Influence of Supply Chain Collaborative Innovation on Sustainable Development of Supply Chain: A Study on Chinese Enterprises

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Abstract: The recent trade friction between the two largest economies, US and China, is having a profound impact on the sustainable development of supply chains at a global scale. Supply chain collaborative innovation has not only become the main means for enterprises in various countries to cope with imponderable changes, but also been the driver of increasing supply chain dynamic capability and of achieving sustainable development of supply chains. Based on the survey data of 510 Chinese enterprises, this paper adopts the hierarchical regression analysis and a structural equation model to study the impact of supply chain collaborative innovation on the sustainable development of supply chains. The results show that: (1) Three modes of supply chain collaborative innovation (namely, technology collaborative innovation, management collaborative innovation, and market collaborative innovation) have different effects on supply chain dynamic capability and sustainable supply chain performance. (2) Supply chain dynamic capability plays a significant intermediary role between supply chain collaborative innovation and sustainable supply chain performance. (3) Supply chain technology collaborative innovation has the greatest direct impact on sustainable supply chain performance, followed by supply chain management collaborative innovation. However, the direct effect of supply chain market collaborative innovation on sustainable supply chain performance is not significant; under the intermediary role of dynamic capability, supply chain market collaborative innovation has a significant indirect effect on sustainable supply chain performance.

Keywords: supply chain collaborative innovation; sustainable supply chain performance; supply chain dynamic capability; hierarchical regression analysis; structural equation model

1. Introduction

The recent Sino–U.S. trade friction is producing a profound impact on the cooperative relationship in the global supply chain that has been formed in the multilateral trading system in the past 25 years. The potential trade policy changes between China and the United States not only affect the suppliers, manufacturers, retailers and other trade participants in the world’s two major economies, but also have a spreading effect on other countries such as many Asian economies including South Korea and Japan. According to the research of Goldman Sachs on the supply chain of smart phones, clothing and airplanes, reshaping the supply chain system will significantly impact investment, labor cost, intellectual property protection, production cycle and consumers for trade partners [1]. Currently, with the integrated development of the world economy, trade between countries is becoming more frequent, and the breadth and depth of mutual participation in supply chain collaboration between...
enterprises will continue to increase. Business activities are gradually being transformed from the past limited links to the large-scale supply chain collaboration across regions and borders. In the complex, dynamic and uncertain global competitive environment, how to achieve the sustainable development of supply chains has rapidly caught the interest of academia, government regulators and industry.

Sustainable development of supply chain is the embodiment of the concept of sustainable development in supply chain management [2]. Carter and Rogers [3] believe that sustainable supply chain management (SSCM) is a process of integrating and realizing the economic, environmental and social objectives for supply chain organization. It is essential to improve the long-term economic benefits through the systematic coordination of core business processes across enterprises. Seuring and Muller [4] indicate that the core issues for SSCM are pressures and incentives, measuring impacts, issues generated at the supplier–buyer interface and collaborative issues across all companies involved in the supply chain. Pagell and Wu [5] introduce “innovation and design capabilities” into the framework of sustainable supply chain management and emphasize the significance of innovation and entrepreneurship for organizations in SSCM practice. Silva et al. [6] study the role of innovation of product and process in practices of green supply chain management and sustainability performance based on survey data from 173 manufacturing firms. As such, supply chain collaborative innovation (SCCI) has become a vital means for enterprises to cope with the drastic changes in the sophisticated environment, and obtain new competitive advantages. The collaborative innovation level of the supply chain will cause an enterprise, for reasons of sustainable development, to allocate resources, adapt to the environment and support services in the global scope, and will also become an important symbol for enterprises in obtaining long-lasting competitive advantages. In addition, SSCM is essentially a dynamic problem imposed by globalization on organizations. The characteristics of globalization are highly vulnerable logistics networks, global competition and almost real-time information sharing. These highly dynamic environmental characteristics are consistent with dynamic capabilities [3,4]. Seuring [7] further investigates the integration of dynamic capabilities into the SSCM framework from the perspectives of “product sustainability” and “supplier management based on risk and the dynamic environment”.

On the basis of the above analysis, from the strategic perspective of response to a complex and dynamic environment, this paper follows the paradigm of “Innovation Behavior-Dynamic Capability-Sustainable Performance” to explore the influence of supply chain collaborative innovation on the sustainable development of supply chains. That is, how to coordinately innovation among supply chain enterprises to effectively manage the logistics, information flow, capital flow and partnership in the supply chain, how to enhance the supply chain dynamic adaptability and how to obtain the higher performance of a sustainable supply chain are the research subjects of this paper. We strive to make contributions from the following three aspects. (1) From the perspective of supply chain collaborative innovation, the article reveals the relationship between supply chain collaborative innovation and sustainable supply chain performance. (2) Following the analysis of “behavior–capability–performance”, the mediating effect of dynamic capability in a supply chain between collaborative innovation and sustainable performance is verified by using a structural equation model. (3) Based on the extensive survey data on Chinese enterprises, the impact path of different collaborative innovation modes on dynamic capability and the sustainable supply chain performance is shown, and this helps enterprises to effectively identify the collaborative innovation approach to ultimately maximize the performance of the sustainable supply chain.

The structure of the article is as follows: Section 1 introduces the background of this research. Section 2 provides a literature review to survey the existing works. In Section 3, the research hypotheses are proposed. Section 4 presents the approach and results of empirical research, including variables and measurement index selection, data acquisition and data testing. Section 5 analyzes the results of hierarchical regression analysis and structural equation modeling. Finally, Section 6 remarks the research findings and major contributions of this article.
2. Literature Review

Considering market diversity, fierce competition and reduced product life cycle, an increasing number of enterprises in the sustainable supply chain are developing collaborative relationships. Synergy can be described as a type of relationship between organizations where the participants agree to invest resources together and make collaborative decisions to solve problems, achieve goals and share information, social responsibility and returns [8]. Cao et al. [9] show that a supply chain can obtain a collaborative advantage which can reduce opportunity cost and monitoring cost through process integration and mutual trust among supply chain members, so as to improve the sustainable development performance of supply chain members. Regarding how to cooperate with global stakeholders to promote sustainable development in special topics, one of the core concerns is how to build and realize collaborative relationships for global sustainable supply chains. Innovation is a foundation, an inexhaustible motive force, and a winning weapon for enterprises to obtain their sustainable competitive advantages in the fierce market competition. Wei et al. [10] believe that a dynamic and flexible cooperative strategy can help enterprises to improve cooperation efficiency and innovation performance. Shin et al. [11] also demonstrate the positive impact of partnership-based supply chain collaboration on commitment, sustainable innovation and performance. At the same time, with the advent of economic globalization and information technology, the global economy has entered the era of integration and innovation. Collaborative innovation, which aims at improving the sustainable ability and realizing the value of innovation, has been gradually accepted by enterprises in the supply chain. For sustainable supply chain collaborative innovation, this means that all stakeholders in the supply chain network innovate and reform in products, processes, markets, technologies, resource allocation and organization to achieve a balance in economic, social and environmental performance. As such, Yang et al. [12] propose that innovative lean production can bring economic and environmental advantages at the same time. Malone and Crowston [13] also believe that enterprises in supply chains need to establish appropriate collaborative innovation to maintain consistency in making decisions, so as to achieve the overall goals of supply chains. Other scholars have also discussed the supply chain collaborative innovation and its impact from the different perspectives. For example, Lambert et al. [14] indicate that the key of supply chain cooperative innovation is to realize the integration of information and other various resources along the supply chain by use of modern technology tools. The goal is to reach the seamless connection and achieve the common goal of both partners. Sezen and Çankaya [15] show that the technological innovation can promote the sustainable development performance of enterprises. Mangun and Thurston [16] argue that coordinating innovation in the product design stage can reduce the impact of product life cycle resources on the environment. In particular, the innovation of green and ecological processes has a positive impact on the company’s sustainable development performance. For sustainable supply chain collaborative management, some scholars have carried out research in terms of coordination within enterprise, as well as external upstream and downstream traditional cooperation. Ryoo and Koo [17] conduct a questionnaire survey and show that the coordination of various departments in green practice activities has positive influence on green performance. Research by Savaskan et al. [18] shows that a simple coordination mechanism built with the downstream retailers can promote retailers’ efforts to recycle products, thus increasing the total profit of the whole renewable supply chain. Zhao et al. [19] illustrate that integrated innovation with a supplier has a significant positive impact on completion and customer satisfaction. Vachon and Klassen [20] also point out that management cooperative innovation in supply chains has a significant positive impact on corporate environmental and economic performance based on an empirical study. Yawar and Seuring [21], from three strategic levels, show that leading enterprises can alleviate the problems of supplier interruption risk, social risk and uncertainty risk of demand by extending the social responsibility of supply chain corporates. As consumers in the market realize the importance of environmental protection for human survival, market collaborative innovation considering customer demand preferences has an important impact on supply chain sustainability [22]. Lin et al. [23] suggest that green supply chain performance considering consumer demand preference is positively correlated
with the level of green product collaborative innovation. Zhao and Zhu [24] analyze the market coordination of supply and demand uncertainty in the remanufacturing supply chain of traditional enterprise. Swami and Shah [25,26] investigate the impact of market channel coordination on efforts by retailers and manufacturers to promote green products. Considering consumer green awareness and green marketing, Hong and Guo [27] analyze the influence of supply chain cooperation level on retailers’ green marketing strategy and manufacturers’ choice of product design in the supply chain.

Sustainable Supply chain performance (SSCP) is regarded as the result of the sustainable development of supply chains. The triple bottom line (TBL), first proposed by Elkington [28], indicates that the unity of corporate profitability, social responsibility and environmental responsibility is more conducive to the sustainable development of enterprises. Seuring and Muller [29] state that sustainable supply chain management is driven by regulation, competition and stakeholders, and cooperative organization brings environmental practices into the supply chain. The same researchers [4] further find that the core issues for sustainable supply chain management are pressures and incentives, measuring impacts, issues generated at the supplier-buyer interface and collaborative issues across all companies involved in the supply chain. As a result, most scholars pay more attention to the economic performance of sustainable supply chains. That is, to reducing the cost of supply chains, improving the response ability and realizing the profit growth. For both traditional supply chain management and sustainable supply chain management, an ultimate goal is to achieve economic growth. Carter and Rogers [3] also agree the performance of sustainable supply chain management is a strategic, transparent aggregation that mainly coordinates the systematic business process to achieve economic, environmental and social goals, while mainly emphasizing the improvement of the long-term economic performance of individual enterprises and the overall supply chain to maintain continual collaboration in the supply chain. Lambert [30] considers that sustainable supply chain performance is an integrated key business process, which provides products, services and information to final consumers through continuous coordination with partners in a supply chain. Olugu and Wong [31] indicate that sustainable supply chain performance is the overall coordinated operation efficiency of supply chains, not only including the internal performance of supply chain enterprises, but also including the performance of coordination and cooperation with node enterprises. As for the measurement of sustainable supply chain performance, there is still no perfect and consistent evaluation system. Vachon and Klassen [20] mention that sustainable supply chain economic performance is the feedback result of response speed, comprehensive ability, customer service level and accessibility for the supply chain. Aramyan et al. [32] develop a conceptual framework for measuring tomato supply chain performance in the Netherlands and Germany and emphasize that efficiency, flexibility, responsiveness and food quality are the key performance factors of the tomato sustainable supply chain management system. Beamon [33] advocates that sustainable supply chain performance should be measured from the three dimensions of resource performance, output performance, and flexible performance, and emphasizes that the three dimensions are balanced and interact with each other. Nyaga et al. [34] measure sustainable supply chain economic performance by shortened order cycles, improved order processing accuracy, improved on-time delivery rates and forecast accuracy. The results from Lim et al. [35] show that learning organization, information/knowledge sharing, joint knowledge creation, information technology and knowledge storage are the most effective measurements of social performance for a sustainable supply chain.

Since the concept of dynamic capability (DC) was first proposed by Teece et al. [36], it has received extensive attention, and mainly been used for explaining how enterprises gain competitive advantage in the dynamic market environment. Some studies introduce dynamic capability to the context of supply chain management. For instance, Reuter et al. [37] adopt the DC concept in analyzing how to gain sustainability competitive advantage in the global supplier management processes. Beske [38] develops a framework integrating DC in sustainable supply chain management, and the proposed framework provides an analytical basis for further empirical research. Delee and Fugate [39] discuss the supply chain dynamic capability (SCDC) and consider support of senior managers as a strategic
orientation, which is a necessary condition for all organizations in the supply chain. Zahra et al. [40] indicate that static capabilities and dynamic capabilities should be distinguished, and the dynamic capability can be used to modify existing capability or create new capability. Zollo and Winter [41] think that SCDC can be used to modify existing capability or create new capability, and SCDC includes knowledge acquisition and co-evolution. Static capabilities are conducive to efficient use, which will bring short-term competitive advantage. The characteristics of globalization include highly vulnerable logistics networks, global competition and almost real-time information sharing, which are compatible with dynamic capability [3,4,42]. Jiang [43] believes that SCDC is the change of the ability of supply chains by extending the dynamic capability from single enterprises to the supply chain, which is a self-organizing capability integration system adapted to the external environment. This can be used to effectively manage the supply chain network and resources so as to obtain the sustainable competitive advantage. Based on the analysis above, supply chain dynamic capability can be understood as the ability of the members in a supply chain to cope with the dynamic changes of the internal and external environment together, which will help members in the supply chain to achieve the goal of sustainable development. Pagell and Wu [5] propose that resource reconstruction and integration refers to the adjustment of original organization, process connection and business field to adapt to the dynamic change of environment. Regarding the measures of supply chain dynamic capability, Jiang [43] also states that SCDC includes operation capability, learning capability, coordination capability and reconstruction capability. Wu [44] measures the supply chain dynamic capabilities from three dimensions: Resource integration capabilities, learning capabilities, and resource reconstruction capabilities. Similarly, Caloghirou et al. [45] measure the supply chain dynamic capabilities from another three dimensions: learning ability, coordination ability and change ability.

3. Hypothesis Development

To explore the influence of supply chain collaborative innovation on the sustainable development of supply chains, this paper follows the paradigm of “behavior–capability–performance” and introduces supply chain dynamic capability as an intermediary variable for a relationship model (as shown in Figure 1). It can be seen that supply chain collaborative innovation (SSCI) consists of three aspects, namely, supply chain technology collaborative innovation (SCTCI), supply chain management collaborative innovation (SCMNCI) and supply chain market collaborative innovation (SCMKCI). An empirical study is conducted to verify the effect of supply chain collaborative innovation on supply chain dynamic capability and sustainable supply chain performance by use of comprehensive survey data in mainland China.

![Diagram](image_url)

**Figure 1.** Relationship among supply chain collaborative innovation (SSCI), supply chain dynamic capability (SCDC) and sustainable supply chain performance (SSCP).
3.1. Relationship between Supply Chain Collaborative Innovation and Performance

In the complex and changeable external environment, the competition between supply and demand markets is increasingly fierce. Supply chain collaborative innovation is gradually replacing individual enterprise innovation and becoming a lifeblood of the survival and development of modern enterprises. Enterprises urgently need to radically break through the bottleneck elements that restrict individual development and pursue cooperative innovation with member enterprises of supply chains to make the operation of each link more efficient, orderly and seamless from production to consumption. This would help the supply chain and the individual enterprises achieve long-term sustainable development goals. According to Goldman Sachs’ research on the impact of the Sino–U.S. trade war, core enterprise collaborative innovation plays a key role in the overall performance of supply chains [1]. Lii and Kuo [46] show that collaborative innovation orientation has a positive impact on supply chain integration, sustainable competitiveness and comprehensive performance. Yang et al. [12] propose that lean production of supply chain collaborative innovation can lead to higher economic and environmental performance. Dey et al. [47] also propose that lean production of supply chain collaborative innovation could eliminate waste, enhance quality, reduce costs and increase flexibility across the supply chain. Sezen and Çankaya [15] describe the positive effect of technological innovation on the performance of sustainable development for enterprises, especially the innovation of green and ecological technology. Versaevel [48] shows that the loose technology synergies of member enterprises in a supply chain have no significant impact on innovation performance. On the contrary, the close cooperation which links technological innovation together is more conducive to improving the sustainable supply chain performance. Kim et al. [49] suggest that integration between virtual enterprises based on information technology can be used as an effective governance mechanism for suppliers, which can improve cross-border supply chain relationships, thereby improving overall performance. Gemnden et al. [50] point out that suppliers’ early cooperation in product innovation projects can also reduce high-cost design changes in the later stages, shorten the development cycle of innovation projects, and improve development efficiency. Lindgreen et al. [51] also point out the use of information technology in managing the supply chain process and improving performance has continued to be a top priority for firms. Vachon and Klassen [20] and Wu [52] show that supply chain cooperation in management innovation has a significant positive impact on performance. Savaskan et al. [18] argue that a simple management coordination mechanism can promote retailers’ efforts to recycle products, thus increasing the environment performance of the whole supply chain. Cruz [53] illustrates that the leading enterprises can alleviate supply-side interruption risk, social risk and demand-side uncertainty through the collaborative management of social responsibility of upstream and downstream enterprises of a supply chain, so as to improve the social performance of sustainable supply chain development. Yang et al. [54] indicate that management collaborative innovation is positively related to the performance of innovative enterprises, while marketing collaborative innovation has a U-shaped relationship with the performance of innovative enterprises and has a positive correlation with the performance of mature enterprises. Moreover, the interaction of management innovation and marketing innovation has a positive effect on the performance of mature enterprises.

In view of this, it is not individual innovation in a sustainable supply chain, but cooperative innovation that can affect the performance of the entire supply chain. In other words, supply chain innovation means the collaborative innovation of technology, management and market among supply chain member enterprises based on mutual trust, which can improve the level of sustainable supply chain performance by realizing the accurate matching and efficient operation of supply and demand from raw material purchase, product creation design and manufacturing, to sales, distribution and so on. To sum up, this paper adopts the following hypotheses:

**Hypothesis 1.** Supply chain technology collaborative innovation (SCTCI) has a positive impact on sustainable supply chain performance (SSCP).
Hypothesis 2. Supply chain management collaborative innovation (SCMNCI) has a positive impact on supply chain performance (SSCP).

Hypothesis 3. Supply chain market collaborative innovation (SCMKCI) has a positive impact on supply chain performance (SSCP).

3.2. Relationship between Supply Chain Collaborative Innovation and Dynamic Capability

As a community of interests, member enterprises in a supply chain need to commit to continuous collaborative innovation in the rapidly changing market environment to improve the keen perception of environmental changes and the ability to respond to market changes, finally realizing the improvement of the overall supply chain performance. In this regard, Kwak et al. [55] show that supply chain innovation has a discernible positive influence on all dimensions of risk management capability, which in turn significantly impacts competitive advantage. Stevenson and Spring [56] believe that technological collaborative innovation, such as information technology, can improve the transmission speed of information by decreasing the exchange of goods among member enterprises, thus reducing supply chain network complexity and increasing supply chain flexibility. Eisenhardt and Martin [42] point out that collision, integration and co-evolution of technology knowledge among partners in sustainable supply chains help to realize the breakthrough and innovation of key technologies and improve the innovation of products and services. Cao [57] conducts an empirical study and discovers that collaborative innovation of supply chain quality management also has a positive effect on the supply chain dynamic capability. Lim et al. [35] believe that learning organization, information/knowledge sharing, joint knowledge creation, information technology and knowledge storage in cooperative innovation in a supply chain are the highest driving forces for improving the dynamic capability of a supply chain. Pagell and Wu [5] state that knowledge sharing among members of supply chain collaborative innovation is helpful for improving supply chain reconstruction and environmental adaptability.

In brief, supply chain enterprises continuously improve the internal operation system of a supply chain through technological innovation, management concept innovation, realizing the optimization of the operation process and lean production and eventually enhancing the supply chain coordinative operation capability. At the same time, supply chain enterprises carry out market collaborative innovation in a timely manner according to the dynamic trend of market environment, effectively combine the internal and external resources of a supply chain, jointly formulate supply plans that meet the market demand and finally improve the supply chain’s dynamic ability to cope with market changes and meet customer needs. Based on this analysis, this paper adopts the following hypotheses:

Hypothesis 4. Supply chain technology collaborative innovation (SCTCI) has a positive impact on supply chain dynamic capability (SCDC).

Hypothesis 5. Supply chain management collaborative innovation (SCMNCI) has a positive impact on supply chain dynamic capability (SCDC).

Hypothesis 6. Supply chain market collaborative innovation (SCMKCI) has a positive impact on supply chain dynamic capability (SCDC).

3.3. Mediating Role of Supply Chain Dynamic Capabilities

Due to the uncertainty of the external environment and the cross-departmental and cross-organizational nature of supply chains, it is required that the member enterprises have the flexibility of self-learning and self-regulation, and have the ability of agile response to the rapid changes of the external environment and customer needs; this can avoid the loss of competitive advantage, and reduce the risk of declined supply chain performance. Hong et al. [58] investigate the moderating
effect of the sustainable supply chain dynamic capacity on the relationship between sustainable supply chain management practices and firm performance, including economic, environmental and social performance, by empirical research based on the data of 209 Chinese manufacturing enterprises. Moreover, Hong et al. [59] discover that absorptive capacity plays a significant mediating role in the relationship between organization–organization and organization–institution collaborative innovation and innovation performance. Kumar et al. [60] show the positive mediating role of dynamic capability between sustainability collaborative strategy and supply chain performance. Teece [61] believes that sustainable supply chain organizations usually have strong innovation ability, and defines the high level of dynamic ability as “enhanced entrepreneurship”, which can bring flexible variability and efficient stability for the sustainable development of a supply chain. Freytag et al. [62] believe that, in order to find a matching strategy and environment, supply chain enterprises need to continuously adjust not only internal forecasting, planning and production systems, but also external relationships and network structure configuration. That is, the supply chain network should be continuously adapted and restructured to promote the improvement of supply chain performance. Teece et al. [36] propose the theory of “dynamic ability”, based on the dynamic change of the market environment, by emphasizing that dynamic ability is the internal source for enterprises to continuously acquire lasting competitive advantage. Lin [63] suggests that the dynamic capability is essentially a capacity of resource reorganization and integration to accelerate enterprises’ adaption to the environment and establish a new competitive advantage to improve the performance. Yu et al. [64] emphasize that the dynamic nature of supply chain capabilities enables companies to reconfigure organizational resources and supply chain processes, which could better respond to environmental changes and improve overall performance. Zott [65] also mentions that dynamic capability can, in a timely way, enable enterprises to adjust their own business resources and operation processes by following the change of the external competitive environment, which can indirectly affect the overall performance of enterprises. Makadok [66] indicates that dynamic capability can play an essential role in achieving sustainable competitive advantage and performance. It improves the organization’s ability to respond to the external environment, and it establishes the ability of resource reorganization to achieve long-lasting performance. Gao and Tian [67] show that building stronger dynamic capabilities can improve the production efficiency of enterprises under the supply chain coordination mechanism. This can not only enhance the flexibility and creativity of enterprises, but also reduce the corresponding production costs and increase efficiency.

As such, in a complex and changeable environment, supply chain collaborative innovation can powerfully enhance the supply chain dynamic capability, form a sustainable competitive advantage that is not easily imitated by competitors and finally realize the optimization of sustainable supply chain performance. Based on the above analysis, the following hypotheses are proposed:

**Hypothesis 7.** Supply chain dynamic capability (SCDC) has a positive impact on sustainable supply chain performance (SSCP).

**Hypothesis 8.** Supply chain dynamic capability (SCDC) has a mediating effect between supply chain technology collaborative innovation (SCTCI) and sustainable supply chain performance (SSCP).

**Hypothesis 9.** Supply chain dynamic capability (SCDC) has a mediating effect between supply chain management collaborative innovation (SCMNCI) and sustainable supply chain performance (SSCP).

**Hypothesis 10.** Supply chain dynamic capability (SCDC) has a mediating effect between supply chain market collaborative Innovation (SCMKCI) and sustainable supply chain performance (SSCP).
4. Methodology

4.1. Research Framework

The framework of this research is shown in Figure 2, which involves four stages. It can be seen that the first stage includes proposing the research problems, developing the hypotheses, selecting measurement variables and gathering data as needed. The second stage tests the reliability and validity of data and analyzes the variable correlations. The third stage develops a hierarchical regression analysis to preliminarily estimate the assumed relationship proposed in this paper. In the last stage, we further perform structural equation modelling analysis (SEM) and confirmatory factor analysis (CFA), and the result provides a strong support for the findings of this paper.

![Detailed research framework of this study.](image-url)
4.2. Variable Measurement

Based on the above literature analysis, this study adopts SCTCI, SCMNCI and SCMKCI as explanatory variables, SSCP as a response variable and SCDC as an intermediary variable. In this research, the specific measurement indicators of the above variables are drawn fully based on the research results of relevant literature (as shown in Table 1). Note that SCTCI 1–4 are the variable notations representing items 1–4 of SCTCI questions, SCMNCI 1–4 are the variable notations representing items 1–4 of SCMNI questions, SCMKCI 1–3 are the variable notations representing items 1–3 of SCMKCI questions, SSCP 1–4 are the variable notations representing items 1–4 of SSCP questions, SCDC 1–3 are the variable notations representing items 1–3 of SCDC questions respectively in the questionnaire. In addition, considering the obvious differences in enterprise nature (EN) and enterprise scale (ES), they are selected as the control variables.

Table 1. Variable selection.

| Variables | Item | References |
|-----------|------|------------|
| SCTCI 1   | 1. We and our partners are committed to continuously improving the technical content of our products; | Lambert et al. [14]; Sezen and Çankaya [15]; Mangun and Thurston [16]; Hopkins and Bailey [68]; Li et al. [69] |
| SCTCI 2   | 2. We and our partners are committed to improving the adoption of information technology; | |
| SCTCI 3   | 3. We work with partners to increase new product development; | |
| SCTCI 4   | 4. We work with partners to shorten new product development cycles. | |
| SCMNCI 1  | 1. We and our partners continue to innovate and improve supply chain management; | Ryoo and Koo [17]; Savaskan et al. [18]; Klassen [20]; Yawar and Seurting [21]; Birkinshaw et al. [70] |
| SCMNCI 2  | 2. We and our partners are constantly innovating organizational structures for collaboration; | |
| SCMNCI 3  | 3. We and our partners continue to innovate and improve internal management systems for collaboration; | |
| SCMNCI 4  | 4. We innovate supply chain management methods with partners for collaboration. | |
| SCMKCI 1  | 1. We broaden the market space with our customers; | Lin et al. [23]; Zhao and Zhu [24]; Swami and Shah [25,26]; Hong and Guo [27]; Damanpour and Gopalakrishnan [71] |
| SCMKCI 2  | 2. We expand new marketing channels with our partners; | |
| SCMKCI 3  | 3. Our effective collaboration with partners can continuously tap the potential demands of customers. | |
| SSCP 1    | 1. We have low customer complaint rate in the supply chain; | Vachon and Klassen [20]; Aramyan et al. [32]; Beamon [33]; Nyaga et al. [34]; Lim et al. [35]; Huo et al. [72] |
| SSCP 2    | 2. Our supply chain has a high on-time delivery rate; | |
| SSCP 3    | 3. Business process of our enterprise’s supply chain is reasonable; | |
| SSCP 4    | 4. We share knowledge between enterprises and its employees in the supply chain. | |
| SCDC 1    | 1. Our supply chain is capable of adapting to changes; | Pagell and Wu [5]; Jiang [43]; Wu et al. [44]; Caloghirou et al. [45] |
| SCDC 2    | 2. Qualification of our employees is satisfactory; | |
| SCDC 3    | 3. Resource allocation and utilization of our enterprise’s supply chain are satisfactory. | |

4.3. Data Collection

The research data are collected based on expert participation and online survey. According to the hypotheses stated earlier, a questionnaire is designed by considering the guidelines suggested by Churchill [73]. The questionnaire design adopts a five-level Likert quantification, in which 5 points, 4 points, 3 points, 2 points and 1 point, respectively, indicate “completely agree”, “agree”, “neutral”, “disagree” and “completely disagree”. The potential enterprises were identified by the research group, and the contact information of the experts was then obtained. The questionnaires were released and collected in the mainland of China from July to September in 2019. After initial screening of the enterprises and experts by phone calls and/or emails, a total of 800 questionnaires were distributed and 581 were recovered. By excluding the invalid questionnaires, 510 valid questionnaires have been kept. The 510 supply chain companies cover various industries across the country, as shown in Figure 3,
and other information on the companies is provided in Table 2. Moreover, the descriptive statistics of survey data are shown in Table 3.

**Figure 3.** Proportion of industry category in the survey.

**Table 2.** Other information on surveyed companies.

| Enterprise Nature                | Number of Samples | Percentage (%) |
|----------------------------------|-------------------|----------------|
| State-owned enterprises          | 62                | 12.22          |
| Private enterprise               | 222               | 43.46          |
| Joint venture enterprise         | 56                | 10.97          |
| Foreign capital enterprise       | 125               | 24.47          |
| Others                           | 45                | 8.86           |
| Total                            | 510               | 100            |

| Annual sales, RMB                | Number of samples | Percentage (%) |
|----------------------------------|-------------------|----------------|
| Under 1 million                  | 67                | 13.08          |
| 1–5 million                      | 133               | 26.16          |
| 5 million–1 billion              | 105               | 20.68          |
| 1–5 billions                     | 131               | 25.74          |
| More than 5 billion              | 74                | 14.35          |
| Total                            | 510               | 100            |

**Table 3.** Descriptive statistics of survey data.

| Variable | Mean  | Variance  | Skewness |
|----------|-------|-----------|----------|
| SCTCI    |       |           |          |
| SCTCI 1  | 3.80  | 1.462     | −0.899   |
| SCTCI 2  | 3.78  | 1.624     | 0.884    |
| SCTCI 3  | 3.78  | 1.683     | −0.929   |
| SCTCI 4  | 3.79  | 1.586     | −0.852   |
| SCMNCCI  |       |           |          |
| SCMNCCI 1| 3.73  | 1.580     | −0.835   |
| SCMNCCI 2| 3.78  | 1.649     | −0.869   |
| SCMNCCI 3| 3.78  | 1.512     | −0.893   |
| SCMNCCI 4| 3.81  | 1.552     | −0.900   |
| SCMKCI   |       |           |          |
| SCMKCI 1 | 3.76  | 1.662     | −0.853   |
| SCMKCI 2 | 3.77  | 1.798     | −0.918   |
| SCMKCI 3 | 3.80  | 1.601     | −0.897   |
| SCDC     |       |           |          |
| SCDC 1   | 3.72  | 1.211     | −0.887   |
| SCDC 2   | 3.84  | 1.200     | −0.827   |
| SCDC 3   | 3.77  | 1.104     | −0.802   |
| SSCP     |       |           |          |
| SSCP 1   | 3.71  | 1.275     | −0.884   |
| SSCP 2   | 3.37  | 1.150     | −0.921   |
| SSCP 3   | 3.38  | 1.215     | −0.934   |
| SSCP 4   | 3.37  | 1.260     | −0.927   |
5. Results and Discussion

5.1. Data Reliability and Validity

To test the quality of the questionnaire data, reliability and validity tests were performed using two software packages, SPSS 17.0 and Amos 21.0 (IBM, Armonk, NY, USA). The results in Table 4 show that the Cronbach’s α value of each variable is greater than 0.8, which reflects a good internal consistency between variables and questionnaire items. Moreover, Composite Reliability (CR) is higher than 0.8. Therefore, the reliability of selected variables in this study is deemed satisfactory. Meanwhile, the validity test deals with constructive validity, which includes convergent validity and distinguishing validity. Convergence validity is mainly measured by three aspects: The factor load, Average Variance Extracted (AVE) and CR. The values of these three items are generally required to be greater than 0.5. It can be seen from Table 4 that factor load, the CR value and the AVE value of each measured variable are all above 0.5, which supports the good convergence validity of the model. The distinguishing validity usually requires that the quadratic root of AVE of each measurement variable is greater than the correlation coefficient between the measurement variable and other variables, and the quadratic root value of AVE is above 0.7. In this paper, we test the distinguishing validity by using the research method of Bagozzi and Yi [74]. Based on the descriptive statistics and correlation analysis of variable shown in Table 5, a positive correlation between SCTCI, SCMNCI, SCMKCI, SCDC and SSCP is found. The correlation coefficients between variables are lower than 0.8, which indicates that there is no multicollinearity between variables. Moreover, it is obvious that the quadratic root of AVE of each latent variable is larger than the correlation coefficient between each latent variable, and these values are higher than 0.7. As such, the distinguishing validity of the model is satisfactory. In addition, it is necessary to further examine whether there is a common method bias (CMB). In this regard, the Harman’s single-factor test was conducted. The results show that the single common factor explains the variance of 33.63%, which is lower than the suggested threshold value of 40% [75]. As a result, no serious common method bias exists in the data.

Table 4. Analysis of data reliability and validity.

| Variable | Number of Items | Cronbach’s α | Factor Load | AVE   | CR    |
|----------|-----------------|--------------|-------------|-------|-------|
| SCTCI    | 4               | 0.859        | 0.78        | 0.6128| 0.8635|
| SCMNCI   | 4               | 0.873        | 0.75        | 0.5743| 0.8435|
| SCMKCI   | 3               | 0.871        | 0.81        | 0.6140| 0.8267|
| SSCP     | 4               | 0.867        | 0.78        | 0.5630| 0.8374|
| SCDC     | 3               | 0.883        | 0.76        | 0.5858| 0.8496|

Composite Reliability (CR); Average Variance Extracted (AVE).
Table 5. Statistical description and correlation analysis.

| Variable | Average Value | Standard Deviation | SCTCI | SCMCI | SCMKCI | SCDC  | SSCP  |
|----------|---------------|--------------------|-------|-------|--------|-------|-------|
| SCTCI    | 7.5148        | 0.083              | 0.7828|       |        |       |       |
| SCMCI    | 7.693         | 0.086              | 0.617 *| 0.7578|        |       |       |
| SCMKCI   | 6.996         | 0.081              | 0.596 *| 0.601 *| 0.7836|       |       |
| SCDC     | 7.384         | 0.079              | 0.632 **| 0.639 **| 0.703 ***| 0.7653|       |
| SSCP     | 7.486         | 0.076              | 0.649 ***| 0.713 **| 0.681 *| 0.715 ***| 0.7503|

Note: *** represents $p < 0.001$, ** represents $p < 0.01$; the diagonal data is AVE square root.

5.2. Hierarchical Regression Analysis

The above correlation analysis only shows there is a high correlation between variables, but the specific causal relationship cannot be determined. Therefore, a hierarchical regression analysis is carried out to analyze the relationship among independent variables, dependent variables and intermediate variables before using the structural equation model (SEM). Table 6 presents the result of such an analysis. It can be seen from Models 1 and 10 that EN has a significant positive impact on SSCP (beta = 0.229, $p < 0.01$) and SCDC (beta = 0.198, $p < 0.05$); ES has a significant positive impact on SSCP (Beta = 0.245, $p < 0.01$) and SCDC (beta = 0.210, $p < 0.05$). According to Models 2 and 3, SCTCI (beta = 0.331, $p < 0.001$) and SCMNCI (beta = 0.324, $p < 0.001$) have a significant positive impact on SSCP, which implies that H1 and H2 are verified. From Model 4, SCMCI (beta = 0.169) has no significant positive impact on sustainable supply chain performance, which means that H3 is not supported. From Model 5, it can be seen that SCDC (beta = 0.321, $p < 0.001$) has a significant positive impact on SSCP, which indicates that H7 is supported. In addition, from Models 8–10, it can be found that SSCP, SCMNCI (beta = 0.285, $p < 0.05$) and SCMCI (beta = 0.524, $p < 0.001$) all have significant positive effects on the SCDC, which supports H4, H5 and H6. Lastly, in Model 6, $R^2$ is the largest when all independent variables and intermediary variables are added; this implies that the interpretation effect of the model is good. Furthermore, respectively, comparing Model 2 and Model 6, Model 3 and Model 6, Model 4 and Model 6, it can be found that the introduction of intermediary variables reduces the regression coefficient of independent variables to dependent variables.

Table 6. Hierarchical regression analysis.

| Variable | SSCP          | SCDC          |
|----------|---------------|---------------|
|          | Model 1       | Model 2       | Model 3       | Model 4       | Model 5       | Model 6       | Model 7       | Model 8       | Model 9       | Model 10      |
| EN       | 0.229 **      | 0.212 **      | 0.199 **      | 0.195 **      | 0.192 **      | 0.189 **      | 0.198 **      | 0.176 *       | 0.168 *       | 0.161 *       |
| ES       | 0.245 **      | 0.228 *       | 0.219 *       | 0.209 *       | 0.205 **      | 0.196 **      | 0.210 **      | 0.227 **      | 0.216 **      | 0.198 **      |
| SCTCI    | 0.33 ***      | 0.299 **      | 0.289 **      | 0.269 **      | 0.289 **      | 0.293 **      | 0.285 **      |                |               |               |
| SCMNCI   | 0.324 *       | 0.276 *       | 0.276 *       |                |               |               |               |                |               |               |
| SCDC     | 0.169         | 0.114         | 0.324 **      |                |               |               |               |                |               |               |
| R^2      | 0.194         | 0.231         | 0.254         | 0.267          | 0.281         | 0.296         | 0.049         | 0.051         | 0.056         | 0.069         |
| Adjust R^2| 0.217        | 0.220         | 0.235         | 0.244          | 0.262         | 0.276         | 0.050         | 0.055         | 0.059         | 0.063         |
| F value  | 21.58 **      | 22.65 ***     | 24.76 **      | 25.17 **       | 26.34 **      | 31.69 **      | 7.51 **       | 8.26 **       | 8.54 **       | 8.76 **       |

Note: ** represents $p < 0.001$, * represents $p < 0.05$.

5.3. Structural Equation Modeling and Path Analysis

In order to further test the fitness and rationality of the proposed theoretical model and research hypothesis, this study further employs the structural equation modelling (SEM) approach and confirmatory factor analysis (CFA) by using Amos21.0 software. After the association is established between the error terms e2 and e4, e6 and e9 with larger MI values, the Chi-square value of the model is reduced, and the matching degree of the model is more ideal. The SEM approach intuitively reflects the impact of supply chain innovation on supply chain performance, as shown in Figure 4. As shown in Table 7, the Chi-square value divided by degrees of freedom (χ2/df) is 1.213, which meets
the requirement of less than 3. Root mean square error of approximation (RMSEA) also meets the requirements of less than 0.1. In addition, the goodness of fit index (GFI), the normed fit index (NFI), the incremental fit index (IFI) and the comparative fit index (CFI) are also greater than 0.9. Therefore, the model fit is deemed excellent.

Figure 4. Standardized estimation results of the structural equation model. Note: e1–e21 represents error terms.

Table 7. Results of model fitting.

| Index          | Fit Index          | Judgement Criteria | Model Fit Results |
|----------------|--------------------|--------------------|-------------------|
| Absolute fit index | \(\chi^2/df\)   | <3                 | 1.213             |
|                | RMSEA              | <0.10              | 0.031             |
|                | GFI                | >0.90              | 0.918             |
| Value added fit index | NFI                | >0.90              | 0.917             |
|                | IFI                | >0.90              | 0.951             |
|                | CFI                | >0.90              | 0.958             |
| Simple fit index | PNFI               | >0.50              | 0.872             |
|                | PGFI               | >0.50              | 0.821             |

Meanwhile, maximum likelihood estimation (MLE) is used to obtain the path coefficients and the significance between variables in this paper. As shown in Table 8, the path coefficient of SCTCI to SSCP is 0.53, with the p value reaching a significant level of 0.001. Therefore, it can be concluded that SCTCI significantly affects SSCP, that is, H1 is validated. The path coefficient of SCMNCI to SSCP is 0.42, and the p value reaches the significant level of 0.01. This indicates that SCMNCI significantly influences SSCP, that is, H2 is validated. The path coefficient of SCMKCI to SSCP is 0.03, which fails to pass the significance test. As such, H3 is not supported.

For the test of indirect effect, Bootstrap is employed in this paper. Among them, the indirect effect of SCTCI→SCDC→SSCP is 0.18, and the p value reaches a significant level of 0.01. Therefore, H7 is supported. The indirect effect of SCMNCI→SCDC→SSCP is 0.21, and the p value reaches a significant level of 0.01. As such, H8 is supported. The indirect effect of SCMKCI→SCDC→SSCP is 0.14, and the
p value reaches a significant level of 0.01. This indicates that H9 is verified. The results are shown in Table 9. Therefore, SCMKCI has the most significant indirect impact on SSCP through SCDC. The second most significant indirect impact comes from SCTCI and SCMNCI. In general, SCDC has a significant intermediary effect on supply chain innovation and supply chain performance.

Table 8. Summary of hypotheses test results.

| Hypothesis | Path | Path Coefficient | Standard Error | p Value | Assumption Results |
|------------|------|------------------|----------------|---------|-------------------|
| H1         | SCTCI→SSCP  | 0.53             | 0.075          | ***     | established       |
| H2         | SCMNCI→SSCP | 0.42             | 0.078          | **      | established       |
| H3         | SCMKCI→SSCP | 0.03             | 0.054          | 0.61    | not established   |
| H4         | SCTCI→SCDC  | 0.41             | 0.062          | **      | established       |
| H5         | SCMNCI→SCDC | 0.32             | 0.057          | *       | established       |
| H6         | SCMKCI→SCDC | 0.48             | 0.072          | ***     | established       |
| H7         | SCDC→SSCP   | 0.44             | 0.064          | ***     | established       |

Note: *** represents $p < 0.001$, ** represents $p < 0.01$.

Table 9. Indirect effects analysis.

| Hypothesis | Path | Mediating Effect | p Value | Assumption Results |
|------------|------|------------------|---------|-------------------|
| H8         | SCTCI→SCDC→SSCP | 0.18 | **     | established       |
| H9         | SCMNCI→SCDC→SSCP | 0.21 | ***    | established       |
| H10        | SCMKCI→SCDC→SSCP | 0.14 | **     | established       |

Note: *** represents $p < 0.001$, ** represents $p < 0.01$.

6. Concluding Remarks

6.1. Major Findings

This paper conducts an empirical study regarding the impact of supply chain collaborative innovation (SCCI) on sustainable supply chain performance (SSCP) and investigates the intermediary mechanism of supply chain dynamic capability (SCDC). Based on the comprehensive survey data for firms in China, the main findings are summarized below. (1) The supply chain collaborative innovation in terms of SCTCI, SCMNCI and SCMKCI has an important positive impact on SCDC. This is essentially in agreement with the existing research results on a single aspect of innovation, research results such as those of Lim et al. [35], Pagell and Wu [5], Eisenhardt and Martin [42] and Stevenson and Spring [56], who all believe that information technology and knowledge sharing/storage in SCCI are the highest driving forces for improving the dynamic capability of a supply chain. Moreover, Kwak et al. [55] indicate the positive impact of supply chain innovation on robustness and resilience of risk capability. Cao [57] discovered that collaborative innovation of supply chain quality management has a positive effect on supply chain dynamic capability. (2) SCCI has certain positive impacts on SSCP. This is also similar to the findings of existing studies considering a single aspect of innovation. For example, Sezen and Çankaya [15], Versaevel [48], Kim et al. [49] and Lindgreen et al. [51] all show the positive effect of technological innovation on performance of sustainable development, such as synergism innovation in information technology or green and ecological technology. (3) SCDC plays a significant intermediary role between SCCI and SSCP, and this finding is slightly different from the findings of Hong et al. [58,59], in which only partial such intermediary role is found.

6.2. Contributions

While many researchers have taken up the topics of SCCI, SCDC and SSCP, most scholars pay more attention to the interaction between SCDC and SSCP. In the literature of SCCI, many researchers study the technical cooperation innovation in sustainable supply chain practice, while only a few address
management or marketing collaborative innovation. This paper provides new insights concerning SSCI, SCDC and SSCP based on the paradigm of “Innovation Behavior-Dynamic Capability-Sustainable Performance”. There are three major contributions of this research. First, the paper reveals the impact path of supply chain collaborative innovation from three aspects (instead of a single one) on sustainable supply chain performance. This enriches the relationship theory between supply chain collaborative innovation and sustainable supply chain management. Second, the paper constructs a hierarchical regression analysis and structural equation model to verify the intermediary effect of SCDC on SSCI and SSCP. The results further strengthen the significance of DC theory in SSCM practice. Third, the influence mechanism is investigated by the empirical research. Therefore, it verifies and expands the existing theoretical framework of sustainable supply chain management. The results help enterprises to identify the ways of supply chain collaborative innovation, promote the improvement of supply chain dynamic capability and improve the overall sustainable supply chain performance.

6.3. Managerial Implications

Implementation of supply chain technology collaborative innovation not only effectively maximizes the sustainable supply chain performance, but also helps to improve the dynamic adaptability to changes in the external environment. Therefore, enterprises should make full use of the new technology tools such as renewable technology, information technology, Internet of things and green technology to improve enterprise digitalization, shorten processes and reduce pollution, with the ultimate objective of improving the economic, social and environmental performance. Moreover, it is essential to further cultivate technical cooperation with upstream and downstream enterprises of supply chains, which can effectively improve the sustainable supply chain performance.

Meanwhile, according to the research results, supply chain management collaborative innovation has a significant impact on sustainable supply chain performance. To facilitate supply chain management collaborative innovation, enterprises should improve timely communication with different upstream and downstream partners in management decisions, achieve the agility and flexibility of supply chain organizations and cultivate unique core competitiveness of supply chains. Moreover, it can be found that supply chain market collaborative innovation indirectly affects supply chain performance through the supply chain dynamic capability. Therefore, enterprises need to grasp the dynamic changes of market demand and improve the ability of market collaborative innovation with the customer and supply chain partner. By further exploring the potential needs of customers, jointly filling in the market gaps and reforming the original marketing channels, enterprises can reduce the marketing costs, broaden living space, form a unique competitive advantage, improve the market sensitivity and market responsibility and thus improve sustainable supply chain performance.

In addition, due to the significant intermediary role of supply chain dynamic capability in affecting supply chain performance, enterprises need to develop dynamic adaptability to internal and external changes, improve the self-organization ability of the supply chain (especially resource reorganization and integration capability, environment adaptability, coordination capability and quality of employees), ensure that member enterprises obtain sustainable competitive advantages from the supply chain collaborative innovation and thus maximize sustainable supply chain performance.

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References

1. Sachs, G. Made in the USA or China? 25 Years of Supply Chain Investment at a Crossroads. Available online: http://xqdoc.imedao.com/16251202b1c17a403fee8650.pdf (accessed on 7 April 2020).

2. Linton, J.D.; Klassen, R.; Jayaraman, V. Sustainable supply chains: An introduction. J. Oper. Manag. 2007, 42, 451–469. [CrossRef]

3. Carter, C.R.; Rogers, D.S. A framework of sustainable supply chain management: Moving toward new theory. Int. J. Phys. Distrib. Logist. Manag. 2008, 38, 360–387. [CrossRef]

4. Seuring, S.; Muller, M. Core issues in sustainable supply chain management—A Delphi study. Bus. Strategy Environ. 2008, 17, 455–466. [CrossRef]

5. Pagell, M.; Wu, Z. Building a more complete theory of sustainable supply chain management using case studies of 10 exemplars. J. Supply Chain Manag. 2009, 45, 37–56. [CrossRef]

6. Silva, G.M.; Gomes, P.I.; Sarkis, J. The role of innovation in the implementation of green supply chain management practices. Bus. Strategy Environ. 2019, 28, 819–832. [CrossRef]

7. Seuring, S. Supply chain management for sustainable products—Insights from research applying mixed-methodologies. Bus. Strategy Environ. 2011, 20, 471–484. [CrossRef]

8. Soosay, C.A.; Hyland, P.; Ferrer, M. Supply chain collaboration: Capabilities for continuous innovation. Supply Chain Manag. Int. J. 2008, 13, 160–169. [CrossRef]

9. Cao, M.; Zhang, Q. Supply chain collaboration: Impact on collaborative advantage and firm performance. J. Oper. Manag. 2011, 29, 163–180. [CrossRef]

10. Wei, S.; Zhang, Z.; Ke, G.Y.; Chen, X. The more cooperation, the better? Optimizing enterprise cooperative strategy in collaborative innovation networks. Phys. A Stat. Mech. Its Appl. 2019, 534. [CrossRef]

11. Shin, N.; Park, S.H.; Park, S. Partnership-based supply chain collaboration: Impact on commitment, innovation, and firm performance. Sustainability 2019, 11, 449. [CrossRef]

12. Yang, M.G.; Hong, P.; Modi, S.B. Impact of lean manufacturing and environmental management on business performance: An empirical study of manufacturing firms. Int. J. Prod. Econ. 2011, 129, 251–261. [CrossRef]

13. Malone, T.W.; Crowston, K.G. The interdisciplinary study of coordination. ACM Comput. Surv. 1994, 26, 87–119. [CrossRef]

14. Lambert, D.M.; Copper, M.C.; Pagh, J.D. Supply chain management: Implementation issues and research opportunities. Int. J. Logist. Manag. 1998, 9, 1–20. [CrossRef]

15. Sezen, B.; Çankaya, S.Y. Effects of green manufacturing and eco-innovation on sustainability performance. Procedia Soc. Behav. Sci. 2013, 99, 154–163. [CrossRef]

16. Mangun, D.; Thurston, D.L. Incorporating component reuse, remanufacture, and recycle into product portfolio design. IEEE Trans. Eng. Manag. 2002, 49, 479–490. [CrossRef]

17. Ryoo, S.Y.; Koo, C. Green practices-IS alignment and environmental performance: The mediating effects of coordination. Inf. Syst. Front. 2013, 15, 799–814. [CrossRef]

18. Savaskan, R.C.; Bhattacharya, S.; Wassenhove, L.N.V. Closed-loop supply chain models with product remanufacturing. Manag. Sci. 2004, 50, 239–252. [CrossRef]

19. Zhao, L.; Huo, B.; Sun, L.; Zhao, X. The impact of supply chain risk on supply chain integration and company Performance: A global investigation. Supply Chain Manag. Int. J. 2013, 18, 115–127. [CrossRef]

20. Vachon, S.; Klassen, R.D. Environmental management and manufacturing performance: The role of collaboration in the supply chain. Int. J. Prod. Econ. 2008, 11, 299–315. [CrossRef]

21. Yawar, S.A.; Seuring, S. Management of social issues in supply chains: A literature review exploring social issues, actions and performance outcomes. J. Bus. Ethics 2017, 141, 621–643. [CrossRef]

22. Fraj, E.; Martinez, E. Ecological consumer behavior: An empirical analysis. Int. J. Consum. Stud. 2007, 31, 26–33. [CrossRef]

23. Lin, R.J.; Tan, K.H.; Geng, Y. Market demand, green product innovation, and firm performance: Evidence from Vietnam motorcycle industry. J. Clean. Prod. 2013, 40, 101–107. [CrossRef]

24. Zhao, S.L.; Zhu, Q.H. Remanufacturing supply chain coordination under the stochastic remanufacturability rate and the random demand. Ann. Oper. Res. 2017, 257, 661–695. [CrossRef]

25. Swami, S.; Shah, J. Channel coordination in green supply chain management. J. Oper. Res. Soc. 2013, 64, 336–351. [CrossRef]
26. Swami, S.; Shah, J. Channel coordination in green supply chain management: The case of package size and shelf-space allocation. Technol. Oper. Manag. 2011, 2, 50–59. [CrossRef]
27. Hong, Z.; Guo, X. Green product supply chain contracts considering environmental responsibilities. Omega 2019, 83, 155–166. [CrossRef]
28. Elkington, J. Accounting for the triple bottom line. Meas. Bus. Excell. 1998, 2, 18–22. [CrossRef]
29. Seuring, S.; Muller, M. From a literature review to a conceptual framework for sustainable supply chain management. J. Clean. Prod. 2008, 16, 1699–1710. [CrossRef]
30. Lamberton, D.M. Supply Chain Management: Processes, Partnerships, Performance, 2nd ed.; Supply Chain Management Institute: Sarasota, FL, USA, 2005.
31. Olugu, E.U.; Wong, K.Y. Supply chain performance evaluation: Trends and challenges. Am. J. Eng. Appl. Sci. 2009, 2, 202–211. [CrossRef]
32. Aramyan, L.H.; Oude Lansink, A.G.; van der Vorst, J.G.; van Kooten, O. Performance measurement in agri-food supply chain systems: A case study. Supply Chain Manag. 2007, 12, 304–315. [CrossRef]
33. Beamon, B.M. Measuring supply chain performance. Int. J. Oper. Prod. Manag. 1999, 19, 275–292. [CrossRef]
34. Nyaga, G.N.; Whipple, J.M.; Lynch, D.F. Examining supply chain relationships: Do buyer and supplier perspectives on collaborative relationships differ? J. Oper. Manag. 2010, 28, 101–114. [CrossRef]
35. Lim, M.K.; Tseng, M.L.; Tan, K.H.; Bui, T.D. Knowledge management in sustainable supply chain management: Improving performance through an interpretive structural modelling approach. J. Clean. Prod. 2017, 162, 806–816. [CrossRef]
36. Teece, D.J.; Pisano, G.; Shuen, A. Dynamic capabilities and strategic management. Strateg. Manag. J. 1997, 18, 509–533. [CrossRef]
37. Reuter, C.; Foerstl, K.A.I.; Hartmann, E.V.I.; Blome, C. Sustainable global supplier management: The role of dynamic capabilities in achieving competitive advantage. J. Supply Chain Manag. 2010, 46, 45–63. [CrossRef]
38. Beske, P. Dynamic capabilities and sustainable supply chain management. Int. J. Phys. Distrib. Logist. Manag. 2012, 42, 372–387. [CrossRef]
39. Defee, C.C.; Fugate, B.S. Changing perspective of capabilities in the dynamic supply chain era. Int. J. Logist. Manag. 2010, 21, 180–206. [CrossRef]
40. Zahra, S.A.; Sapienza, H.J.; Davidsson, P. Entrepreneurship and dynamic capabilities: A review, model and research agenda. J. Manag. Stud. 2006, 43, 917–955. [CrossRef]
41. Zollo, M.; Winter, S.G. Deliberate learning and the evolution of dynamic capabilities. Organ. Sci. 2002, 13, 339–351. [CrossRef]
42. Eisenhardt, K.M.; Martin, J.A. Dynamic capabilities: What are they? Strateg. Manag. J. 2000, 21, 1105–1121. [CrossRef]
43. Jiang, C. Supply Chain Dynamic Capability and Its Impact on Enterprise Competitive Advantage. Ph.D. Thesis, Jinan University, Jinan, Shandong Province, China, 2011.
44. Wu, L.Y. Applicability of the resource-based and dynamic-capability views under environment volatility. J. Bus. Res. 2010, 63, 27–31. [CrossRef]
45. Caloghirou, Y.; Protoperou, A.; Spanos, Y.; Papagiannakis, L. Industry-versus firm-specific effects on performance: Contrasting SMEs and large-sized firms. Eur. Manag. J. 2004, 22, 231–243. [CrossRef]
46. Lii, P.; Kuo, F.I. Innovation-oriented supply chain integration for combined competitiveness and firm performance. Int. J. Prod. Econ. 2016, 174, 142–155. [CrossRef]
47. Dey, P.K.; Petridis, N.; Petridis, K.; Malesios, C.; Nixon, J.D.; Ghosh, K. Environmental management and corporate social responsibility practices of small and medium-sized enterprises. J. Clean. Prod. 2018, 195, 687–702. [CrossRef]
48. Versaevel, B. Co-ordination costs and vertical integration in production franchise networks: A common agency model. Res. Econ. 2002, 56, 157–186. [CrossRef]
49. Kim, D.; Jean, R.J.B.; Sinkovics, R.R. Drivers of virtual inter-firm integration and its impact on performance in international customer–supplier relationships. Manag. Int. Rev. 2018, 58, 495–522. [CrossRef]
50. Gemnden, H.G.; Pitter, T.; Heydebreck, P. Network configuration and innovation success: An empirical analysis in German high-tech industries. Int. J. Res. Mark. 1996, 13, 449–462. [CrossRef]
51. Lindgreen, A.; Di Benedetto, C.A. Citation classics from industrial marketing management: Celebrating forty-seven years of publications on business-to-business marketing management. Ind. Mark. Manag. 2018, 73, 1–6. [CrossRef]
52. Wu, G.C. The influence of green supply chain integration and environmental uncertainty on green innovation in Taiwan’s IT industry. *Supply Chain Manag. Int. J.* **2013**, *18*, 539–552. [CrossRef]

53. Cruz, J.M. Mitigating global supply chain risks through corporate social responsibility. *Int. J. Prod. Res.* **2013**, *51*, 995–4010. [CrossRef]

54. Yang, W.; Liu, Y.; Shen, H.; Wang, L. Administrative innovation, marketing innovation and firm performance—Based on samples of new firm and mature firm. *Sci. Sci. Manag. S. T.* **2011**, *03*, 69–75.

55. Kwak, D.W.; Seo, Y.J.; Mason, R. Investigating the relationship between supply chain innovation, risk management capabilities and competitive advantage in global supply chains. *Int. J. Oper. Prod. Manag.* **2018**, *38*, 2–21. [CrossRef]

56. Stevenson, M.; Spring, M. Supply chain flexibility: An inter-firm empirical study. *Int. J. Oper. Prod. Manag.* **2009**, *29*, 946–971. [CrossRef]

57. Cao, Y. Research on Mechanism of Supply Chain Quality Management Impact on the Quality Performance from the Perspective of Dynamic Capability. Ph.D. Thesis, Zhejiang University, Hangzhou, Zhejiang Province, China, 2016.

58. Hong, J.; Zhang, Y.; Ding, M. Sustainable supply chain management practices, supply chain dynamic capabilities, and enterprise performance. *J. Clean. Prod.* **2018**, *172*, 3508–3519. [CrossRef]

59. Hong, J.; Zheng, R.; Deng, H.; Zhou, Y. Green supply chain collaborative innovation, absorptive capacity and innovation performance: Evidence from China. *J. Clean. Prod.* **2019**, *241*, 118377. [CrossRef]

60. Kumar, G.; Subramanian, N.; Arputham, R.M. Missing link between sustainability collaborative strategy and supply chain performance: Role of dynamic capability. *Int. J. prod. Econ.* **2018**, *203*, 96–109. [CrossRef]

61. Teece, D.J. Explication dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strateg. Manag. J.* **2007**, *28*, 1319–1350. [CrossRef]

62. Freytag, P.V.; Munksgaard, K.B.; Clarke, A.H.; Damgaard, T.M. Organizing and strategizing in changing networks: Contributions to theory, methodology and management. *Ind. Mark. Manag.* **2016**, *58*, 4–10. [CrossRef]

63. Lin, P. The regulating role of environmental turbulence: An empirical study of the relationship between dynamic capabilities and performance. *J. Shanghai Univ. (Soc. Sci. Ed.)* **2009**, *16*, 66–77.

64. Yu, W.; Chavez, R.; Jacobs, M.A.; Feng, M. Data-driven supply chain capabilities and performance: A resource-based view. *Transp. Rev.* **2018**, *114*, 371–385. [CrossRef]

65. Zott, C. Dynamic capabilities and the emergence of intraindustry differential firm performance: Insights from a simulation study. *Strateg. Manag. J.* **2003**, *24*, 97–125. [CrossRef]

66. Makadok, R. Toward a synthesis of the resource based and dynamic capability views of rent creation. *Strateg. Manag. J.* **2001**, *22*, 387–401. [CrossRef]

67. Gao, T.; Tian, Y. Mechanism of supply chain coordination cased on dynamic capability framework—the mediating role of manufacturing capabilities. *J. Ind. Eng. Manag.* **2014**, *7*, 1250–1267. [CrossRef]

68. Hopkins, D.S.; Bailey, E.L. New product pressure. *Conf. Board Rec.* **1981**, *16–24.

69. Li, Y.; Su, Z.F.; Liu, Y. Can strategic flexibility help firms profit from product innovation? *Technovation* **2010**, *30*, 300–309. [CrossRef]

70. Birkinshaw, J.; Hamel, G.; Mol, M.J. Management innovation. *Acad. Manag. Rev.* **2008**, *33*, 825–845. [CrossRef]

71. Damanpour, F.; Gopalakrishnan, S. The dynamics of the adoption of product and process innovations in organizations. *J. Manag. Stud.* **2001**, *38*, 45–65. [CrossRef]

72. Bagozzi, R.P.; Yi, Y. On the evaluation of structural equation models. *J. Acad. Mark. Sci.* **1998**, *16*, 74–94. [CrossRef]

73. Podsakoff, P.M.; Mackenzie, S.B.; Lee, J.Y.; Podsakoff, N.P. Common method biases in behavioral research: A critical review of the literature and recommended remedies. *J. Appl. Psychol.* **2003**, *88*, 879–903. [CrossRef]