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# How Does Supply Chain Resilience Affect Supply Chain Performance? The Mediating Effect of Sustainability

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**Abstract:** In recent years, interruption or failure events have occurred due to frequent natural disasters, the outbreak of COVID-19, policy environment turbulence, an increasingly complex business environment, and the increasingly fragile global supply chain. This has reduced the efficiency of supply chains and customer service quality and increased operating costs, creating new requirements for supply chain flexibility and sustainability. When investigating 21 companies based on 200 questionnaires and a structural equation model analysis, the results showed that the elasticity of the supply chain for supply chain sustainability, economic sustainability, social sustainability, and environment sustainability has an obvious positive effect: supply chain sustainability has an obvious positive effect on supply chain performance. Supply chain resilience has no direct positive effect on supply chain performance, but it has a strong indirect effect on supply chain performance under the mediating effect of supply chain sustainability. In view of this, in order to create sustainable supply chain development and improve the performances of supply chains, it is necessary to establish the awareness of risk prevention, root the risk culture in supply chain network organization, and improve supply chain resilience in multiple dimensions. Enterprises in the supply chain should continue to build their resilience and establish effective strategies to integrate supply chains. The intermediary role of sustainability in supply chains and of supply chain flexibility in supply chain performance shows the influence of economically, socially, and environmentally sustainable angles, such as the implementation of supply chain management, the maximization of the interests of the whole supply chain, improving the ability of supply chain enterprises to innovate and develop, establishing customer awareness, and enhancing humanistic ideas. Dynamic selection of supply chain partners while focusing on their green performance promotes the green development of supply chain enterprises.

**Keywords:** supply chain resilience; supply chain sustainability; supply chain performance

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## 1. Introduction

In recent years, the COVID-19 pandemic has significantly affected the global economy, particularly the real economy. The security of industrial and supply chains has attracted worldwide attention. Academic researchers have increased their focus on optimizing energy supply elasticity [1]; there have been studies on the food industry [2], dairy industry [3], agriculture [4], the hotel industry [5], health care services [6], smart city [7], elastic efficiency evaluation [8,9], along with other digital technology research on supply chain resilience [10].

On the eve of the 19th National Congress of the Communist Party of China, the General Office of the State Council publicly issued "the Guiding Opinions on Actively Promoting Supply Chain Innovation and Application" (called "Opinions" for short), which noted that modern supply chains had officially become a national strategy. "Opinions" pointed out that it was necessary to "actively advocate green supply chain, strive to build a global supply chain and improve the security level of global supply chain" [11]. It can

be seen that advocating green supply chains is conducive to enhancing the sustainability of supply chains, making supply chain enterprises realize that while developing themselves, they should take into account their economic, social, and environmental effects, and enhance their sustainable competitive strength [12]. The resilience of supply chains can help the enterprises in supply chains maintain their normal operations when encountering external forces, which is conducive to improving the prevention and control of supply chain risks [13] and fully demonstrates the development concept of green coordination [14]. Enhancing the sustainability and resilience of supply chains will help to improve the performance level of supply chains, but the relationship between the resilience and sustainability of supply chains needs further study. Therefore, it is meaningful to systematically explore the relationship between supply chain resilience, supply chain sustainability, and supply chain performance, and to determine the role of supply chain resilience in supply chain sustainability. Therefore, the main research questions of this paper are as follows:

First, what is the relationship between supply chain resilience, supply chain sustainability, and supply chain performance?

Second, does supply chain elasticity affect supply chain performance? What is the mechanism?

The rest of the paper is structured as follows. Section 2 offers a literature review, theoretical model, and research hypothesis. Section 3 presents the research design, followed by an empirical analysis, and the results are demonstrated in Section 4. Section 5 presents the conclusions and implications. Section 6 features the limitations and future prospects.

## 2. Literature Review, Theoretical Models, and Assumptions

With the theme of "supply chain sustainability and performance", 126 articles were searched in the EBSCO database, and 5055 articles were searched in the core collection of Web of Science (Wos). Combining the two, five highly cited articles were selected for analysis. The core concepts of "sustainable operation management" [15], "sustainable supply chain: introduction" [16] and specific applications [17], a literature review of "conceptual framework of sustainable supply chain management" [18], and a proposal of "fuzzy multi-criteria evaluation method of supplier's sustainable performance based on triple bottom line method" [19] were found, all of which shared similar connotations. This literature review is focused on "supply chain resilience and performance" and "supply chain resilience and sustainability".

With "supply chain resilience and performance" and "supply chain resilience and supply chain sustainability" as the themes or keywords, 70 and 30 articles of two kinds of research were preliminarily searched in foreign-language databases, such as EBSCO, Wos Core Collection, and Emerald, and 13 and 11 articles of two kinds of research with strong correlations were screened out according to their titles, abstracts, key words, and other content.

### *2.1. Research on the Relationship between Supply Chain Resilience and Supply Chain Enterprise Performance*

Describing the research on the impact of supply chain resilience on supply chain performance, such as "the impact of choosing resilience determinants on supply chain relationship performance" [20], the "resilience index, which is used to evaluate the performance of complex supply chains operating under demand uncertainty" [21], and the "lean and elastic management of supply chain and its impact on performance" [22], etc., Swierczek (2015) [20] explained that the decisive factor in supply chain resilience involves the scope of integration, which plays an important role in obtaining and maintaining competitive advantage, and revealed the trade-off relationship between supply chain resilience and the scope of integration. Empirical research shows that some determinants are conducive to relationship performance but not conducive to the level of resilience. Other factors have negative effects on relationship performance, but they may help supply chains to maintain their resilience. The design and planning of resilient supply chains is a major challenge.

For this reason, Cardoso et al. (2015) [21] considered 11 elastic characteristic indicators, including network design, centralization, and operation, to evaluate the performances of complex supply chains operating under demand uncertainty. In a similar vein, Ruiz et al. (2018) [22] further studied the relationship between lean supply chains and resilient supply chains, and their impact on supply chain performance. The results show that in practice, lean supply chains create greater performance improvements than resilient supply chains. The reason for this is that supply chain resilience does not affect all supply chain performance indicators in the same way as lean supply chains.

Liu et al. (2018), Gunessee et al. (2018), and others studied the relationship between supply chain resilience and enterprise performance from specific industry perspectives: Taiwan Province liner shipping [23] and personal computers (PCs) [24]. In the former study, the theoretical constructions of risk management culture, agility, integration, and supply chain resilience (SCR) were integrated into a model, on which an empirical test was carried out. The results show that risk management culture has a direct and significant impact on agility, integration, and supply chain re-engineering, while agility, integration, and supply chain re-engineering have an impact on enterprise performance. Therefore, managers should pay attention to the role of risk management performance and realize the performance value of SCR. The latter study focused on the change in enterprise performance in the PC supply chain under the impact of natural disasters (NDs). Through the inventory of terminal assemblers and suppliers, the moderating effect of delivery and procurement (resilience and agility of supply chain) is studied. Moreover, NDs, as catastrophic events, are different from other disturbances in that they are difficult to predict and they have a significant impact. Because little is known about the impact of NDs on enterprise performance and supply chains, we should clearly model NDs and conduct an empirical study on the vulnerability of supply chains to these events.

Rajesh [25] and Dixit [26] studied the relationship between supply chain resilience and supply chain performance through the application of particular methods. The former suggested an improved gray prediction model to predict the cyclical indicators of resilient performance, while the latter took the two performance indicators of "percentage of unsatisfied demand and total transportation cost after the disaster" as the objective function, and conducted quantitative analysis through the multi-objective stochastic mixed-integer programming model, thus solving the problem of insufficient attention to the two important performance indicators described above in the supply chain network. Managers can evaluate the objective function through rich Pareto boundaries and can make wise choices based on high prediction accuracy.

The research on the relationship between supply chain resilience and supply chain (enterprise) performance from the perspective of dynamic capability includes studies by Gu and Huo [27] and by Altay et al. [28], etc. The former defines supply chain resilience and divides it into three dimensions: supplier resilience, internal resilience, and customer resilience. From the perspective of dynamic capability, this paper empirically tests the impact of supply chain resilience on enterprise performance and the relationship between the three dimensions of supply chain resilience. By modeling the structural equations of 171 Chinese mainland enterprises, these relationships are tested. The results show that internal resilience positively affects the resilience of suppliers and customers. Furthermore, internal customer resilience indirectly improves financial performance through operational performance. Although supplier resilience has no direct impact on business performance, it directly improves financial performance. The latter study discusses the influence of supply chain agility (SCAG) and supply chain resilience (SCRES) on performance according to organizational culture. Based on dynamic capability view (DCV), the theoretical models of different stages (pre-disaster and post-disaster stages) of humanitarian supply chains (HSCs) were conceptualized, and the research hypothesis put forward by the partial least squares (PLS) test was used, using 335 questionnaires from Indian organizations. The results show that SCAG and SCRES are two important dynamic capabilities of supply chains, which have a significant impact on supply chains' pre-disaster performance. The direction

of control has no significant effect on the path connecting supply chain agility (SCAG) and pre-disaster performance (PRE-DP). However, the control direction has a significant interaction on the path connecting supply chain resilience (SCRES) and pre-disaster performance (PRE-DP). Similarly, supply chain resilience (SCRES) has a significant impact on post-disaster performance (POST-DP), while supply chain agility (SCAG) has no significant impact on post-disaster performance. The flexible orientation has a significant regulatory effect on the SCAG/SCRES and POST-DP paths. These findings help to understand the different effects of SCAG/SCRES on supply chain performances in different situations.

In addition, on supply chain resilience, Li et al. (2018) empirically examined the impact of supply chain resilience on corporate financial performance [29], and several Italian scholars (Donadoni et al. 2018) linked product complexity, destructiveness, and performance and studied the moderating effect of supply chain resilience [30]. Liu and Li (2018) studied the relationship between different types of integration, SCR, and service performance from the perspective of third-party logistics suppliers [31]. Karl et al. (2018) systematically reviewed the impact of non-financial key performance indicators (KPIs) on supply chain resilience (SCRES) [32].

### *2.2. Research on the Relationship between Supply Chain Resilience and Supply Chain Sustainability*

From the analysis of 11 closely related foreign studies, it was found that from 2012, in chronological order, scholars' research on "the relationship between supply chain resilience and supply chain sustainability" was first qualitative and then quantitative, taking the form of research presentation characteristics from structural analysis, followed by network design and, subsequently, empirical tests or simulations. On the qualitative side, Malindretos and Binioris (2012) re-explored the overall re-engineering strategy related to resilience, and suggested that improving the collective ability would help to overcome the vulnerability risk and improve business and economic sustainability. By redesigning and establishing management processes, the stability of enterprises can be enhanced, and increasing vulnerabilities and crises can be effectively dealt with to ensure sustainable development [33]. Rajesh (2018) explained how to coordinate the goal of sustainable development and resilience in the supply network by analyzing several cases of manufacturing networks. The case analyses can help managers find related cases through the explained model, so as to match and review their supply networks. Positioning the partition line in the supply network and assigning strategic objectives on both sides provides a new perspective for the sustainable development and the classification of elastic oriented networks [34].

In terms of quantitative research, empirical research is carried out with survey data, such as the study by Andrew et al. [35]. Through the analysis of the basic business data of the sales and manufacturing costs of 72 manufacturing enterprises, the study shows that companies with greater sustainability and resilience can better participate in the development and application of resilience and sustainability models. Pereira et al. (2017) used a structural equation model to explore how agility and resilience lead to the environmental, social, and economic sustainability of Australian manufacturing supply chains. The results showed that although supply chain resilience has no impact on economic sustainability, it does have a positive impact on social and environmental sustainability [36].

There are mathematical planning or scheduling models based on operational research, such as those presented by Baynham et al. [37], Amien et al. [38], Ramezankhani et al. [39], and Dmitry et al. [40]. The first part aims to discuss the relationship between sustainability and resilience in supply chain design, and it proposes a multi-objective optimization model based on a sustainability performance scoring method and a random fuzzy goal programming method, which is used for a dynamic sustainability trade-off analysis and the design of an "elastic sustainability" supply chain. In the second part, a hybrid method is proposed to design a sustainable supply network, and the resilience in the face of random interruption is studied. In the third chapter, a new dynamic network data envelopment analysis framework is proposed, and the performance of the supply chain is dynamically

evaluated from two perspectives: sustainability and resilience. The model also combines the hybrid method of Quality Function Deployment (QFD) and Decision Test and Evaluation Laboratory (DEMATEL), systematically selects the optimal sustainability and resilience factors and applies them to the data envelopment analysis model for the automobile manufacturing industry to verify its effectiveness. The fourth chapter extends the existing literature to supply chain scheduling and resilience analysis, integrates the optimal plan recovery strategy with supply chain resilience, suggests a scheduling model considering the coordination of recovery actions in the supply chain, and uses the concept of realizable sets to propose a resilience index. Based on the results of the scheduling control model and the minimax regret method of continuous time parameters given by interval, the model estimates the impact of interruption on supply chain planning performance.

In addition, there are simulation-based methods to determine which sustainable factors reduce the chain reactions in supply chains and which sustainable factors enhance this effect [41]. In addition, there has also been a study "applying lean and flexible practices to supply chains to evaluate their impact on the three dimensions of sustainable development" [42]. Furthermore, Husseini et al. (2019), along with other scholars, systematically combed and summarized the literature on the quantitative modeling of supply chain resilience (SCR) in recent years, and compared it with the original concept of elastic capability, holding that supply chain resilience (SCR) denotes the ability of a network to bear, adapt to, and recover from interruptions to meet the needs of customers [43]. Based on the core collection of WOS, with "supply chain resilience or resilient supply chain" as the theme or keyword, the online version of CNKI was selected for an advanced search, the journal sources selected were "Core", "CSSCI" and "CSCD", and 30 studies were retrieved. According to the titles, abstracts, keywords, and other contents, it was found that there was no research related to performance or sustainability. The literature analysis and collation showed that there are many observations in the research on the impact of supply chain resilience on supply chain performance and the impact of supply chain sustainability on supply chain performance. However, in the field of supply chain management, the relationship between resilience and sustainability is not fully reflected. Therefore, this relationship was analyzed in depth and empirically tested, so as to provide a theoretical and practical reference for supply chain enterprises to develop their sustainability and resilience and improve their performance.

Based on the existing research, the author suggests the following assumptions. Supply chain resilience is an important condition for supply chain sustainability, and supply chain resilience plays a very important role in improving supply chain sustainability and supply chain performance. Supply chain sustainability helps to enhance the performance levels of supply chains. Figure 1 is a conceptual model describing the relationship between the related variables. In the model, supply chain resilience is closely related to supply chain sustainability and supply chain performance. Supply chain sustainability can be divided into three dimensions: social sustainability, environmental sustainability, and economic sustainability [42]. The continuous improvement of supply chain resilience enhances the sustainability and performances of supply chains; that is, the sustainability and performances of supply chains have an obvious positive relationship with supply chain resilience. The relationship between the variables is discussed in detail below.

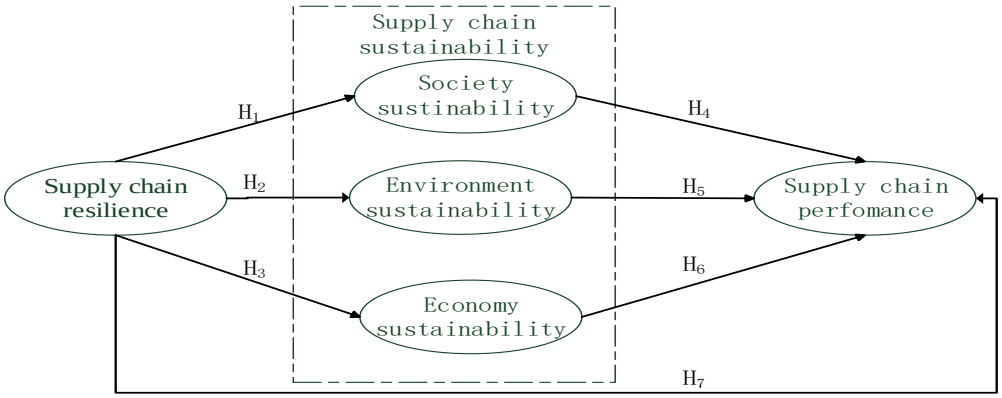



**Figure 1.** Conceptual model of research.

### *2.3. Supply Chain Sustainability and Supply Chain Resilience*

The supply chain environment has become increasingly complex, resulting in increasing uncertainty. These disturbances or risks have a negative impact on the normal operations of supply chains. In response to disturbances, some countries or non-governmental organizations have set up emergency agencies [44] to deal with emergencies and make production and life sustainable. However, the key issue is how to build sustainable supply chains. In the existing research, Folk [45] and L Dayton Marchese [46] contend that resilience can enhance sustainability in turbulent environments. In the problem of supply chain management, the use of supply chain resilience is conducive to enhancing the anti-risk ability of supply chains and promoting their continuous operation. In addition, due to the change in environment, the available resources are decreasing continuously, which leads to continuous increases in the operational costs of supply chains. It is necessary to use new technologies to promote the development of supply chains in different industries and, subsequently, to change from resource-pulling to technology-driving. In this process, as the carriers of technology, the role of people is prominent; therefore, people-oriented thinking will also have a certain impact on supply chain operations. Furthermore, the resulting social benefits are also an urgent question for supply chain enterprises. Therefore, in order to enhance the sustainability of supply chains, the resilience of supply chains is indispensable. Thus, the following assumptions are made:

**H1.** *Supply chain resilience has an obvious positive effect on social sustainability.*

**H2.** *Supply chain resilience has an obvious positive effect on environmental sustainability.*

**H3.** *Supply chain resilience has an obvious positive effect on economic sustainability.*

### *2.4. Supply Chain Performance and Supply Chain Sustainability*

With the deepening of economic globalization, the competition among enterprises has gradually changed into competition among supply chains. At the same time, industrial structures have changed from resource-intensive to technology-intensive, so as to make up for the adverse effects on the economy, environment, and society. Therefore, the pursuit of economic benefits alone is no longer in line with the concept of sustainable development. Elkington [47] argues that enterprises should fulfill their economic, environmental, and social responsibilities. In addition, Subhabrata contends believes that the purpose of enterprise sustainability is to create more flexible organizations by constantly integrating economic, environmental, and social systems [48]. Therefore, against the background of sustainable environment, taking into account environmental and social objectives while fulfilling economic objectives is more conducive to effectively managing supply chain products or services, meeting the requirements of relevant interest groups in supply chains, and enhancing the competitiveness and resilience of supply chains. Consequently, the following assumptions are made:

**H4.** *Social sustainability has an obvious positive effect on supply chain performance.*

**H5.** *Environmental sustainability has an obvious positive effect on supply chain performance.*

**H6.** *Economic sustainability has an obvious positive effect on supply chain performance.*

### *2.5. Supply Chain Performance and Supply Chain Resilience*

Supply chain resilience refers to the adaptability of supply chains, which can reduce the destructive effects of event disturbances. By maintaining the management of the structure and function of the supply chain, the spread of disturbance is controlled and, at the same time, timely and effective response measures are taken to restore normal operations [49].

In other words, the elements of supply chain resilience should include the ability to adapt to disturbances and the ability to manage risks. When a disturbance occurs, supply chain enterprises can flexibly adjust, after which they can return to their previous performance level or even improve their performance.

Some supply chain enterprises seek solutions to reduce costs in order to pursue higher profits, which may lead to supply chain vulnerability and increase supply chain risk. Previous studies showed that resilience is conducive to improving the coordination degree and quality of supply chains, as well as improving on-time delivery rates in order to quickly respond to the market and improve customer service levels [50]. In addition, some studies show that in supply chain resilience, internal resilience and customer resilience indirectly improve the financial performance of enterprises by improving operational performance [27]. Therefore, the following hypothesis is suggested:

**H7.** *Supply chain resilience has a direct positive effect on supply chain performance.*

### *2.6. Multi-Intermediary Role of Supply Chain Sustainability*

By decomposing the scope of supply chain resilience management, it can be observed that supply chain resilience management is not a virtual state but includes many aspects, such as supply chain entity state, financial strength, human resources, dynamic capability, and supply chain performance. Profit maximization is the ultimate goal of enterprises, and this is also true in supply chains; that is, the profit maximization of the whole supply chain is considered. When a risk occurs, it affects the upstream and downstream enterprises in the supply chain to varying degrees, making it difficult for them to reach their original performance levels. As an overall strategy in supply chain management, resilience management is conducive to reducing potential risks and increasing vulnerability, as well as enhancing the sustainability of businesses and economy [33]. Therefore, the following assumption can be made:

**H8.** *Economic sustainability plays an intermediary role in the effect of supply chain resilience on supply chain performance.*

The enterprise is a node in the supply chain, and employees are the main body of the enterprise. Paying attention to employees' innovative role is conducive to improving the performance levels of enterprises and, thus, the operations of supply chains. When every enterprise in a supply chain can be coordinated and unified, and the overall goal of the supply chain is their main goal, maximum profits can be obtained throughout the supply chain. Therefore, it is very important to give full play to the role of employees in the practice of supply chain management, which is conducive to enhancing the ability to identify and control risks, enhancing the innovation and development ability of supply chain enterprises, building customer awareness, strengthening the "people-oriented concept", and enhancing the sustainability of supply chain performance in social management. Therefore, the following assumption can be made:

**H9.** *Social sustainability plays an intermediary role in the effect of supply chain resilience on supply chain performance.*

At present, environmental problems are becoming increasingly serious, and strengthening environmental supervision has become an irreversible trend [51]. However, for supply chains, the greatest risk lies not in supervision, but in the cost problem in the transformation of supply chain enterprises caused by the changing environmental risks to supply chains. Reducing costs, improving the performance levels of supply chains, and moving towards environmental protection, energy saving, and low-carbon development are urgent problems for supply chain enterprises. Therefore, the necessary condition for supply chain enterprises to achieve sustainable operations and enhance their performances is the flexible selection of supply chain partners and the attachment of importance to their green performance, so as to change the traditional business model of supply chain enterprises, promote their green development, and enhance the sustainability of supply chain performance in the environment. Therefore, the following hypothesis can be suggested:

**H10.** *Environmental sustainability plays an intermediary role in the effect of supply chain resilience on supply chain performance.*

## 3. Research Design

### *3.1. Research Samples and Data Collection*

The reliability and validity of questionnaires is the basis of questionnaire investigation. In this paper, a third party (Questionnaire Research Studio) was entrusted to conduct research. Research platforms used were Questionnaires, Questionnaire Network, etc. Survey duration was 15 March 2022 to 31 March 2022. In total, 200 valid questionnaires were obtained. Different industries, such as FMCG and catering (see Table 1 for specific information), were involved.

**Table 1.** Research group industry.

| Options | Subtotal | Options | Subtotal |
|---|---|---|---|
| IT/software and hardware services/ e-business/internet provider | 12 | Office goods and facilities | 6 |
| Fast-moving consumer goods | 82 | Accounting and auditing | 4 |
| Wholesale/retail | 8 | Bank/insurance/securities/venture fund | 6 |
| Apparel/textiles/leather goods | 5 | Electronic technology/integrated circuit | 2 |
| Furniture/crafts/toys | 2 | Instrumentation/industrial automation | 4 |
| Education/training/research/colleges | 10 | Trade/import and export | 5 |
| Home appliances | 3 | Medical/nursing/health/hygiene | 2 |
| Communication/telecom operation/network equipment/value-added services | 10 | Advertising/public relations/media/art | 3 |
| Automobiles and components | 7 | Real-estate development/decoration/design | 2 |
| Catering/entertainment/hotel/life services | 22 | Property management/business center | 4 |
| Aerospace/aviation/energy/chemical industry | 1 | | |
| Number of valid questionnaires | 200 | | |

### *3.2. Variable Design*

The variables used in this study are all from the existing literature, and were measured by Likert's seven-point scoring method (see Table 2 for variable information). This involved three main variables: supply chain resilience, supply chain sustainability, and supply chain performance. Supply chain resilience includes resilience, supply chain risk management, and supply chain resilience; supply chain sustainability mainly includes economic sustain-

ability, social sustainability, and environmental sustainability. The numbers from 1 to 7 indicate the degree of consistency, from very inconsistent to very consistent, respectively.

**Table 2.** Variable design.

| Construct | Items | Problem Description | SL | Reliability | IC | Item Source |
|---|---|---|---|---|---|---|
| flexibility | ASCR01 | Improve manufacturing time | 0.63 | 0.85 | 0.84 | Töyli (2013) [52] |
| | ASCR02 | Adapt to customers | 0.82 | | | |
| | ASCR03 | Adjust delivery reliability | 0.85 | | | |
| | ASCR04 | Adapt to changing market needs | 0.76 | | | |
| supply chain risk management | SCRMC1 | We share risks with supply chain members | 0.72 | 0.87 | 0.72 | Chowdhury (2016) [53] |
| | SCRMC2 | We have a supply chain continuity team | 0.64 | | | |
| | SCRMC3 | We try to understand the risks | 0.87 | | | |
| | SCRMC4 | We consider risk in our decision making | 0.82 | | | |
| recovery capability | ABS1 | Over time, you and your partner thoroughly maintain relevant knowledge | 0.75 | 0.84 | 0.83 | Cheng (2017) [54] |
| | ABS2 | You and your partners can quickly analyze and interpret the changing market requirements for your technology | 0.81 | | | |
| | ABS3 | You and your partners continually improve existing operational processes | 0.87 | | | |
| sustainability of the economy | ESC01 | We share relevant and timely information | 0.72 | 0.89 | 0.92 | Lee (2016) [55] |
| | ESC02 | We provide technical and managerial assistance | 0.72 | | | |
| | ESC03 | Our company solves problems together | 0.79 | | | |
| | ESC04 | Our companies trust each other | 0.89 | | | |
| | ESC05 | Our partners see us as a long-term partner | 0.82 | | | |
| sustainability of society | SSC01 | Formal processes for assessing our social performance | 0.87 | 0.94 | 0.94 | Lee (2016) [55] |
| | SSC02 | Conduct regular audits of social issues, such as those related to labour, ethics, and community relations | 0.88 | | | |
| | SSC03 | We provide useful information on how to comply with societal requirements | 0.91 | | | |
| | SSC04 | We provide technical, managerial, and financial assistance to solve social problems | 0.78 | | | |
| | SSC05 | Our company worked together to identify possible social problems, prepare for them, and respond to them | 0.87 | | | |
| environmental sustainability | GSC01 | We assess our environmental performance through formal and green procurement processes | 0.66 | 0.87 | 0.88 | |
| | GSC02 | We implement an environmental management system | 0.78 | | | |
| | GSC03 | We conduct regular environmental audits | 0.74 | | | |
| | GSC04 | We provide technical, managerial and financial assistance to solve environmental problems | 0.78 | | | |
| | GSC05 | Our company has jointly developed environmentally friendly products | 0.78 | | | |
| supply chain performance | SCP1 | We have the expected level of sales | 0.73 | 0.83 | 0.68 | Chowdhury (2016) [53] |
| | SCP2 | Our production costs are lower than those of our competitors | 0.66 | | | |
| | SCP3 | We can reach our target profit | 0.77 | | | |
| | SCP4 | Our customers are satisfied with our service | 0.83 | | | |
| | SCP5 | We deliver customer orders on time | 0.77 | | | |

Notes: SL is Standard Load, IC is Internal Consistency.

## 4. Empirical Research Analysis and Results

### *4.1. Descriptive Statistical Analysis*

As shown in Table 3, the average scores for each item were mostly between 5 and 5.5, which suggests that the overall level of enterprise management is high. The standard deviation of the item scores was between 1.5 and 1.8, which indicates that the sample data had a good concentration trend, and it can be seen that the information reflected by the survey data was ideal.

**Table 3.** Descriptive statistics of variables of each item.

| Construct | Items | Mean | S.D. | Construct | Items | Mean | S.D. |
|---|---|---|---|---|---|---|---|
| flexibility | ASCR01 | 5.13 | 1.553 | Supply chain risk management | SCRMC1 | 5.1 | 1.665 |
| | ASCR02 | 4.87 | 1.708 | | SCRMC2 | 5.02 | 1.575 |
| | ASCR03 | 5.19 | 1.587 | | SCRMC3 | 5.22 | 1.594 |
| | ASCR04 | 5.07 | 1.703 | | SCRMC4 | 5.26 | 1.612 |
| sustainability of the economy | ESC01 | 5.01 | 1.679 | The sustainability of society | SSC01 | 5.29 | 1.532 |
| | ESC02 | 5.25 | 1.572 | | SSC02 | 4.71 | 1.653 |
| | ESC03 | 5.31 | 1.648 | | SSC03 | 5.39 | 1.628 |
| | ESC04 | 5.25 | 1.61 | | SSC04 | 4.97 | 1.523 |
| | ESC05 | 5.39 | 1.628 | | SSC05 | 5.31 | 1.705 |
| environmental sustainability | GSC01 | 5.2 | 1.507 | Supply chain performance | SCP01 | 5.43 | 1.685 |
| | GSC02 | 5.04 | 1.645 | | SCP02 | 4.6 | 1.733 |
| | GSC03 | 5.35 | 1.61 | | SCP03 | 5.2 | 1.666 |
| | GSC04 | 5.11 | 1.549 | | SCP04 | 4.99 | 1.701 |
| | GSC05 | 5.36 | 1.654 | | SCP05 | 4.81 | 1.806 |
| recovery capability | ABS1 | 5.19 | 1.605 | | | | |
| | ABS2 | 4.79 | 1.806 | | | | |
| | ABS3 | 5.25 | 1.698 | | | | |

Notes: S.D. is standard deviation.

### *4.2. Reliability and Validity of the Questionnaire*

Using SPSS23 data analysis software, the reliability test of the item content, namely the KMO and Bartlett ball test, showed that the KMO value was 0.941, the approximate chi-square value of the Bartlett sphericity test was 6001.158, and the significance level was 0, which is less than 0.05, indicating that the selected item variables were very suitable for factor analysis. The analysis results are shown in Tables 4 and 5. Next, principal component analysis was adopted to maximize the rotation of the equation, the factor was extracted according to the characteristic value of 1, and the factor selection standard was above 0.5. According to the calculation, the economic sustainability item (ESC01) and the social sustainability item (SSC03) did not meet the conditions, and the social sustainability item (SSC01) was mixed with other groups in the results of the factor rotation. Therefore, there were 28 remaining items after deletion. According to the reliability test, the Kronbach coefficient of the supply chain sustainability in the remaining dimensions of this study was 0.922, the KMO value was 0.878, the overall correlation after rotation was 0.6–0.75, the factor load was 0.6–0.89, the AVE was 0.585, and the combined reliability was 0.944, which met the relevant test standards [56]. According to the validity test, all the measurement items were greater than 0.6, which shows that the variables were reliable and had good content validity. The average variance extraction (AVE) was around the standard threshold of 0.5; therefore, the observed variables met the requirements of measurement variables [57]. The validity is shown in Table 6. The values of all the variables met the test conditions, indicating that the discrimination between the latent variables was ideal [58].

### *4.3. Data Normality Analysis*

Using the AMOS version 23.0 estimation model, the default algorithm was maximum likelihood estimation (ML), and the premise was that the obtained survey data would conform to normal distribution, that is, Gaussian distribution. Therefore, according to the normality test of the survey data (see Table 6 for the results), the absolute value of the skewness of the observed variables should be between 0.586 and 1.64, and it should not exceed the standard value of 2.58. The absolute value of kurtosis was between 0.179 and 4.417, which was less than the standard value of 10. It can be judged that the obtained data conformed to normal distribution characteristics [59].

As shown in Table 6, the skewness and kurtosis of the supply chain resilience variables (ASCR01, ASCR03, SCRMC1, SCRMC4, ABS1), supply chain sustainability variables (ESC02, SSC02, GSC02, GSC04), and supply chain performance variables (SCP01, SCP02,

SCP03, SCP04) before correction did not conform to normal distribution. There are many methods to correct the normality of data [60]. According to the characteristics of the survey data in this paper, the logarithmic method was adopted to correct the non-conforming data, so as to achieve the effect of partial normality and meet the requirements of structural equation modeling.

**Table 4.** Measurement scale test.

| Construct | Measurement Index | Factor Loading | Overall Correlation | AVE | Composite Reliability/CR | Coefficient of Reliability |
|---|---|---|---|---|---|---|
| flexibility | ASCR01 | 0.8 | 0.781 | 0.658 | 0.950 | 0.948 |
| | ASCR02 | 0.822 | 0.782 | | | |
| | ASCR03 | 0.822 | 0.777 | | | |
| | ASCR04 | 0.796 | 0.749 | | | |
| supply chain risk management | SCRMC1 | 0.782 | 0.732 | | | |
| | SCRMC2 | 0.786 | 0.736 | | | |
| | SCRMC3 | 0.835 | 0.795 | | | |
| | SCRMC4 | 0.876 | 0.841 | | | |
| recovery capability | ABS1 | 0.757 | 0.707 | | | |
| | ABS2 | 0.752 | 0.699 | | | |
| | ABS3 | 0.866 | 0.835 | | | |
| sustainability of the economy | ESC01 | 0.370 | 0.726 | 0.491 | 0.931 | 0.940 |
| | ESC02 | 0.736 | 0.704 | | | |
| | ESC03 | 0.560 | 0.780 | | | |
| | ESC04 | 0.696 | 0.712 | | | |
| | ESC05 | 0.730 | 0.747 | | | |
| the sustainability of society | SSC01 | 0.831 | 0.700 | 0.504 | 0.828 | 0.892 |
| | SSC02 | 0.879 | 0.623 | | | |
| | SSC03 | 0.441 | 0.764 | | | |
| | SSC04 | 0.725 | 0.642 | | | |
| | SSC05 | 0.581 | 0.754 | | | |
| environmental sustainability | GSC01 | 0.729 | 0.621 | 0.575 | 0.871 | 0.884 |
| | GSC02 | 0.752 | 0.587 | | | |
| | GSC03 | 0.774 | 0.687 | | | |
| | GSC04 | 0.737 | 0.639 | | | |
| | GSC05 | 0.796 | 0.669 | | | |
| supply chain performance | SCP1 | 0.876 | 0.801 | 0.784 | 0.948 | 0.931 |
| | SCP2 | 0.881 | 0.813 | | | |
| | SCP3 | 0.918 | 0.865 | | | |
| | SCP4 | 0.895 | 0.829 | | | |
| | SCP5 | 0.856 | 0.776 | | | |

### *4.4. Factor Analysis of Model Validation*

#### 4.4.1. Test of Measurement Model

When the measurement model passes the test-model fitness index, it should be considered whether the test model violates the estimation. Therefore, before determining the fitness of the model, the correctness of the estimation should be checked. According to the suggestions given by Hair, we should examine two aspects. On one hand, whether there is negative error variance in the estimation model; and on the other hand, whether the normalized parameter coefficient is greater than 1 [61]. It was calculated that the error variance in the model was between 0.005 and 1.5, and there was no negative value. The normalized parameter coefficient was between 0.066 and 0.914, and did not exceed 1. This showed that there was no false estimation in the overall preliminary model, and the fitting degree of the preliminary model could be tested. According to the preliminary model test (see Table 7 for specific results), $\chi^2/DF = 3.358(\chi^2 = 1151.286,\ DF = 343)$, GFI = 0.697, RMSEA = 0.109, SRMR = 0, AGFI = 0.642, NFI = 0.8, CFI = 0.850, and IFI = 0.851. It can be seen that the fitness of the measurement model was low, and that the model needed to be adjusted. In this paper, the modification indices (MI) provided by AMOS23.0, combined with the related literature, support the requirement of modifying one set of parameters at a time, modifying the model one by one, and obtaining the final relational model. It can be seen from Table 8 that the ratio of the chi-square to the degree of freedom in the preliminarily estimated model was greater than 3; this was limited by the amount of data. The larger the amount of data, the greater the chi-square value. Therefore, according to

Wu Minglong's point of view, this value is loose in a range of less than 5 [62]. Most of the revised fitting parameters were near the ideal values, except AGFI, which was far from ideal. The reason for this is that there was still a gap between the collected data and the model, which led to a poor fitting degree for some of the indicators. However, as far as the overall model is concerned, the standardized path parameters reflect the variable relationship in the conceptual model as a whole, which can meet the analysis requirements in general.

**Table 5.** Measurement scale test after modification.

| Construct | Measurement Index | Factor Loading | Overall Correlation | AVE |
|---|---|---|---|---|
| flexibility | ASCR01 | 0.800 | 0.781 | 0.658 |
| | ASCR02 | 0.822 | 0.782 | |
| | ASCR03 | 0.822 | 0.777 | |
| | ASCR04 | 0.796 | 0.749 | |
| supply chain risk management | SCRMC1 | 0.782 | 0.732 | |
| | SCRMC2 | 0.786 | 0.736 | |
| | SCRMC3 | 0.835 | 0.795 | |
| | SCRMC4 | 0.876 | 0.841 | |
| recovery capability | ABS1 | 0.757 | 0.707 | |
| | ABS2 | 0.752 | 0.699 | |
| | ABS3 | 0.866 | 0.835 | |
| sustainability of the economy | ESC02 | 0.876 | 0.770 | 0.745 |
| | ESC03 | 0.851 | 0.733 | |
| | ESC04 | 0.845 | 0.721 | |
| | ESC05 | 0.881 | 0.779 | |
| the sustainability of society | SSC02 | 0.907 | 0.767 | 0.757 |
| | SSC04 | 0.868 | 0.694 | |
| | SSC05 | 0.834 | 0.647 | |
| environmental sustainability | GSC01 | 0.793 | 0.673 | 0.682 |
| | GSC02 | 0.803 | 0.690 | |
| | GSC03 | 0.853 | 0.754 | |
| | GSC04 | 0.817 | 0.711 | |
| | GSC05 | 0.864 | 0.773 | |
| supply chain performance | SCP1 | 0.876 | 0.801 | 0.784 |
| | SCP2 | 0.881 | 0.813 | |
| | SCP3 | 0.918 | 0.865 | |
| | SCP4 | 0.895 | 0.829 | |
| | SCP5 | 0.856 | 0.776 | |

**Table 6.** Discriminant validity of construction.

| Construct | Mean | S.D. | SCR | ESC | SSC | GSC | SCP |
|---|---|---|---|---|---|---|---|
| SCR | 5.100 | 1.334 | (0.811) | | | | |
| ESC | 5.300 | 1.394 | 0.805 | (0.863) | | | |
| SSC | 4.993 | 1.415 | 0.736 | 0.663 | (0.870) | | |
| GSC | 5.214 | 1.317 | 0.607 | 0.636 | 0.538 | (0.826) | |
| SCP | 5.007 | 1.520 | 0.776 | 0.800 | 0.719 | 0.612 | (0.885) |

Note: Supply chain resilience (SCR) consists of three factors: flexibility, supply chain risk management, and resilience. ESC, SSC, GSC, and SCP are economic sustainability, social sustainability, environmental sustainability, and supply chain performance, respectively. Data correlation was significant at the significance level of 0.01, and the square root of mean variance extraction (AVE) is represented in parentheses. S.D. is standard deviation.

**Table 7.** Normal distribution test and correction.

| Items | Data before Correction | | Revised Data | |
|---|---|---|---|---|
| | **Skewness** | **Kurtosis** | **Skewness** | **Kurtosis** |
| ASCR01 | −0.837 | 0.152 | −2.031 | 4.616 |
| ASCR02 | −0.736 | −0.298 | −0.736 | −0.298 |
| ASCR03 | −0.896 | −0.033 | −1.861 | 3.588 |
| ASCR04 | −0.832 | −0.217 | −0.832 | −0.217 |
| SCRMC1 | −0.872 | 0.168 | −2.023 | 3.908 |
| SCRMC2 | −0.890 | 0.219 | −0.890 | 0.219 |
| SCRMC3 | −0.853 | −0.198 | −0.853 | −0.198 |
| SCRMC4 | −1.079 | 0.165 | −1.812 | 2.819 |
| ABS1 | −0.932 | 0.101 | −1.907 | 3.622 |
| ABS2 | −0.602 | −0.444 | −0.602 | −0.444 |
| ABS3 | −1.232 | 0.183 | −1.232 | 0.183 |
| ESC02 | −0.797 | 0.025 | −1.063 | 0.445 |
| ESC03 | −1.117 | 0.245 | −1.964 | 3.021 |
| ESC04 | −0.976 | 0.222 | −1.117 | 0.245 |
| ESC05 | −1.148 | 0.566 | −0.976 | 0.222 |
| SSC02 | −0.511 | −0.254 | −1.148 | 0.566 |
| SSC04 | −0.940 | 0.448 | −1.015 | 0.530 |
| SSC05 | −1.155 | 0.415 | −1.642 | 2.445 |
| GSC01 | −1.084 | 0.845 | −1.163 | 0.381 |
| GSC02 | −0.736 | −0.118 | −0.940 | 0.448 |
| GSC03 | −1.111 | 0.408 | −1.155 | 0.415 |
| GSC04 | −0.882 | 0.038 | −1.084 | 0.845 |
| GSC05 | −1.196 | 0.743 | −1.833 | 3.357 |
| SCP01 | −0.990 | −0.164 | −1.111 | 0.408 |
| SCP02 | −0.767 | −0.099 | −1.798 | 3.179 |
| SCP03 | −1.093 | −0.054 | −1.196 | 0.743 |
| SCP04 | −1.011 | −0.177 | −1.760 | 2.892 |
| SCP05 | −0.706 | −0.455 | −1.594 | 1.427 |

**Table 8.** Model Fitting Test.

| Fitting Indicators | $\chi^2/DF$ | GFI | RMSEA | SRMR | AGFI | NFI | CFI | IFI |
|---|---|---|---|---|---|---|---|---|
| ideal parameters | [1,3] | ≥0.9 | <0.1 | <0.05 | ≥0.9 | ≥0.9 | ≥0.9 | ≥0.9 |
| concept model | 3.358 | 0.697 | 0.109 | 0.000 | 0.642 | 0.800 | 0.850 | 0.851 |
| modified model | 2.013 | 0.829 | 0.071 | 0.000 | 0.780 | 0.890 | 0.941 | 0.941 |

#### 4.4.2. Verification and Analysis of Structural Relationship Model

According to the calculation of the modified model by AMOS, Figure 2 shows the normalized path coefficient. The results show that supply chain resilience has a significant impact on supply chain sustainability (social sustainability, environmental sustainability, and economic sustainability), with path coefficients of 0.861, 0.626, and 0.905, respectively, which indicates that improving supply chain resilience is conducive to supply chain sustainability. H4 and H5 played a relatively small role in the hypothetical relationship set by the model, but they were still significant at the level of $p < 0.05$, indicating that there was a positive relationship; that is, supply chain sustainability (social sustainability and environmental sustainability) has a positive impact on supply chain performance, with path coefficients of 0.228 and 0.123, respectively, while economic sustainability has a greater impact on supply chain performance, with a path coefficient of 0.403, and the direct impact of supply chain resilience on supply chain performance is not significant.

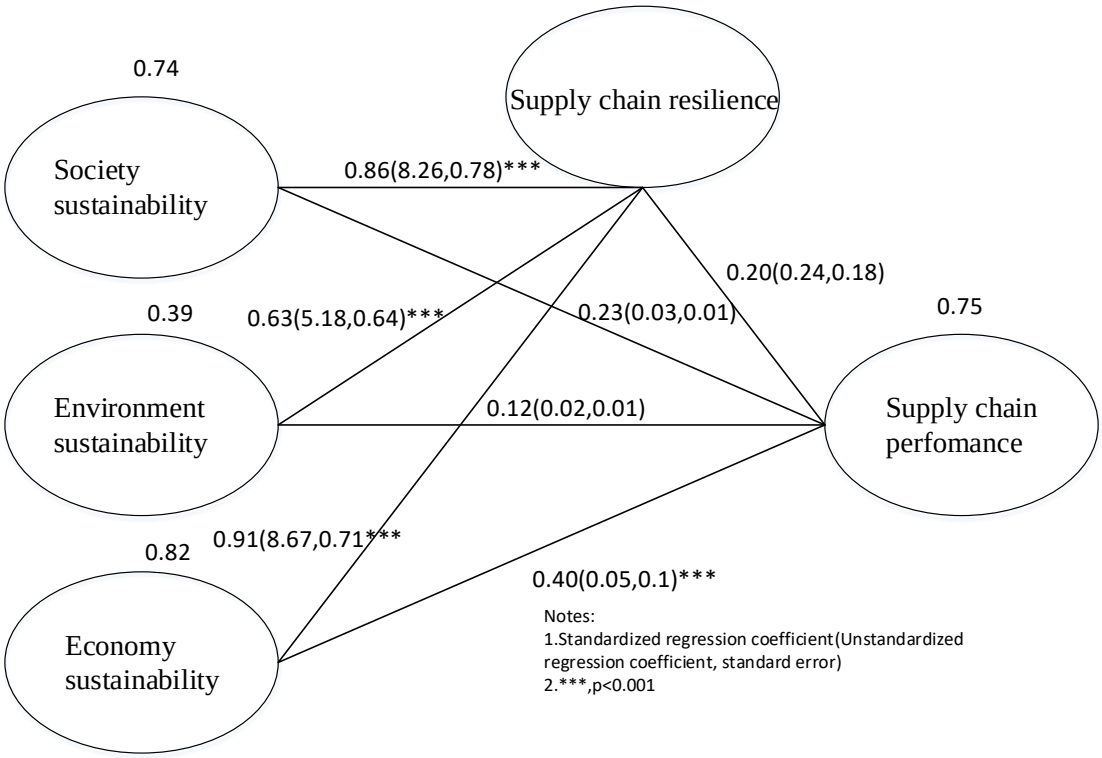



**Figure 2.** Revised normalized estimation graph.

### *4.5. Verification and Analysis of Intermediary Effect*

In order to determine the intermediary effect of supply chain sustainability, according to the Bootstrap method proposed by Preacher [63] and Hayes [64], PROCESS in SPSS was used to test the intermediary effect of the variables. The Bootstrap method was used to sample the samples 5000 times, consecutively, and the confidence test level was 95%. Table 9 displays the results. The test data showed that the confidence interval of the overall supply chain sustainability was (0.588, 0.859), which does not contain 0, indicating that supply chain sustainability is an intermediary variable between supply chain resilience and supply chain performance, with an intermediary effect of 70.9%. The different aspects of sustainability, economic sustainability and social sustainability, are completely mediated, with 79% and 72.2% mediating effects, respectively. Environmental sustainability has some mediating effects on supply chain resilience and supply chain performance. In summary, the assumptions H8 to H10 are valid.

**Table 9.** Intermediary effect test of supply chain sustainability.

| Variable | | Supply Chain Sustainability | | | |
|---|---|---|---|---|---|
| | | Economic Sustainability | Social Sustainability | Environmental Sustainability | |
| supply chain resilience→ supply chain performance | | 0.790 | 0.722 | 0.544 | |
| $R^2$ | | 0.775 | 0.723 | 0.557 | |
| $\triangle R^2$ | | 0.600 | 0.552 | 0.310 | |
| $F$ | | 297.69 | 216.214 | 88.861 | |
| LLCI | | 0.700 | 0.625 | 0.430 | |
| ULCI | | 0.880 | 0.818 | 0.657 | |
| effect coefficient | | 0.384 | 0.265 | 0.060 | |
| Boot SE | | 0.115 | 0.101 | 0.040 | |
| Boot LLCI | | 0.177 | 0.110 | −0.005 | |
| Boot ULCI | | 0.630 | 0.517 | 0.154 | |
| judgement conclusion | | complete mediation | complete mediation | partial mediation | |
| intermediate inspection (Bootstrap method) (samples = 5000) | indirect effect | effect coefficient | Boot SE | Boot LLCI | Boot ULCI |
| | | 0.709 | 0.067 | 0.588 | 0.859 |

## 5. Research Conclusions and Indications for Management

The research on supply chain resilience began with the research of Professor Sheffi in 2001 [65], while the research on supply chain sustainability originated with the application of the concept of sustainable development to the field of supply chains. Based on survey data from enterprises, this paper explored the relationship between supply chain resilience, supply chain sustainability, and supply chain performance. The empirical results show that supply chain resilience has obvious positive effects on social sustainability (H1 holds), environmental sustainability, and economic sustainability (H2 and H3 hold). Furthermore, supply chain sustainability (economic sustainability, social sustainability, and environmental sustainability) has obvious positive effects on supply chain performance (H4, H5, and H6 are established), supply chain resilience has no direct positive effects on supply chain performance (H7 is not established), and supply chain resilience indirectly affects supply chain performance through supply chain sustainability (economic sustainability, social sustainability, and environmental sustainability) (H8, H9, and H10 are established). According to the overall effect of the model, the path coefficients of the direct effects of supply chain resilience on social sustainability, environmental sustainability, and economic sustainability are 0.861, 0.626, and 0.905, respectively, which indicates that supply chain resilience directly increases the sustainability of supply chains and is the foundation of sustainable operations. These findings are generally consistent with the views of the two documents "Analysis of the Resilience and Sustainability of British Manufacturing Enterprises" [35] and "Research on the Impact of Agility and Resilience on Sustainable Supply Chain" [36]; that is, resilience has a positive impact on social and environmental sustainability, but it is inconsistent with the view of "the impact of resilience on economic sustainability". There are two reasons for these differences: first, there are differences in the concept, which is defined in the literature as "enterprise resilience". The concept of "supply chain resilience", defined in this paper from the perspective of supply chains, is very similar, and supply chain resilience must be presented as the carrier of enterprise resilience, but there are some differences in perspective and evaluation indicators. Enterprise resilience is based on enterprises' perspectives on how to deal with risks and set up resilience indicators, while supply chain resilience not only considers the factors at the enterprise level, but also considers entire upstream and downstream supply chains. Second, the focus of consideration is different. From enterprises' perspective, resilience involves balancing the flexible costs and benefits created by the enterprise itself; therefore, the impact is not significant. From the perspective of supply chains, resilience involves the risk of supply chain interruption and the overall benefits of supply chains. In addition, the direct effect of supply chain resilience on supply chain performance is not significant, but the value of the indirect effect is 0.637, which indicates that it has a strong indirect effect on supply chain performance through the intermediation of supply chain sustainability. This finding is different from those in the literature [53]. Most studies have focused on the influence of supply chain resilience on supply chain performance, and some have analyzed the moderating effect of supply chain resilience [30,66]. The authors of [66] used a closed questionnaire to collect cross-sectional data from 458 respondents working in food, beverage, and pharmaceutical companies. A partial least squares structural equation model (PLS-SEM) was used to investigate the impact of Industry 4.0 on supply chain performance (SCP). The results showed that SCR had an important mediating effect on SCP. This differed from the observation that when SCR is the independent variable and sustainability is the mediating variable, SCR influences SCP, although the research method was the same. Gupta, H. shows that "high cost of investment", "lack of monetary resources", "inadequate internet connectivity", "lack of IT (Information Technology) infrastructure", and "unclear economic benefit of digital investment" are the top five barriers to implementing innovative digitalization technologies in developing countries, such as India, during pandemics. These findings reveal insights into digitalization barriers during pandemics that can be of value to managers and researchers [10].

Furthermore, some researchers focus on the topic of the resilience of supply chains after the COVID-19 pandemic. With the COVID-19 pandemic raging, recovery is the most effective response to short-term disruptions [7]. A dual-channel supply chain policy is preferable to a traditional single-channel supply chain because companies are able to offer customized products to their customers [67].

However, there are few empirical studies on the mediating effect of sustainability between resilience and performance. Nevertheless, this does not contradict the views in the existing literature, but further confirms the effect of supply chain resilience on supply chain performance: the economic and social sustainability of supply chains play a complete mediating role, as can the environment.

The above conclusions offer the following two observations for management practice. First, they theoretically and empirically show the importance of improving supply chain resilience. Therefore, in practice, from the perspective of supply chains, in order to achieve the sustainable development of supply chains and improve supply chain performance, the relevant departments should deal with interruption risks, embed a risk culture in supply chain network organizations, improve supply chain resilience in multiple dimensions, and make full preparations for improving supply chain performance. From the perspective of enterprises, it has become the consensus that competition among enterprises has risen to competition among supply chains. Every enterprise is a node in a supply chain. It is an effective strategy to effectively integrate competition into supply chains by applying the risk culture in enterprises and continuously shaping the resilience of enterprises. Second, the discovery of the intermediary mechanism through which supply chain sustainability affects supply chain performance will help to clarify whether enterprises should build and improve resilience because, from the perspective of enterprises, building and improving resilience carries costs, and the purpose of resilience is to deal with interruption events that are low in frequency but high in damage. Many enterprises think that since such events have a low probability of occurrence, the cost is not worthwhile, and that not investing in preparation leads to savings in costs. This is the reason why many business executives are reluctant to take action. In fact, the intermediary role of sustainability suggests that, regardless of low-frequency and high-loss interruptions, the resilience of supply chains affects performance through sustainability. Therefore, after recognizing this mechanism, enterprises should attach importance to the shaping and upgrading of resilience to the level of strategic understanding and apply this in daily management, so as to make their operations sustainable.

## 6. Research Limitations and Prospects

This paper features the following shortcomings. The relationship between supply chain resilience, sustainability, and performance in different industries was not analyzed, and although the research results are applicable, they lack pertinence. Furthermore, there were 200 valid research samples, mainly distributed in FMCG, catering, and other industries, and the distribution ratio was too concentrated, which means it was not possible to guarantee the balance of the supply chain ratio in various industries. In addition, the selection of supply chain performance indicators was single. In follow-up research, various further aspects could be studied. For example, research on the relationship between supply chain resilience, sustainability, and performance for a specific industry supply chain would enhance the pertinence of this research. Furthermore, while further increasing the number of effective samples, it is more important to control the proportion of sample distribution and balance the number and coverage of samples to enhance the robustness of the analysis conclusion in this study. Finally, further investigations could be conducted on the practice of supply chain management and on further improving the composition of the index system, based on the perspective of supply chains in combination with the actual situations of enterprises and the characteristics of industries.

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