the recovery, we restrict the first time window to 20 trading days. To capture the full recovery trajectories of most firms, we extend the last time window to 120 trading days. We thus observe OR in six observation windows ranging from 20 to 120 trading days with almost one-month (20 trading days) increment.

2.1.2. Green supply chain management (GSCM)

GSCM reflects a firm’s performance in improving its supply chain management to reduce the use of materials, energy, or water and to find more eco-efficient solutions. To measure GSCM, we use Resource Use scores from Refinitiv Datastream, formerly known as Thomson Reuters ASSET4. “The resource use score reflects a company’s performance and capacity to reduce the use of materials, energy and to find more eco-efficient solutions. To measure GSCM, we use Resource Use scores from Refinitiv Datastream, formerly known as Thomson Reuters ASSET4. “The resource use score reflects a company’s performance and capacity to reduce the use of materials, energy and water, and to find more eco-efficient solutions by improving supply chain management”. Environmental data from Refinitiv are reliable and are widely used in academic literature. Refinitiv rates thousands of companies on a scale from 0 (the lowest) to 100; however, we divide the scores by 100 to bring them between 0 and 1. As a robustness check, we also perform the analysis using the specific “environmental supply chain management” information obtained from Refinitiv, also used by Fasan et al. (2021). Based on this, we create a binary variable (GSCMD) that equals 1 if “the firm uses environmental criteria (ISO 14000, energy consumption, etc.) in the selection process of its suppliers or sourcing partners” and 0 otherwise.

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Therelationshipcanbeexpressedasfollows:

\[ \text{the positive impact of covariates on the probability of recovery at time } t. \]

We perform the survival analysis to examine whether GSCM improves OR during the COVID-19 crisis. We specifically employ the Cox Proportional Hazard model (Cox, 1972), which estimates the impact of covariates on the probability of recovery at time t. The relationship can be expressed as follows:

\[ h_t(t) = h_0(t) e^{(\beta X)} \]

Where \( h_t(t) \) represents the probability of recovery for observation ith. \( h_0(t) \) is the baseline hazard function which this model leaves unestimated. \( X \) represents the independent as well as the set of control variables. Whereas \( \beta \) is the beta coefficient and its positive sign indicates that the respective covariate has a positive link with OR (i.e., a negative association with time to recovery).

The COVID-19 crisis may have a different effect across different countries; therefore, a random effect at the country level may affect the relationship. We thus consider the existence of a random effect at the country level. Our analysis uses the Shared Frailty Cox PH model to test for shared frailty at the country level.

### Table 3

| Organizational Resilience (Time to Recovery) | (1) | (2) | (3) | (4) | (5) | (6) |
|---------------------------------------------|-----|-----|-----|-----|-----|-----|
| RECOV Pr                                    | .05 | .27*** | .33*** | .35*** | .32*** | .29*** |
| GSCM                                        | (2.82) | (4.57) | (5.58) | (6.16) | (5.61) | (4.89) |
| EPI                                         | 1.2 | 2.18** | 1.12 | 1.02 | 1.27 | 1.97* |
| SIZE                                        | (1.08) | (2.01) | (1.17) | (1) | (1.17) | (1.83) |
| B/M                                         | .02*** | .02** | .02** | .01*** | .01** | .01 |
| ROA                                         | (5.13) | (4.21) | (3.29) | (2.92) | (2.33) | (1.3) |
| D/A                                         | .21*** | .18*** | .19*** | .18*** | .18*** | .17*** |
| Age                                         | (7.8) | (6.51) | (6.87) | (6.51) | (6.24) | (5.66) |
| ROA                                         | .24 | .4** | .69** | .71** | .82** | 1.34*** |
| D/A                                         | (5.11) | (5.21) | (5.28) | (5.75) | (3.47) | (3.17) |
| Beta                                        | .12*** | .12** | .13** | .13** | .08** | .08** |
| RD                                          | .43*** | .34** | .32** | .32** | .28** | .34** |
| Age                                         | (4.87) | (3.9) | (3.71) | (3.9) | (3.37) | (3.96) |
| Beta                                        | (5.71) | (5.21) | (5.28) | (5.75) | (3.47) | (3.17) |
| RD                                          | .01 | .05 | .12** | .09*** | .16*** | .16*** |
| RDD                                         | (1.5) | (1.33) | (3.4) | (2.62) | (4.53) | (4.41) |
| CAPEX                                       | .09** | .04** | .04** | .04** | .03** | .02*** |
| Industry                                    | (.986) | (.974) | (.915) | (.921) | (.69) | (.51) |
| Region                                      | (.986) | (.974) | (.915) | (.921) | (.69) | (.51) |
| theta                                       | -.07 | -.1* | -.1* | -.1* | -.09 | .03 |
| Recovered N                                 | (.145) | (.213) | (.231) | (.29) | (.19) | (.37) |
| Observations                                | (.371) | (.277) | (.95) | (.87) | (.02) | (1.58) |

Organizational Resilience (OR) is the dependent variable, measured by time to recovery. GSCM represents green supply chain management measured by resource use scores from Refinitiv. \( * p<0.01, ** p<0.05, * p<0.1 \)
Table 4
Impact of GSCM on organizational resilience (Cox PH Shared Frailty Model).

|                | Time | Time | Time | Time | Time | Time |
|----------------|------|------|------|------|------|------|
| GSCM           | .02  | .1***| .12***| .14***| .12***| .09**|
|                | (.52)| (2.67)| (3.37)| (3.84)| (3.23)| (2.35)|
| Controls       | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  |
| Industry       | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  |
| Region         | Yes  | Yes  | Yes  | Yes  | Yes  | Yes  |
| Observations   | 5696 | 5696 | 5696 | 5696 | 5696 | 5696 |

Organizational resilience (OR) is the dependent variable, measured by time to recovery. GSCM is a dummy variable that is equal to 1 if “a firm uses environmental criteria (ISO 14000, energy consumption, etc.) in the selection process of its suppliers or sourcing partners”, and 0 otherwise. t-values are in parentheses.

Table 5
Robustness check (60 days time window).

|                | (1)     | (2)     | (3)     | (4)     | (5)     | (6)     |
|----------------|---------|---------|---------|---------|---------|---------|
|                | OR      | OR      | OR      | RECOV Pr.| S.Loss  |         |
| Weibull        | .34***  | .34***  | .39***  | .43***  | −.03*** |         |
| (5.84)         | (5.76)  | (6.61)  | (6.68)  | (−7.42) |         |         |
| GSCM           | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Controls       | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Industry       | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Region         | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Observations   | 5696    | 5696    | 5696    | 5696    | 5696    | 5694    |

OR represents the Organizational Resilience measured by time to recovery. “RECOV Pr” represents the probability of recovery, equals 1 if a firm is recovered in the 60 days time window, and 0 otherwise. S.Loss represents the severity of maximum loss in stock prices in the 60 days time window. GSCM represents green supply chain management measured by resource use scores from Refinitiv. t-values are in parentheses.

As a robustness check, we first re-estimate the previous models by replacing GSCM with the binary variable (GSCMD). As shown in Table 4, the relationship is consistent with our previous findings. Secondly, we re-estimate other shared frailty survival models, i.e., Weibull, Gompertz, and Exponential models, and the Probit model using the RECOV Pr and OLS regression model using the severity of loss (S.Loss) in market prices. For a 60-day time window, Table 5 shows the results are coherent with our previous findings. Moreover, further tests, not tabulated, show that the relationship is the same for firms from high and low carbon-intensive sectors. This is coherent with the findings of Fasan et al. (2021) that GSCM is positively and significantly related to firms’ performance recovery irrespective of environmentally sensitive industry.

Overall, our findings suggest that GSCM improves a firm’s ability to deal with the financial crisis caused by COVID-19. We find that GSCM significantly mitigates the time to recover from the crisis, enhancing the organization’s financial resilience. We found this finding robust to alternative measures of GSCM and OR and using different analysis models.

In line with the instrumental version of the stakeholder theory (Donaldson and Preston, 1995; Jones, 1995), GSCM may benefit firms to cope with the COVID-19 crisis because of environmental skills and long-term relations with stakeholders leading to competitive advantage. Since Fasan et al. (2021) found that GSCM is positively related to abnormal returns, our results complement their finding that GSCM also improves firms’ share price recovery.

4. Conclusion

This study at hand tackled an unexplored question of investigating whether GSCM improves a firm’s recovery from the COVID-19 crisis. This study provides empirical evidence that the firms that implement GSCM practices are far better in recovery from the adverse effects of economic and financial crises resulting from the COVID-19 pandemic. After performing the survival analysis over an international sample from 35 countries, our findings suggest that implementing GSCM practices help firms to cope with the COVID-19 crisis since they recover quickly. In other words, the firms with GSCM practices recover to their performance, such as pre-crisis share price levels earlier than those without GSCM practices. Results of additional statistical tools suggest that our findings are robust and can be used for policy implications for various stakeholders directly or indirectly related to those firms. The study has theoretical and methodological significance by investigating the rarely tested relationship between the GSCM and the organizational resilience of global companies during the COVID-19 crisis.

Since previous studies did not agree on the GSCM effectiveness, we make an important contribution to the academic literature by highlighting its unexplored benefit, namely organizational resilience. Our findings stimulate corporate managers to prepare for situations like COVID-19 in the future and all stakeholders, including investors, governments, and policymakers, to push firms to become more eco-friendly and resilient.

Data availability

The authors do not have permission to share data.

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