

# Achieving Supply Chain Resilience: The Role of Network Capability and Supply Chain Visibility

Yuanhao Wu<sup>1</sup>, Shuang Zhao<sup>2</sup>

<sup>1</sup>School of Economics and Management, Dalian University, Dalian, 116622, China

<sup>2</sup>School of Economics and Management, Dalian University, Dalian, China

**Keywords:** Network capability; Supply chain resilience; Supply chain visibility

**Abstract:** The outbreak of COVID-19 has disrupted supply chains around the world. How to quickly respond to the crisis and achieve supply chain resilience has attracted widespread attention from researchers and practitioners. Based on IPT, this study aims to explore how network capability and supply chain visibility affect supply chain resilience. Through a survey of China's manufacturing industry, the mediating role of supply chain visibility and the moderating role of environmental dynamism is proposed and tested. The results show that supply chain visibility plays a partial mediating role between network capability and supply chain resilience, and environmental dynamism negatively moderates the impact of network capability on supply chain resilience. This study deepens network capabilities' understanding of supply chain resilience and provides managerial insights on how to improve supply chain resilience in a dynamic environment.

## 1. Introduction

In recent years, competition is no longer between firms, but among supply chains. With the competition's intensification, the supply chain faces a sea of events, including irresistible natural disasters, or human factors, which may interrupt normal business operations. All of those events that cause supply chain interruption have common features: Low occurrence but far-reaching effects; Their scale and type are difficult to identify; It's intermittent and irregular<sup>[1]</sup>. Since 2020, the Covid-19 virus has rapidly spread across the world. The impact of the Covid-19 pandemic continues to ricochet across the globe despite the efforts made by the government, worsening performance entailing lower revenues. From a business continuity perspective, it is causing tremendous disruptions to the supply chains of countless different industries.

In a recent study by the World Economic Forum and Accenture, 80% of firms reported that resilience to supply chain disruptions has become a prioritized task. Firms also realized the negative impact of supply chain disruptions and began to pay attention to the construction of supply chain resilience (SCR) to mitigate the impact of disruptions. SCR has gradually become an indispensable core mechanism for organizations to effectively deal with risk crises. Therefore, as the ability of the supply chain to recover and maintain the continuity of material, information, and cash flows in the presence of supply chain disruptions, SCR gets more attention from scholars and practitioners<sup>[2]</sup>. As Remko (2020) argues, empirical studies on improving during the COVID-19 crisis have made both theoretical and practical contributions<sup>[3]</sup>. So, this paper will continue the study of previous scholars and analyze how to enhance SCR effectively to deal with the subsequent possible interruption of the supply chain.

This paper develops a research framework based on IPT and the literature, and then empirically validate the relationship between NC, SCV, and SCR through a survey targeting manufacturers in China. Our study contributes to the literature in several ways. First, this study enriched supply chain management literature and fills the research gap by connecting NC and SCR, strengthening the NC implications in improving SCR. Second, the study introduces SCV into the model, which explains a mechanism that how NC relates to SCR through SCV. Finally, based on IPT, we identify a contextual factor, environmental dynamism, to investigate the effect of NC on SCR.

## 2. Theoretical Model and Hypothesis Development

### 2.1 Network Capability and Supply Chain Resilience

According to Ritter(2003), Network capability (NC) includes two dimensions which are task execution and qualification<sup>[4]</sup>. Dimension 1 is task execution, which includes relationship-specific tasks and cross-relationship tasks. Cross-relationship task mainly focuses on the simultaneous management of multiple strategic relationships and the interconnectedness of these relationships. IPT confirms that the firm, as a highly open information processing system, must deal with a variety of information from uncertain sources. The cross-relationship task can effectively and timely transmit information within the supply chain network, reducing the risk of sending conflicting and confusing information to partners, sensing the presence or absence of crisis factors, reduce the occurrence of disruptive supply chain behavior, prevent disruption, and improve the ability to deal with risks. Direct contact between individuals and firms can effectively transmit important information, and contribute to the strategic integration of firms. This helps to provide firms with the latest external information for decision-making, to cope with the possible supply chain disruption crisis, and improve SCR.

H1a: Task execution has a positive impact on supply chain resilience.

Dimension2 is qualifications, which can be divided into specialist qualifications and social qualifications<sup>[4]</sup>.IPT points out that by strengthening the connections between firms in the supply chain, it is possible to directly integrate, share, and transmit a large amount of information, reduce information distortion and ensure quality, enhance the firm`s ability of information process . Therefore, partner knowledge plays a crucial role in information processing. Knowledge about the other actors plays a vital role in this aspect. This knowledge includes information about the operations of partners, their personnel, and resources, which are important for understanding their behavior and the development of the network. Learning expertise and knowledge from partners contribute to the development of cooperation and trust between businesses. As a source of sustainable competitive advantage, high-level cooperation ability can improve the coping ability in the face of uncertainty and improve SCR.

Based on those arguments, the paper hypothesize that:

H1b: Qualifications have a positive impact on supply chain resilience.

### 2.2 The Mediating Role of Supply Chain Visibility

NC allows supply chains to establish an open dialogue with their supply chain partners as well as develop trust with them, which helps to reach effective operations with supply chain firms, and improve the transparency of communication between supply chains.

Relationships between organizations do not arise spontaneously and are the result of specific investments. Identify potential partners by leveraging existing partner tips and visiting trade shows, all of which are task execution initiate activities<sup>[4]</sup>. The exchange will allow the flow of products, services, funds, information, and proprietary technology between supply chains. Coordination combines supply chain firms into a network designed for mutually supportive communication, so that they can coordinate operations, improve the flow of information and enhance the accessibility of information across supply chain firms, enhancing SCV.

Qualifications enable employees to communicate and deal with risks and conflicts<sup>[4]</sup>. These individual abilities are used to manage inter-firm relationships and are considered organizational attributes. Managing the relationship between partners is very important for the consistency of strategic objectives between customers and suppliers and the promotion of long-term business planning. This means that firms can coordinate partnerships through employee social qualifications, and use and share resources and capabilities through programs to gain partner knowledge, to improve the level of information exchange, which has great significance to improve visualization among firms.

Through reading and reviewing the literature on SCV, we found three topic characteristics of SCV, namely: accessibility, quality, and usefulness of information. First of all, higher SCV provides an in-depth understanding of the firm's owners and its supplier's sourcing processes. It can improve the clarity of the procurement process and enhance the preparation and response-ability of the supply chain<sup>[5]</sup>. Secondly, SCV can predict the change in demand and inventory information of the supply

chain in a timely. At the same time, improve the accuracy of demand forecasting to adapt to the change needs, which can guide the next production strategic plan. Thirdly, SCV is considered to be a key factor used to reduce supply chain risks.

So NC will enhance the quality and level of information collection while improving the organization's information processing and decision-making capabilities, thereby strengthening the ability of firms to connect with major suppliers and customers, thus enabling firms to have a better understanding of information among the supply chains. The improvement of SCV is a qualitative leap in the efficiency, quality, and quantity of information transmission in the supply chain. Therefore, firms can operate and manage according to more accurate information. At the same time, the construction of SCV helps to realize the interconnection of upstream and downstream supply chains and form a community of shared future, which will make the decision-making of firms more integrated, especially when facing the risk of supply chain interruption, it can effectively improve responsiveness and SCR.

Based on the above arguments, the paper proposes the following hypotheses:

H2a: Supply chain visibility positively mediates the relationship between task execution and supply chain resilience.

H2b: Supply chain visibility positively mediates the relationship between qualifications and supply chain resilience.

### 2.3 The Moderating Role of Environmental Dynamism

Generally, environmental dynamism describes the rate and instability of changes in a firm's external environment. Study shows that environmental variables impact the implementation of supply chain management-related practices and their outcome. Especially in a highly unstable environment, opportunities flow rapidly, market demand is constantly changing, and the threat of competitors reduces the coordination between supply chain enterprises and the ability to communicate information. As a result, forecasting and the implementation of operational responses are more complex and difficult in contrast with stable environments. With the increase in environmental vitality, it will be difficult for all interested parties, to accurately assess the current and future environmental conditions. Rising environmental dynamism may increase operational complexity and expose firms to greater risks and vulnerabilities, leading to supply chain disruptions<sup>[6]</sup>. Therefore, environmental dynamism will have a terrific influence on information exchange and cooperation between supply chains, affecting SCR.

H3a: Environmental dynamism negatively moderates the direct effect of task execution on supply chain resilience.

H3b: Environmental dynamism negatively moderates the direct effect of qualifications on supply chain resilience.

Figure 1 presents the conceptual framework of this study.

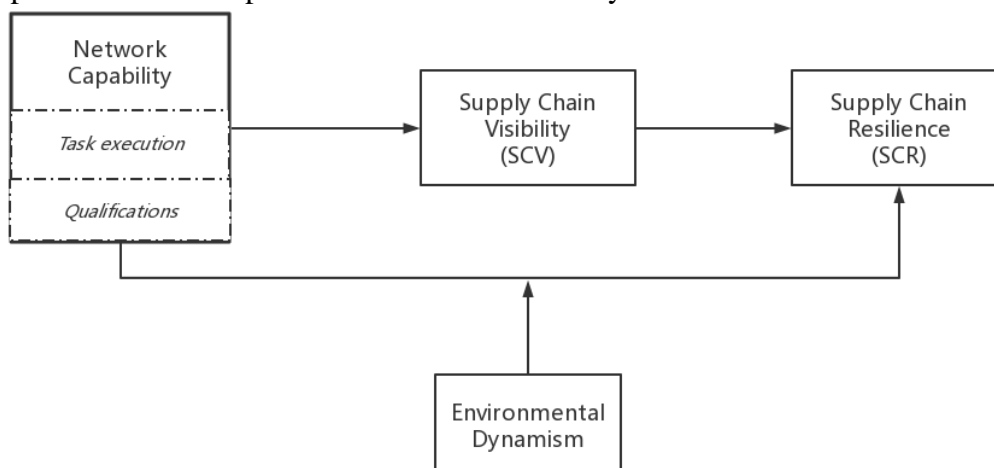


Figure 1 Conceptual framework.

### 3. Research Methods

#### 3.1 Sampling and Data Collection

This study conducted a questionnaire survey in China. The respondents were middle and senior managers of Chinese manufacturing firms, 331 questionnaires were finally used for follow-up research. Table 1 sorted out the basic information of respondents, further indicating the representativeness of this questionnaire.

Table 1 Demographics of respondents.

Position	Frequency	Percentage
CEO	3	0.9
Production manager	73	22.1
Purchasing manager	55	16.6
Product manager	65	19.6
R&D manager	38	11.5
Marketing manager	77	23.3
Plant manager	11	3.3
Others	9	2.7
Number of employees	Frequency	Percentage
<50	15	4.5
51-100	57	17.2
101-500	132	39.9
501-1000	81	24.5
>1000	46	13.9
Firm nature	Frequency	Percentage
Foreign-owned	23	6.9
Joint venture	52	15.7
State-owned	78	23.6
Private firm	173	52.3
Others	5	1.5

#### 3.2 Measures

Measures for the relevant constructs in this study were adapted from established instruments in previous literature. Table 2 shows the measurement results of this questionnaire.

Network Capability (NC): This study uses scale developed by Thomas Ritter (1999), which are Task execution and Qualifications, respectively.

Supply Chain Visibility (SCV): This study uses scale developed by Gosain (2004) to measure the visibility of the supply chain of the respondent's firm.

Supply Chain Resilience (SCR): This study uses scale developed by Ambulkar (2015) to measure the supply chain resilience of the respondents' firms.

Environmental Dynamism (ED): This study uses the scale developed by Li (2014) to measure environmental dynamism.

Table 2 Construct reliability and validity analysis.

Constructs	Cronbach's $\alpha$	AVE	CR
TE	0.863	0.5203	0.8660
Qu	0.846	0.5775	0.8453
SCV	0.915	0.5570	0.9181
ED	0.861	0.6151	0.8635
SCR	0.822	0.5382	0.8232

#### 3.3 Reliability and Validity

The study used CFA to measure the convergent validity and discriminant validity of the questionnaire. The indices for the CFA five-factor model,  $\chi^2/df=1.247$ , RMSEA=0.027, SRMR=0.0421, IFI=0.983, TLI=0.981, CFI=0.983, GFI=0.920, indicated a reasonably high level of

model fit. Table 2 shows the standardized factor loading, composite reliability (CR), and average variance extracted (AVE) of all items on the scale. The estimated value of CR was greater than 0.7, ranging from 0.8232 to 0.9181. The estimated value of AVE was greater than 0.5, ranging from 0.5203 to 0.6151.

In this paper, multi-factor models were constructed to test the discriminant validity of the structure. From Table 3, it can be seen that the original model five-factor model has a higher model fit, and is better than other factor models. So this paper considers that the study ensures discriminant validity.

Table 3 Model Fit Results for Confirmatory Factor Analyses.

Model	X <sup>2</sup> /df	RMSEA	SRMR	IFI	TLI	CFI	GFI
Five-factor model	1.247	0.027	0.0421	0.983	0.981	0.983	0.920
Four-factor model	1.678	0.045	0.0474	0.952	0.947	0.952	0.881
Three-factor model	2.667	0.071	0.0735	0.881	0.869	0.880	0.809
Two-factor model	4.495	0.103	0.1047	0.749	0.726	0.748	0.715
One-factor model	7.058	0.135	0.1332	0.564	0.525	0.561	0.523

#### 4. Analyses and Results

This study uses the SPSS24.0 extension PROCESS for hypothesis model testing. We first choose "Model 4" in PROCESS to construct a mediation model, as shown in Figure 2, to test hypotheses 1a, 1b, 2a, and 2b. Table 4 summarizes the regression results. H1a and H1b examine the impact of task execution and qualifications on SCR, respectively. As shown in the figure, Model 1 shows that task execution has a significant positive impact on SCR ( $\gamma=0.5288$ ,  $P<0.001$ ). Model 2 shows that qualifications have a significant positive effect on SCR ( $\gamma=0.4373$ ,  $P<0.001$ ). Therefore, hypothesis 1a and hypothesis 1b are supported.

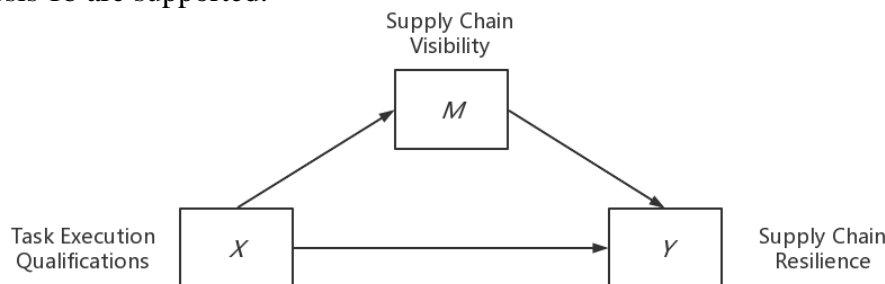


Figure 2 The mediation model in the conceptual diagram.

Table 4 Regression result for mediation effect of supply chain visibility.

Construct	SCR				SCV	
	Model1	Model2	Model3	Model4	Model5	Model6
Nature	-0.0112	-0.0211	-0.0115	-0.0160	0.0010	-0.0124
Employee	-0.0234	0.0135	-0.0032	-0.0107	0.0677	0.0581
TE	0.5288***		0.3622***		0.4243***	
Qu		0.4373***		0.2716***		0.3983***
SCV			0.3928***	0.4160***		
R <sup>2</sup>	0.1859	0.1511	0.2789	0.2544	0.1739	0.1812
F	24.8895	19.3971	31.5158	27.8102	22.9457	24.1172

Note: N=331, \*\*\*p<0.001, \*\*p<0.01, \*p<0.05.

Hypothesis 2a and 2b examine the mediating role of SCV between NC and SCR. The results are shown in Table 4, Model 5 shows that task execution has a significant positive impact on SCV ( $\gamma=0.4243$ ,  $P<0.001$ ), and Model 6 shows that qualifications have a significant positive impact on SCV ( $\gamma=0.3983$ ,  $P < 0.001$ ). Put task execution, qualifications, SCV, and SCR into the model simultaneously (Model 3 and Model 4). The results show that task execution still has a significant positive effect on SCR ( $\gamma=0.3928$ ,  $P<0.001$ ); qualifications still have a significant positive effect on SCR ( $\gamma=0.4160$ ,  $P<0.001$ ). This indicates that SCV has a partial mediation effect between NC and SCR. So hypotheses 2a and 2b are supported.

Regarding hypotheses 3a and 3b, the study predicts that ED negatively moderates the positive effects of task execution and qualifications on SCR. To build "Model1" by PROCESS program as shown in Figure 3. Put the task execution and ED interaction term and SCR into the model, and build Model7; put the qualifications and ED interaction term and SCR into the model, and build Model8. The results are shown in Table 5, task execution and the interaction item of ED have a significant negative impact on SCR ( $\gamma=-0.2453$ ,  $P<0.01$ ), indicating that ED negatively moderates the relationship between task execution and SCR. Hypothesis 3a is supported. The interaction term between management qualifications and ED has a significant negative impact on SCR ( $\gamma=-0.1639$ ,  $P<0.05$ ), indicating that ED negatively moderates the relationship between qualifications and SCR. Hypothesis 3b is supported. In order to more intuitively reflect the moderating effect of ED, this study uses the Simple Slope Test to draw an interaction diagram of the moderating effects of ED at a level one standard deviation above and below the mean. As shown in Figure 4 and Figure 5, when the ED level is low, the NC has a strong impact on the SCR; when the ED level is high, the NC has a weak impact on the SCR. Therefore, hypothesis 3a and hypothesis 3b are further verified.

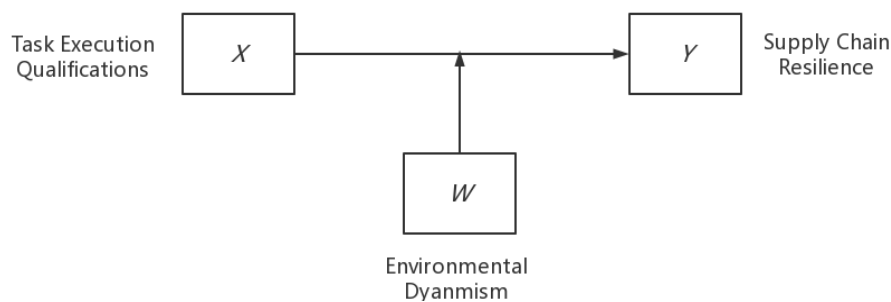


Figure 3 The moderation model in the conceptual diagram.

Table 5 Regression result for moderation effect of environmental dynamism.

Construct	SCR	
	Model7	Model8
Nature	-0.0136	-0.0186
Employee	0.0443	0.0232
ED	0.0187	-0.0110
TE	0.5376***	
Qu		0.4329***
TE*ED	-0.2453**	
Qu*ED		-0.1639*
R <sup>2</sup>	0.2097	0.1649
F	17.2448	12.8349

Note: N=331, \*\*\*p<0.001, \*\*p<0.01, \*p<0.05.

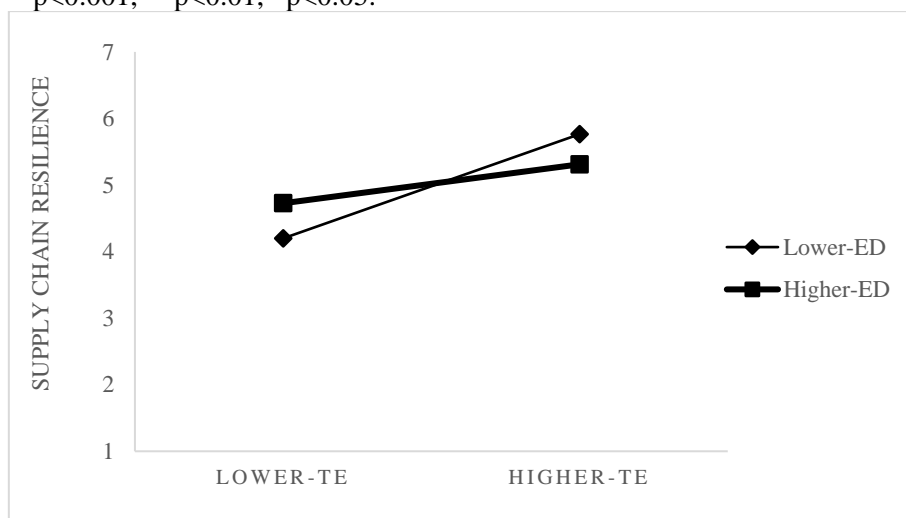


Figure 4. The moderating effect of ED on the relationship between TE and SCR

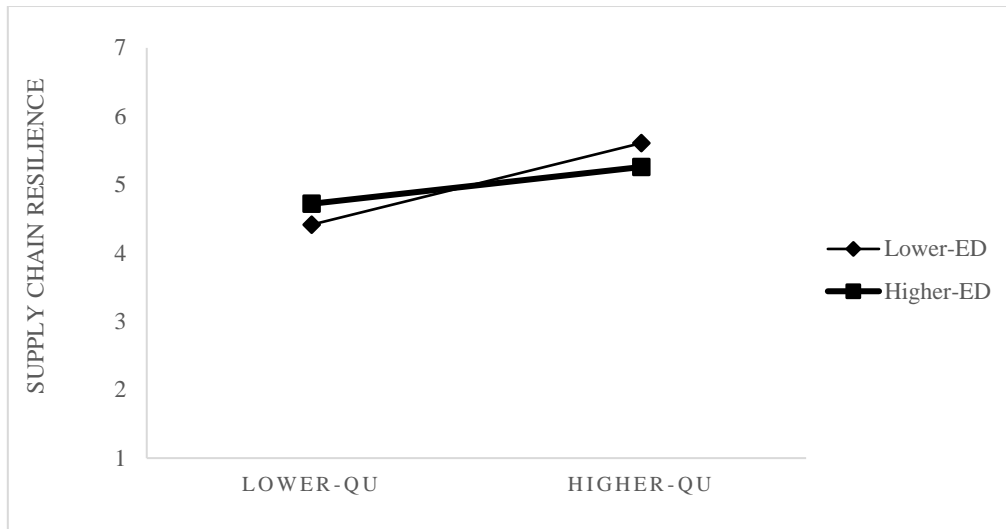


Figure 5. The moderating effect of ED on the relationship between QU and SCR

## 5. Managerial Implications

The findings in this study provide the following managerial insights for manufacturing firms. This study has implications for policymakers, and management in practice firms that are operating especially in developing countries. It should be recognized that operations and management activities in the current business environment are highly information-intensive, and information quality and circulation have become indispensable parts of the firm's competition. In this case, this paper suggested that manufacturing firms build network capabilities to address disruption risk and improve SCR. Through the construction of NC, it can help firms establish a good relationship with partners, help to quickly collect and process information related to products and production, to form effective decision-making in a dynamic business environment, and help supply chain firms restore normal operation quickly.

In addition, this paper also highlights the importance of SCV in the supply chain. This paper suggests that firms adopt quality management methods. The adoption of these management methods will make firms pay more attention to fact-based decision-making and process management based on customer demand, improve the ability to adapt to external market changes, and enhance the response-ability and resilience of firms in the face of crisis. As a result, under the impact of COVID-19, firms with access to accurate and real-time information can gain a competitive advantage in an increasingly competitive environment. Meanwhile, firms can use these management methods to better realize the fluidity and visibility of information and enhance SCR.

To sum up, these joint efforts can make top management more creative, flexible, and desirable in identifying and dealing with impending crises or opportunities. Therefore, for the sake of strategic flexibility and the need to improve SCR, managers must focus on NC, which can help companies use synergies to identify and exploit opportunities, and enhance the ability to defuse and respond to crises ability.

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