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Determinants of a Firm's Sustainable Competitive Advantages under Supply Chain Disruptions

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Abstract

This study examined the significance and mechanisms of the roles of the determinant factors play in gaining sustainable competitive advantage. The factors include supply chain resilience, performance, and awareness of potential disruptions. The investigation was conducted within manufacturers in the US in the context of their supply chain operations under disruptions. Employing a linear regression on the four factors, this empirical examination shows that supply chain resilience, performance, and awareness of potential disruptions exert positive effects on the improvement of sustainable competitive advantage. Additionally, this study investigated the role of market volatility, which plays a negative role in building sustainable competitive advantage and the role is marginal. The findings of this study offer practical implications to supply chain managers. Limitations of this study suggest future research directions. First, the regression analysis was based on a dataset with small sample size, which might constrain the generalizability of the findings of the investigation. Further research might include a substantial sample size to better represent the manufacturers in the US. Second, inventory management can impose disruptions on supply chain operations and generate ripple effects in a supply chain. However, it is not considered in the study. Future research is expected to assess its role in building sustainable competitive advantage.

Keywords: Sustainable competitive advantage, Supply chain resilience, Performance, Market volatility, Awareness, Disruption.

1. Introduction

Supply chain disruptions are unanticipated events that interrupt usual operations of a supply chain and put supply chain firms at risk financially and operationally. During unprecedented supply chain disruptions, traditional supply chain practices such as globalization and lean operations could increase supply chain vulnerability because of the imbalance of product supply and customer demand. For instance, during the Covid pandemic, highly increased demand for masks and medical products resulted in severe supply shortage and automobile companies had to switch to produce masks and personal protective equipment to cope with the unexpected changes in the market. Such vulnerability leads to more disruptions in supply chain processes including planning, sourcing, manufacturing, delivery, and return. The disruptions' ripple effect adversely influences supply chain parties from suppliers, manufacturers, distributors, to customers. To survive and recover from supply chain disruptions, it is crucial for firms to gain sustainable competitive advantages through supply chain management. Prior studies suggested that building supply chain resilience (e.g., Zhao, et al., 2023) and fostering awareness of potential disruptions (e.g., Stephens, et al., 2022) can be effective ways to cope with the adversities. However, research on the link between supply chain resilience or awareness of potential supply chain disruptions and sustainable competitive advantages is scarce. Furthermore, market volatility has not been considered as an explanatory factor for sustainable competitive advantages.

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Lastly, improved supply chain performance might help gain a firm's sustainable competitive advantages under supply chain disruptions, which has not been discussed in the literature. This study aims to fill these research gaps by examining the determinant roles of both internal and external factors in building sustainable competitive advantages. To explore the determinant factors of sustainable competitive advantage, we will conduct an empirical investigation within the manufacturers in the US in the context of supply chain operations to evaluate the significance and mechanism of the roles of both internal and external factors including supply chain resilience, performance, market volatility, and awareness of potential supply chain disruptions. The anticipated findings of this study would be significant impact of the four factors, with internal factors exerting positive impact and external factor (market volatility) exerting negative impact on sustainable competitive advantage.

2. Literature Review

Prior studies have empirically investigated determinant factors of achieving sustainable competitive advantage in different contexts and regions. It is suggested that knowledge management and dynamic capabilities foster sustainable competitive advantages through a survey conducted in Iran (Beigi et al., 2023). This survey was conducted from Iranian knowledge firms in the context of general business environment. Another study performed by Lee and Yoo (2021) assessed the role of marketing and innovation capability in enhancing sustainable competitive advantage within small business enterprises in Korea. The results show both capabilities are contributing factors to the improvement of sustainable competitive advantage. Two studies were conducted respectively in Indonesia. Suryantini et al. (2023) examined the five factors of achieving sustainable competitive advantage including technology adoption, intellectual capital, strategic flexibility, open innovation, and business performance within small and medium enterprises. The other study by Astuti et al. (2023) suggested that sustainable competitive advantage is dependent on three types of capitals (human, relational, and structural). Strategic flexibility is also a determinant of sustainable competitive advantage in a study of Malaysian hotels (Hossain et al., 2022).

The empirical studies on the determinants of sustainable competitive advantage in the relevant literature focused on eastern cultures in the context of general business management. Since global supply chain operations were largely disrupted during the Covid pandemic, to achieve sustainable competitive advantages, they need to be restored (resilience), maintain efficient operations (performance), and disruption-oriented (awareness of potential disruptions) in turbulent markets (market volatility). In particular, the three capabilities of readiness, response, and recovery of supply chain resilience cope with three phases of supply chain disruptions respectively including before, during, and after disruptions (Ali et al., 2022; Zhao et al., 2023). The capabilities embedded in supply chain resilience equip firms with dynamic capabilities in different phases of disruptive events. Post Covid, it is of paramount importance to examine the factors determining sustainable competitive advantages in the context of supply chain management within manufacturers in the US. Thus, this study assesses the significance and mechanism of the roles of the factors including supply chain resilience, performance, market volatility, and awareness of potential supply chain disruptions in the context of supply chain operations within manufacturers in the US.

3. Research Methodology

3.1 Dataset

The dataset was collected through a web survey. A list of emails were selected from D&B Hoovers based on functional groups in the US. We chose the following screening criteria for the email list: manufacturing and operations related functional groups, industry index of 31, 32, and 33 indicating manufacturing industry, contact levels at vice presidents, senior vice presidents, and executive vice presidents, job functions as manufacturing executive, operations executive, and purchasing executive, employees (single site) more than 100, revenue more than 1 million. A link to the survey was sent to each identified respondent. After two rounds of data collection, we received 83 responses in total. The industries include Materials and Industrial Machinery, Construction and Engineering, Electronic Products

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and Telecommunications, Chemical and Pharmaceutical/Healthcare, Energy, Automotive and Transportation, Food and Beverages, Textiles and Clothing, Automotive and Transportation, and others.

3.2 Missing Value Analysis and Non-Response Bias

There are different ways to cope with a missing value in a dataset. Scholars can either delete an observation with missing values or replace missing values with the mean, median, or mode. Data selection bias might be introduced when the observations with missing values are all deleted. We choose not to delete an observation if the missing values are less than 25%. 2 out of 83 collected observations were removed due to more than 25% values missing. For the rest of the 81 observations, we replaced the missing value of categorical variables with the mode and replaced the missing value of quantitative variables with the median. As a result, for the rest of the data analyses, 81 samples were included in the study.

Since the data were collected through two rounds of efforts, we need to check the non-response bias by comparing the respondents in the two rounds. ANOVA was performed for the analysis of comparison between the two rounds of data collection. The results show that the difference is ignorable at $p \leq 0.05$ in terms of the firm's size, age, and annual sales. Thus, there is no evidence for non-response bias in the data collection efforts.

3.3 Scale Development for Independent and Dependent Variables

In this study, we included one dependent variable and four independent variables. In particular, for the four independent variables, a firm's supply chain resilience, performance, and its awareness of potential disruptions are internal factors and market volatility as an external factor.

All scales used in the survey were either adopted, adapted, or newly developed from previously published articles in an extant literature review. In particular, sustainable competitive advantage (ca) is a dependent variable, which is measured by six items in the questionnaire to reflect the level of recognition from customers, reputation of products, differentiation in products, loyalty of customers and connections with them, and just-in-time delivery in the face of disruptions. This measure was from Abeysekara et al. (2019).

Four independent variables in this study include supply chain resilience (resi), performance (scp), market volatility (vola), and awareness of potential disruption (aware). The scale for supply chain resilience was gauged by three questions developed through an extant review of the literature. There are many resilience scales in the literature, however, few of them reflect the capabilities of supply chain transformability, adaptability, and agility. In this study, the measure of supply chain resilience (resi) taps the degree to which the respondent firms' transformability, adaptability, and agility in under disruptions. Supply chain performance (scp) is measured by the degree of reduction in costs and lead time and by the level of process flexibility and customer satisfaction. Market volatility (vola) is measured by capturing the degree of changes in a respondent firm's business environment and its products, customers' needs, supplier capabilities, and competitors' products. For the measure of awareness of potential supply chain disruptions (aware), we adapted from Bode et al. (2011). It includes six items in the questionnaire about a firm's supply chain disruption experience, alertness and awareness of potential disruptions, improvement for coping with potential disruptions, measures to reduce the disruption impact, and disruption analyses.

3.4 Descriptive Statistics

In this study, we used uniform and consistent scale measurement from 1 (strongly disagree/not at all/very stable) through 5 (strongly agree/a very large extent/very volatile). There is no issue for consistency and normality for the scales. Descriptive statistics shown in Table 1 include minimum and maximum value

Table 1. Detailed Statistics

	N	Min	Max	Mean	Std. Dev.
ca	81	1.00	5.00	3.5523	.75711
resi	81	1.00	5.00	3.4846	.74304
scp	81	1.00	5.00	3.5185	.80891
vola	81	1.00	4.75	2.8323	.71133
aware	81	1.33	5.00	3.6144	.67016
Valid N (listwise)	81				

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for each variable, and their respective mean and standard deviation. The mean of the five variables included in the study ranges from 2.83 to 3.61 with 81 valid samples entered in the model.

3.5 Correlations

Correlation matrix shows the relationships between the variables which are included in the study. The coefficient of correlation is from 0 (no correlation) to 1 (perfect correlation). The significance of the correlation between two variables reflects whether a correlation is significant. The following criteria is used for significance testing:

When the significance level is less than 0.005, it is strongly significant;
When the significance level is between 0.005-0.01, it is significant;
When the significance level is between 0.01-0.05, it is moderately significant.

Table 2. Correlations

		ca	tran	scp	vola	aware
Pearson Correlation	ca	1.000	.771	.704	.023	.655
	resi	.771	1.000	.708	.025	.706
	scp	.704	.708	1.000	.142	.543
	vola	.023	.025	.142	1.000	-.003
	aware	.655	.706	.543	-.003	1.000
Sig. (1-tailed)	ca	.	<.001	<.001	.420	<.001
	resi	.000	.	.000	.412	.000
	scp	.000	.000	.	.104	.000
	vola	.420	.412	.104	.	.489
	aware	.000	.000	.000	.489	.

As shown in Table 2, sustainable competitive advantage is significantly correlated with supply chain resilience, performance, and awareness of potential disruptions.

The correlations matrix in Table 2 also shows that there exists significant correlation between several predictor variables, we need to check for multicollinearity to see whether the correlations are severe enough to affect the regression and results interpretation.

3.6 Reliability Test of the Scales

Reliability of the scales refers to the internal consistency of the items in the scale measurement. It is tested using SPSS to show the Cronbach's alpha coefficient for each scale in the analysis. The coefficient indicates whether the measurement items are internally consistent and reliable. When a coefficient has a value greater than 0.70, the scale has acceptable reliability. In this study, we tested reliability for each variable. Tables 3-7 show the results of reliability test for the five variables respectively. The alpha coefficients are from 0.80 to 0.90, exceeding the threshold 0.70, indicating good reliability for each scale. In particular, Cronbach's alpha for sustainable competitive advantage is 0.89 (Table 3), resilience is 0.80 (Table 4), supply chain performance is 0.85 (Table 5), market volatility is 0.83 (Table 6), and awareness of potential supply chain disruption is 0.86 (Table 7). The last column in the table shows the Cronbach's alpha coefficient if an item is deleted. We remove an item from the measurement for a scale when the coefficient increases significantly after

Table 3: Reliability statistics for sustainable competitive advantage

Alpha	Alpha with Standardization	N
.897	.898	6

Statistics for Item-Total

	Mean with Deletion	Variance with Deletion	Correlation	Squared Correlation	Alpha with Deletion
ca1	17.67	14.400	.768	.678	.872
ca2	17.63	13.811	.830	.756	.862
ca3	17.81	15.378	.627	.435	.893
ca4	17.81	14.178	.783	.645	.870
ca5	17.68	14.346	.776	.671	.871
ca6	17.81	15.403	.562	.385	.904

Table 4. Reliability statistics for resilience

Alpha	Alpha with Standardization	N
.803	.803	4

Statistics for Item-Total

	Mean with Deletion	Variance with Deletion	Correlation	Squared Correlation	Alpha with Deletion
resi1	10.58	5.447	.560	.404	.779
resi2	10.52	4.803	.697	.516	.712
resi3	10.25	4.988	.642	.433	.741
resi4	10.32	5.146	.571	.379	.776

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an item is removed. We also remove an item when the coefficient becomes greater than 0.70 after the removal. Consequently, we don't need to remove any item in this study based on the outcomes of the reliability testing.

Table 5: Reliability statistics for supply chain performance

Alpha		Alpha with Standardization		N	
.846		.848		4	
Statistics for Item-Total					
	Mean with Deletion	Variance with Deletion	Correlation	Squared Correlation	Alpha with Deletion
scp1	10.60	6.370	.733	.618	.787
scp2	10.74	6.044	.711	.620	.793
scp3	10.51	6.050	.686	.491	.804
scp4	10.41	6.397	.612	.424	.836

Table 6: Reliability statistics for market volatility

Alpha		Alpha with Standardization		N	
.831		.832		4	
Statistics for Item-Total					
	Mean with Deletion	Variance with Deletion	Correlation	Squared Correlation	Alpha with Deletion
vola1	8.33	4.500	.665	.446	.785
vola2	8.54	5.026	.636	.406	.796
vola3	8.49	4.778	.687	.472	.774
vola4	8.59	4.819	.651	.424	.790

Table 7: Reliability statistics for awareness of potential supply chain disruption

Alpha		Alpha Standardization		N	
.856		.858		6	
Statistics for Item-Total					
	Mean with Deletion	Variance with Deletion	Correlation	Squared Correlation	Alpha with Deletion
aware1	18.37	12.722	.431	.236	.871
aware2	17.97	12.281	.659	.538	.830
aware3	17.94	11.547	.684	.505	.824
aware4	18.09	11.364	.731	.562	.815
aware5	18.09	11.159	.694	.583	.822
aware6	18.09	11.184	.689	.583	.823

3.7 Multicollinearity Test

In regression analyses, multicollinearity exists when independent variables are correlated and these variables cannot offer unique information as they are supposed in the model. With multicollinearity, issues could be caused in modeling fitting and result interpretation. To avoid multicollinearity, we used mean-centered value for both dependent and independent variables (Aiken and West, 1991). As shown in Table 8, the collinearity tolerance values for the variables are from 0.35 and 0.97, which exceed 0.10. The threshold value is 0.10 for collinearity tolerance in the regression model (Hair et al., 1998).

At the same time, we also checked the variance inflation factor (VIF) in the output of the regression model to see whether the correlations between the independent variables are strong. The threshold value for VIF is 5. When VIF is greater than 5, a potential strong correlation between independent variables would cause multicollinearity, which results in unreliable outcomes of a regression model. Table 8 shows that the VIF of the independent variables ranges from 1.04-2.85, indicating that multicollinearity between the independent variables is at a low degree and can be ignorable.

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4. Linear Regression and Results

We performed linear regression using SPSS by entering sustainable competitive advantage as dependent variable and the other four as independent variables including supply chain resilience, performance, market volatility, and awareness of potential disruptions. The regression results are presented in Tables 8 and 9. Standardized coefficients (Beta) and significance level for the t-value indicate whether a predictor variable is significant and has explanatory power for the dependent variable.

The results show that out of the four predictors, three are significant and one is non-significant. Sustainable competitive advantage is dependent on three factors including supply chain resilience, performance, and awareness of potential disruptions. However, market volatility only plays a marginal role in improving sustainable competitive advantage. As expected, the results show a negative impact on sustainable competitive advantage with a coefficient Beta of -0.03. Although it is not significant, they are related in a negative way. That is, a high level of market volatility will lower the level of sustainable competitive advantage. For the other three predictor variables, they all have positive coefficient Beta, indicating positive effects on sustainable competitive advantage. When supply chain resilience, performance, and awareness of potential disruptions increase, sustainable competitive advantage will be improved. Table 9 shows the linear regression model is significant at the significance level less than 0.001, which means that the predictor variables explain a great amount of variance in sustainable competitive advantage. The value of R square of 0.64 in Table 9 means 64% of variance in sustainable competitive advantage can be explained by the regression on the four predictor variables.

4.1 The linear regression equation in the model is as follows

Sustainable competitive advantage =
0.36+0.43×supply chain resilience
+0.29×supply chain performance
-0.03×market volatility
+0.22×awareness of potential supply chain disruptions

4.2 The interpretation of the results are as follows

The intercept is the value of the dependent variable when explanatory variables take on the value of zero. This is not always possible in some cases. The intercept is only meaningful when the independent variables can hold a value of zero, otherwise, the intercept can only determine the position of the regression line in the graph. In this study, the intercept of the regression model is 0.36, which is not meaningful since the four predictor variables cannot have a value of zero. For example, it is barely possible for supply chain resilience, performance, market volatility, awareness of potential disruptions to have a value of zero.

4.3 At the significance level of 0.05,

On average, holding other predictor variables constant, when supply chain resilience increases by one-unit, sustainable competitive advantage will be improved by 0.43 unit.
On average, holding other predictor variables constant, when supply chain performance is enhanced by one-unit, sustainable competitive advantage will be improved by 0.29 unit.
On average, holding other predictor variables constant, when market volatility increases by one-unit, sustainable competitive advantage will be reduced by 0.03 unit.
On average, holding other predictor variables constant, when awareness of potential supply chain disruptions is boosted by one-unit, sustainable competitive advantage will be improved by 0.22 unit.

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Table 8. Coefficients[a]

Model					t	Sig.	Interval of Confidence (0.95) for B		Collinearity	
		B	Std. Error	Beta			Lower	Upper	Tolerance	VIF
1	(Constant)	.361	.347		1.041	.301	-.330	1.052		
	resi	.426	.114	.418	3.731	<.001	.199	.654	.351	2.845
	scp	.288	.090	.308	3.208	.002	.109	.467	.480	2.085
	vola	-.033	.072	-.031	-.456	.649	-.176	.110	.967	1.035
	aware	.217	.106	.192	2.041	.045	.005	.429	.497	2.012
a. Dependent Variable: ca										

Table 9: Summary of the Regression Model

Model	R	R Square	Adjusted	Std. Error	Statistics for Change				
					Change in R Square	F Change	df1	df2	Sig. F Change
1	.815[a]	.664	.647	.44999	.664	37.616	4	76	<.001
a. Predictors: (Constant), aware, vola, scp, resi									

5. Managerial Implications

This study assessed the roles of four factors (supply chain resilience, performance, market volatility, and awareness of potential disruptions) play in developing a firm's sustainable competitive advantage under unanticipated supply chain disruptions. The investigation was conducted within manufacturers in the US in the context of supply chain operations. The findings of this empirical investigation provide several implications for supply chain professionals. First, managers are suggested to focus on building resilience to cope with adversities. In particular, supply chain firms should be capable of (a) restoring and reforming processes to overcome adversities induced by disruptions; (b) reconfiguring both external and internal resources to restore normal operations during and after disruptions; (c) ensuring continuity of restored operations; (d) meeting evolving market demand. Second, it is crucial for supply chain managers to lower costs, shorten lead time, enhance process flexibility, and improve customer satisfaction. Third, supply chain firms are suggested to bolster marketing capabilities to rapidly cope with the unpredictable changes in customer requirements and supplier capabilities as well as competitors' products. Fourth, managers are encouraged to promote a risk management culture and awareness of potential risks so that disruption orientation can be fostered within an organization.

6. Conclusion

This study examined the determinants of a supply chain firm's sustainable competitive advantage under supply chain disruptions employing a linear regression on supply chain resilience, performance, market volatility, and awareness of potential supply chain disruptions. It contributes to the literature and offers practical implications for supply chain managers. Three factors play significant and positive roles in improving sustainable competitive advantage except for market volatility, which has marginal explanatory power with a negative association with sustainable competitive advantage. The findings of this study offer practical implications for supply chain professionals that internal factors including supply chain resilience, performance, and awareness of potential disruptions play vital roles in improving sustainable competitive advantage, while external factor such as market volatility is less significant in bolstering sustainable competitive advantage. This study contributes to the existing literature by considering both internal and external factors in assessing the role of determinant factors of sustainable competitive advantages. This study also helps us better understand the mechanism by which supply chain resilience, performance, awareness of potential disruptions, and market volatility exert impact on the improvement of sustainable competitive advantage.

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The limitations of this investigation lie in the fact that the regression analysis was based on a dataset with small sample size, which might constrain the generalizability of the findings of the investigation. Further research might include a substantial sample size to better represent the manufacturers in the US. Furthermore, inventory management can impose disruptions on supply chain operations and generate ripple effects in a supply chain. However, it is not considered in the study. Future research is expected to assess its role in building sustainable competitive advantage.

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