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The association among collaboration, risk and supply chain performance

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A B S T R A C T

The global supply chain is facing risks and challenges that disrupt the supply chain and negatively affect performance. The high-quality cooperation between supply chain members is a useful solution to help limit risks and improve its performance. This study was conducted to demonstrate the relationship between collaboration, supply chain risk, and supply chain performance of organic agricultural products in Vietnam. Research data were collected from 162 enterprises producing organic agricultural products. Applying the structural equation modeling (SEM), the study has shown that supply chain risks negatively affect the supply chain performance of organic agricultural products. The close cooperation between members of the supply chain limits supply chain risks, thereby improving the efficiency of the supply chain of Vietnamese organic agricultural products.

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1. Introduction

In recent years, global supply chains have become increasingly vulnerable due to the presence of different risks (Duhamel et al., 2016). Production activities of enterprises face risks as the product life cycle is getting shorter and the supply chain is expanding on a global scale (Christopher et al., 2011). Hence, enterprises participating in the supply chain have become more and more interdependent (Thun & Hoenig, 2011; Li et al., 2015). Supply chain risks negatively affect supply chain performance and its participants' performance (Nyamah et al., 2017; Afshar & Fazli, 2018; Truong Quang & Hara, 2018; Mai et al., 2022). Building close cooperative relationships between members of the supply chain helps improve operational efficiency (Simatupang & Sridharan, 2004; Cao & Zhang, 2011; Huo, 2012; Dragan et al., 2015; Topolšek & Dragan, 2016); avoid supply chain risks (Faisal et al., 2006; Kim, 2010; Zhao et al., 2013; Chen et al., 2013; Ali & Shukran, 2016; Duhamel et al., 2016); and improve supply chain performance (Narasimhan & Kim, 2002; Elofson & Robinson, 2007; Eyaa et al., 2010; Srinivasan et al., 2011; Ali & Shukran, 2016; Manikanda Prabhu & Selvakumar, 2018; Mofokeng & Chinomona, 2019). Recently, there are many studies about the relationship between cooperation, supply chain risk, and supply chain performance. Most studies have been conducted in developed countries while very few studies work on this topic in developing countries with similar contexts to Vietnam. In the complicated development of the Covid-19 epidemic, the supply chain of organic agricultural products is facing unexpected risks. The issue of cooperation in building and completing the supply chain of organic agricultural products is an appropriate approach to limit risks, and improve supply chain performance and operational efficiency of enterprises.

2. Theoretical Framework and Research Hypothesis

2.1 Theoretical framework

Supply Chain

Today, enterprises realize that a single department or company cannot meet the increasing needs of customers, it is necessary to have a close association of all members in the company in an entire supply chain (Barratt & Barratt, 2012). The supply

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chain is a tool to meet the requirements of sustainable economic, environmental, and social development of each actor participating in that supply chain (Normansyah & Matteo, 2012). A supply chain is a network of organizations, including upstream linkages and downstream linkages through processes and activities that create value for the products and services provided in the market (Lambert & Stock, 1993; Cooper et al., 1997).

Collaboration

Formal collaboration is based on written contracts between suppliers and buyers or established by organizations of common interest (Henriksen, 1995). Researchers often focus their attention on formal collaborations. However, a detailed analysis of collaboration requires both formal contracts and informal agreements. Supply chain collaboration is the formation of close and long-term partnerships that share information, resources, and risks to accomplish common goals or individual goals (Bowersox et al., 2003). Collaboration brings lots of benefits and it is a way to operate a continuous and smooth supply chain that connects all members (Piboonrungroj & Disney, 2009). The ability to initiate and maintain a partnership has a significant effect on a firm's competitiveness and improves market outcomes (Gadde & Snechota, 2000).

Supply chain risk

Several researchers have offered different definitions of supply chain risk (Jüttner et al., 2003; Wagner & Bode, 2006; Bogataj & Bogataj, 2007). According to Ho et al. (2015), supply chain risk is the likelihood and impact of undesired macro- or micro-events (or conditions) that adversely affect any part of a supply chain, resulting in failures or irregularities at the level of operation, tactic, or strategy. Supply chain risks are damages occurring during the operation of the supply chain. They may cause disturbances and disruptions in the distribution system of goods, services, information, and finance that negatively impact the company's performance or the entire supply chain (Colin et al., 2011). Some common supply chain risks, mentioned by many studies include supply risk, demand risk, regulatory risk, infrastructure risk, and disaster risk (Ho et al., 2015).

Supply chain performance

In the competitive environment, supply chain performance is considered a top issue in many different industries (Balfaqih et al., 2016). An important aspect of successful supply chain management is the measurement and monitoring of information on operational parameters and supply chain performance (Gunasekaran & Ngai, 2004). According to Balfaqih et al. (2016), there are various criteria to measure supply chain performance. Supply chain performance is defined as the ability to produce and deliver products/services to meet customer needs, reaching superior efficiency to supply chain participants (Vickery et al., 2003; Chen et al., 2004). Supply chain performance is measured by flexibility, membership integration, and responsiveness to customer requirements (Vickery et al., 1999; Stock et al., 2000; Chen et al., 2004; Qrunfleh & Tarafdar, 2014).

2.2 Research hypothesis

Relationship between collaboration and supply chain risk

The close cooperation among supply chain members helps reduce supply chain risks (Kim, 2010, Kache & Seuring, 2014). Enhancing partnerships with suppliers not only helps prevent disruptions in the supply chain but also responds quickly to the disruption (Mai et al., 2022). According to Chen et al. (2013), supply chain collaboration is a strategy to reduce risks. In recent times, many studies have pointed out an inverse correlation between collaboration and supply chain risks (Zhao et al., 2013; Chen et al., 2013; Ali & Shukran, 2016; Duhamel et al., 2016). Therefore, the study proposes hypothesis

H_1: *Collaboration is negatively correlated with supply chain risks of organic agricultural products.*

The relationship between collaboration and supply chain performance

Close integration in the supply chain positively affects the performance of the supply chain (Narasimhan & Kim, 2002, Kache & Seuring, 2014) and improves the performance of enterprises participating in the supply chain (Simatupang & Sridharan, 2004; Cao & Zhang, 2011; Huo, 2012; Dragan et al., 2015; Topolšek & Dragan, 2016). Several studies have demonstrated that collaboration is positively correlated with supply chain performance (Elofson & Robinson, 2007; Eyaa et al., 2010; Srinivasan et al., 2011; Ali & Shukran, 2016; Manikanda Prabhu & Selvakumar, 2018; Mofokeng & Chinomona, 2019). Thus, the proposed research hypothesis is as follows

H_2: *Collaboration positively impacts the supply chain performance of organic agricultural products.*

Relationship between supply chain risk and supply chain performance

According to Afshar & Fazli (2018), supply chain risk negatively impacts supply chain performance. The higher the risk, the more negative impacts and inefficiencies in the supply chain (Christopher & Lee, 2004). Supply chain risks directly impact the performance of enterprises participating in the supply chain (Hendricks & Singhal, 2005; Wagner & Bode, 2008; Florian & Constangioara, 2014). Good supply chain risk management improves supply chain performance (Okoumba, 2018). Recent studies have indicated a negative correlation between supply chain risk and supply chain

performance (Nyamah et al., 2017; Truong Quang & Hara, 2018; Mai et al., 2022). The proposed research hypothesis is as follows

H_3: *Supply chain risk is negatively correlated with supply chain performance of organic agricultural products*.

Based on the literature review and research hypotheses, the study applied the participatory rural appraisal (PRA) method with 5 directors of organic agricultural enterprises. The results of the group discussion help identify appropriate scales for the research model below.

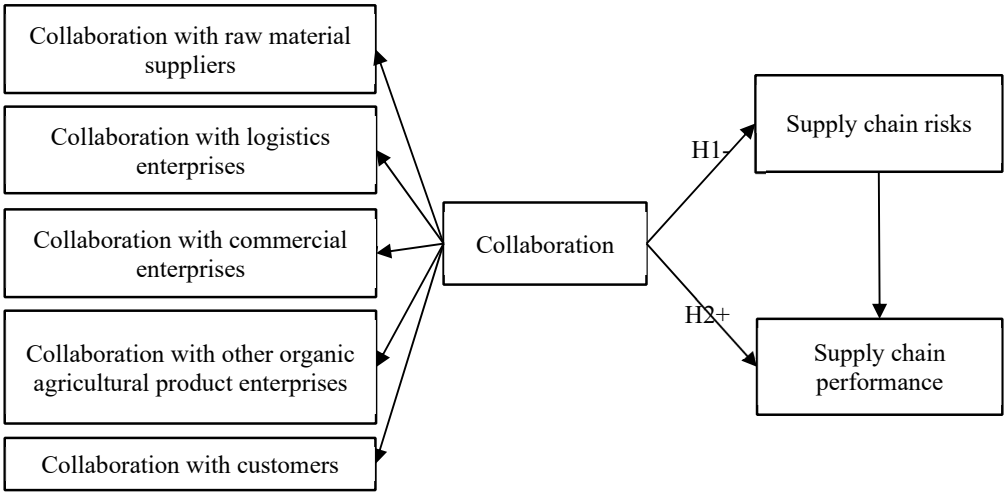

Fig. 1. Proposed research model

Table 1
Interpretation of observed variables in the research model

Factor	Observed variable	Scale
Collaboration with raw material suppliers	MAT1: We maintain a positive cooperative relationship with raw material suppliers.	Likert 1-5
	MAT2: We raw material suppliers improve product/ service quality.	Likert 1-5
	MAT3: We always exchange information with the raw material suppliers during the operation.	Likert 1-5
	Source: Zhao et al. (2013), Li et al. (2006)	
Collaboration with logistics enterprises	LOG: Logistics enterprises share shipping schedules and shipping capacity with us.	Likert 1-5
	LOG2: We share market information and demand forecasts with logistics enterprises.	Likert 1-5
	LOG3: We help logistics enterprises improve procedures to better meet customer needs.	Likert 1-5
	Source: Flynn et al. (2010)	
Collaboration with commercial enterprises	COM1: We always inform the market information with the commercial enterprises.	Likert 1-5
	COM2: We and the commercial enterprises plan to develop the market shares together.	Likert 1-5
	COM3: We share benefits and find solutions for problems with commercial enterprises.	Likert 1-5
	Source: Simatupang & Sridharan (2005); Cao & Zhang (2011)	
Collaboration with other organic agricultural product producers	ORG1: We always exchange information about reserve capacity and market forecast with other organic agricultural product producers.	Likert 1-5
	ORG2: We always exchange and share to solve problems in the supply chain with other organic agricultural product producers.	Likert 1-5
	ORG3: We always work with other organic agricultural producers to reduce costs and improve operational efficiency.	Likert 1-5
	Source: Topolšek & Dragan (2016)	
Collaboration with customers	CUS1: We are in close contact with our customers.	Likert 1-5
	CUS2: Customers give us feedback on product quality.	Likert 1-5
	CUS3: Customers are actively participating in our product improvement process.	Likert 1-5
	Source: Zhao et al. (2013)	
Supply chain risk	SCR1: Problems in logistics and quality of raw materials arise from the supplier side.	Likert 1-5
	SCR2: Customer needs change constantly; it is difficult to predict customer behavior.	Likert 1-5
	SCR3: Administrative barriers; inconsistent, complex, and constantly changing management systems.	Likert 1-5
	SCR4: The epidemic, environmental pollution, and natural disasters are becoming more and more serious.	Likert 1-5
	SCR5: The supply chain is broken, and elements in the supply chain are passive.	Likert 1-5
	Source: Wagner & Bode (2008), Florian & Constangioara (2014)	
Supply chain performance	SCP1: The supply chain can meet the requirements of special customers.	Likert 1-5
	SCP2: The supply chain can provide products that satisfy demands at different prices.	Likert 1-5
	SCP3: The supply chain can quickly adjust to respond promptly to changing customer needs.	Likert 1-5
	SCP4: Supply chains can quickly introduce new products.	Likert 1-5
	SCP5: The supply chain has a fast and flexible response time to customer requests.	Likert 1-5
	Source: Chen et al. (2004), Qrunfleh & Tarafdar (2014)	

3. Research methodology

To test the research hypotheses, quantitative analysis is used in a logical sequence. Step 1: Test the reliability of the scale by Cronbach's alpha coefficient to remove low-reliability variables (Nguyen, 2011, 2014). Step 2: Exploratory factor analysis (EFA) to assess the convergent and discriminant validity (Hair et al., 2010). Step 3: Confirmatory factor analysis (CFA) to

test the structural reliability of the measurement model (Anderson & Gerbing, 1988). Step 4: Covariance-based structural equation modeling (CB-SEM) to test research hypotheses and the validity of the research model (Baumgartner & Homburg, 1996; Hair et al, 2006; Kline, 2011).

According to Hair et al. (1998), to use EFA, the minimum sample size should be 50, preferably 100. The ratio between observations and measurement variables should be 5:1, which means for each measurement variable, a minimum of 5 observations is required. The SEM method requires a large sample size because it is based on sample distribution theory (Raykov & Widaman, 1995). To reach reliability in testing the appropriateness of the SEM model, the sample size from 100 to 200 is suitable (Hoyle, 1995).

A pilot survey was conducted in February 2022 to examine the structure of the questionnaire. The survey subjects are the board of director members from eight organic agricultural production enterprises in Dong Thap and Tien Giang Province. Respondents were asked to answer all questions, then give comments on the overall structure and clarity of each question. According to the survey result, most questions were clearly understood and answered. Respondents agreed with the research scales. An official survey was conducted from March 2022 to April 2022 in 13 provinces/cities in the Mekong Delta, Vietnam. This is the largest agricultural production area in Vietnam, organic farming enterprises are diverse in scale and type. The study used quota sampling to collect data. The grouping criteria include enterprise size and business type. The authors used e-mail interviews to collect detailed information from the board of directors of organic farming enterprises. The number of questionnaires reached 168, after removing the inappropriate ones (incomplete answers, unreliable answers), a total of 162 valid questionnaires were used to test the research model.

4. Research results and discussion

4.1 Evaluate the reliability of scales

Based on the test results in table 2, all research scales have Cronbach's alpha value from 0.874 to 0.931. The corrected item-total correlation of all observed variables is greater than 0.3 (Nunnally & Bernstein, 1994). So no variable is excluded from the research model (Nunnally, 1978; Peterson, 1994; Slater, 1995). Therefore, all scales meet the reliability requirement.

Table 2
Cronbach's alpha test result

Scale	Number of observed variables	Cronbach's alpha	Corrected item-total correlation
Collaboration with raw material suppliers	3	0.931	0.844
Collaboration with logistics enterprises	3	0.894	0.739
Collaboration with commercial enterprises	3	0.874	0.718
Collaboration with other organic agricultural enterprises	3	0.895	0.751
Collaboration with customers	3	0.899	0.747
Supply chain risk	5	0.922	0.741
Supply chain performance	5	0.926	0.767

Following the reliability test, the study conducts the exploratory factor analysis (EFA), and the test achieves the following values. (1) Reliability of observed variables: Factor loading > 0.5 (Hair et al., 1998). (2) Test the appropriateness of the model: 0.5 < KMO = 0.913 < 1.0 (Hair et al., 1998; Kline, 2011). (3) Bartlett's test on the correlation among observed variables: Sig. = 0.00 < 0.05 (Hair et al., 1998; Kline, 2011). The cumulative variance test reaches 81.476% (higher than the level of 50%). This shows that the observed variables have a high explanatory capacity (Anderson & Gerbing, 1988; Hair et al., 1998). Therefore, 7 factors are created from 25 observed variables and there is no disturbance of observed variables, so the names of the factors remain the same.

Table 3
Exploratory factor analysis (EFA) result

Sign	Observed variable	Factor
F1	3 variables: MAT1, MAT2, MAT3	Collaboration with raw material suppliers
F2	3 variables: LOG1, LOG2, LOG3	Collaboration with logistics enterprises
F_3	3 variables: COM1, COM2, COM3	Collaboration with commercial enterprises
F_4	3 variables: ORG1, ORG2, ORG3	Collaboration with other organic agricultural enterprises
F_5	3 variables: CUS1, CUS2, CUS3	Collaboration with customers
F_6	5 variables: SCR1, SCR2, SCR3, SCR4, SCR5	Supply chain risk
F_7	5 variables: SCP1, SCP2, SCP3, SCP4, SCP5	Supply chain performance

Based on the confirmatory factor analysis (CFA) result, the following values are guaranteed: Chi-square/df = 1.254 < 2 with P = 0.004 ≤ 0.05; TLI and CFI coefficient reaches 0.976 and 0.980, all higher than 0.9; and RMSEA = 0.040 < 0.08. This proves that the model fits the market data. The standardized regression weights of the scales are all greater than 0.5 and the standardized weights are statistically significant, so the model achieves convergent validity. The correlation coefficients between factors are all less than 1 and the standard deviation is less than 0.05. The research model achieves discriminant validity.

Calculation results of the composite reliability (Pc) and average variance extracted (Pvc) are suitable. The minimum value of Pc reaches 0.875 and Pvc reaches 0.700, all meeting the statistical requirement (Fornell & Larcker, 1981). According to the

above findings, all the scales in the model meet the requirements in terms of value and reliability, so the model is suitable to be used for the next SEM.

Table 4
Testing the research scales

Scale	Number of observed variables	Composite reliability (P_c)	The average variance extracted (P_{vc})	Reference resources
Collaboration with raw material suppliers	3	0.932	0.820	Fornell & Larcker (1981)
Collaboration with logistics enterprises	3	0.896	0.744	
Collaboration with commercial enterprises	3	0.875	0.700	
Collaboration with other organic agricultural enterprises	3	0.902	0.754	
Collaboration with customers	3	0.897	0.743	
Supply chain risk	5	0.923	0.706	
Supply chain performance	5	0.925	0.712	

4.2 Test the research hypotheses

Structural equation modeling (SEM) was used to test the research hypotheses. Based on table 5, hypotheses H1, H2, and H3 are accepted with a 99% significance level. The relationship among factors is explained in detail below.

Table 5
Research hypothesis test

Relationship	Unstandardized			Standardized estimated value	Significance	Hypothesis
	Estimated value	Standard error SE	Critical ratio CR			
SCR ← COL	-0.811	0.146	-5.566	-0.569	***	H1: accepted
SCP ← COL	0.952	0.156	6.105	0.658	***	H2: accepted
SCP ← SCR	-0.285	0.074	-3.836	-0.281	***	H3: accepted

Hypothesis H1: Collaboration is negatively correlated with organic agricultural products supply chain risk. According to the estimated results in table 5, collaboration negatively affects supply chain risks of organic agricultural products with the standardized estimated value of – 0.569 and the statistical significance of p = 0.000. This shows that the close linkages between organic agricultural enterprises and other members in the supply chain (raw material suppliers, logistics enterprises, commercial companies, other organic agricultural producers, and customers) limit the risks arising in the operation of the supply chain. When the quality of the partnership is improved, it not only helps prevent disruptions in the supply chain but also helps companies respond quickly to those disruptions (Chen et al., 2013; Mai et al., 2022). This research result is consistent with studies proposed by Zhao et al. (2013), Chen et al. (2013), Kache & Seuring (2014), Ali & Shukran (2016), and Duhamel et al. (2016).

Hypothesis H2: Collaboration is positively correlated with the supply chain performance of organic agricultural products. This hypothesis is accepted with the standardized estimated coefficient of 0.658 and a statistical significance of p = 0.000. This demonstrates a positive relationship between collaboration and organic agricultural supply chain performance. The closer the cooperation between the members of the supply chain, the smoother the operation of the supply chain (Piboonrungroj & Disney, 2009). It contributes to improving the performance of participating enterprises in the supply chain (Simatupang & Sridharan, 2004; Cao & Zhang, 2011; Huo, 2012; Dragan et al., 2015; Topolšek & Dragan, 2016). Thereby improving supply chain performance (Elofson & Robinson, 2007; Eyaa et al., 2010; Srinivasan et al., 2011; Ali & Shukran, 2016; Manikanda Prabhu & Selvakumar, 2018; Mofokeng & Chinomona, 2019).

Hypothesis H3: Supply chain risk is negatively correlated with organic agricultural supply chain performance. Table 5 points out a negative correlation between supply chain risk and supply chain performance of organic agricultural products, with a standardized estimated coefficient of - 0,281 and a level of significance p = 0.000. The high risks in a supply chain may cause many negative impacts, leading to inefficiencies in the supply chain operations (Christopher & Lee, 2004; Hendricks & Singhal, 2005; Wagner & Bode, 2008; Florian & Constangioara, 2014). Good supply chain risk management improves supply chain performance (Loury-Okoumba, 2018). The research result is similar to studies proposed by Nyamah et al. (2017), Afshar & Fazli (2018), Truong Quang & Hara (2018), and Mai et al. (2022).

4. Conclusion

The main objective of the study is to demonstrate the relationship between collaboration, supply chain risk, and supply chain performance of organic agricultural products in Vietnam. The study has applied a combination of quantitative analytical tools to reach the research objectives. Research results indicate that supply chain risk negatively affects supply chain performance. However, the close cooperation between members in the supply chain helps limit supply chain risks, thereby improving the efficiency of the whole supply chain. From the above conclusion, enterprises producing organic agricultural products need to attach importance to collaborating in the supply chain, considering the collaboration among supply chain members as a core factor in their risk management strategy for organic agricultural products.

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