THE IMPACT OF SUPPLY CHAIN INTEGRATION ON COMPETITIVE ADVANTAGE IN THE COFFEE INDUSTRY: THE MEDIATING ROLE OF SUPPLY CHAIN AGILITY AND THE MODERATING ROLE OF MARKET UNCERTAINTY

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Abstract: This study examines the Supply Chain Integration (SCI), Supply Chain Agility (SCA), Market Uncertainty (MU) and Competitive Advantage (CA)The study used quantitative analysis and found that supply chain integration has a positive impact on competitive advantage ($r = 0.873$, $p = 0.000$), explaining 76.1% of the variance in competitive advantage. In addition, supply chain agility positively affects competitive advantage ($r = 0.661$, $p = 0.000$); supply market uncertainty positively affects competitive advantage ($r = 0.541$, $p = 0.000$). The mediation analysis shows that supply chain integration plays a key role, indicating that supply chain integration affects competitive advantage to a certain extent through the supply chain agility mechanism. The moderating effect analysis shows that market uncertainty. It plays a moderating role in the relationship between supply chain integration and competitive advantage, indicating that the relationship between supply chain integration and corporate competitive advantage is affected by market uncertainty. Enterprises should pay attention to market risks and develop scientific response strategies.

Keywords: Supply Chain Integration, Competitive Advantage, Market Uncertainty, Supply Chain Agility

Introduction

As a highly globalized industry, the coffee industry involves multiple key links in its supply chain, including planting, processing, distribution, and retail. Against the backdrop of intensified global market competition, increasing supply chain complexity, and increasingly diversified consumer demands, how companies can optimize supply chain management to enhance their competitive advantage has become a core issue of concern in the industry. Supply Chain Integration (SCI) is considered an important strategy to enhance a company's competitive advantage by improving the collaborative efficiency of the supply chain through information sharing, process collaboration, and resource optimization. However, in the context of an increasingly uncertain market environment, Supply Chain Agility (SCA), as a company's ability to respond quickly to market changes, may play an important mediating role between supply chain integration and competitive advantage. In addition, market uncertainty (MU), such as demand fluctuations, raw material price changes, and policy adjustments, may affect the role of supply chain integration in competitive advantage. Therefore, this study explores how supply chain integration affects corporate competitive advantage through supply chain agility and analyzes the moderating effect of market uncertainty on this relationship, in order to fill the gap in existing research and provide empirical support for companies to optimize their supply chain management.

Supply Chain Integration (SCI)It refers to the establishment of close collaborative relationships within the supply chain and with external partners to improve supply chain efficiency and overall competitiveness (Flynn et al., 2010). Supply chain integration includes internal integration, supplier integration and customer integration, which respectively emphasize information sharing among departments within the enterprise, joint collaboration with suppliers and synchronization with customer needs. A high level of supply chain integration helps reduce information asymmetry, improve supply chain visibility and operational efficiency, enable enterprises to respond to market demand faster and more effectively, improve resource utilization and reduce supply chain costs (Cao & Zhang, 2011).

Supply Chain Agility (SCA)It refers to the ability of enterprises to improve market response speed through the flexibility and adaptability of the supply chain in a rapidly changing market environment (Christopher, 2000). Agile supply chains can adjust procurement, production and distribution strategies more quickly to adapt to demand fluctuations and improve competitive advantages (Gligor et al., 2013). Supply chain agility is usually reflected in three aspects: market responsiveness, supply chain flexibility and information sharing. Market responsiveness determines whether an enterprise can quickly adapt to changes in demand, supply chain flexibility measures the adaptability of an enterprise in production, inventory management and logistics, and an efficient information sharing mechanism ensures the accuracy of decision-making and the speed of execution (Swafford et al., 2008).

Market Uncertainty (MU)It refers to the uncertainty of external environmental changes faced

by enterprises in the process of supply chain management, including demand uncertainty, supply uncertainty and competition uncertainty (Lee, 2004). Demand uncertainty refers to the volatility and unpredictability of consumer demand, which affects the production and inventory management of enterprises; supply uncertainty involves fluctuations in raw material prices and supplier reliability issues, which may lead to supply chain disruptions; competition uncertainty refers to the dynamic changes in the market competition landscape, such as the impact of new entrants and industry technological changes (Tang, 2006). Market uncertainty increases the challenges of enterprise supply chain management, requiring enterprises to adopt more agile supply chain strategies to reduce risks and improve adaptability.

Competitive Advantage (CA)It refers to the unique advantages that an enterprise has over its competitors in the market, which are mainly manifested in cost advantages and differentiation advantages (Porter, 1985). Cost advantage is that enterprises can reduce procurement, inventory and logistics costs by optimizing supply chain management, thereby improving profitability (Ketchen & Hult, 2007); differentiation advantage is that enterprises can enhance market competitiveness by optimizing supply chains, improving product quality, enhancing market response speed and improving customer experience (Barney, 1991). Both supply chain integration and supply chain agility can effectively enhance the competitive advantage of enterprises. The former ensures the collaborative efficiency of the supply chain, and the latter enhances the market adaptability of enterprises. The two work together to contribute to the long-term sustainable competitiveness of enterprises.

This study is of great significance both in theory and practice. It provides a new perspective for the development of supply chain management theory and provides empirical evidence for coffee industry enterprises to optimize supply chain strategies in a highly uncertain market environment. From the perspective of theoretical contribution, this study constructs the influence mechanism between supply chain integration (SCI), supply chain agility (SCA), market uncertainty (MU) and competitive advantage (CA) based on the resource-based view (RBV) and dynamic capability theory (DCT), expanding the research system in the field of supply chain management. Different from traditional research that mainly focuses on the direct impact of supply chain integration on corporate performance, this study introduces supply chain agility as a mediating variable to analyze its role in improving competitive advantage. At the same time, market uncertainty is used as a moderating variable to explore its impact on the relationship between supply chain integration and competitive advantage under different market environments, providing a more comprehensive research framework for the academic community. In addition, this study focuses on the supply chain management of the coffee industry, filling the research gap in the interactive relationship between supply chain integration, agility and competitive advantage in this industry, and providing a reference for the supply chain management of other agricultural products.

From the perspective of practical value, this study provides a theoretical basis and feasible

suggestions for coffee industry enterprises to optimize supply chain management. The results show that in an increasingly complex and dynamic market environment, if enterprises can improve information sharing and collaboration capabilities through supply chain integration and improve market response speed with the help of supply chain agility, they can effectively enhance their competitive advantage. Therefore, this study recommends that coffee industry enterprises strengthen the collaboration between upstream and downstream supply chains, optimize data sharing and information transmission mechanisms, and enhance flexible production and inventory management capabilities to enhance market adaptability. In addition, under the condition of high market uncertainty, enterprises need to combine supply chain agility strategies to mitigate the adverse effects of market fluctuations and ensure the stability and competitiveness of the supply chain. Governments and industry associations can also draw on the research conclusions to promote supply chain collaboration policies, promote enterprise informatization construction, and provide supply chain integration support to enhance the overall competitiveness and sustainable development capabilities of the industry. In summary, this study not only enriches the theoretical system of supply chain management, but also provides practical guidance for enterprises to optimize supply chain management and enhance competitiveness.

Research Objective(s)

Objective 1: To explore the impact of supply chain integration on competitive advantage in the coffee industry.

Objective 2: Analyze the role of supply chain agility in competitive advantage in the coffee industry.

Objective 3: Study the impact of market uncertainty on competitive advantage in the coffee industry.

Objective 4: Explore the moderating role of market uncertainty in the relationship between supply chain integration and competitive advantage.

Objective 5: Verify the mediating role of supply chain agility between supply chain integration and competitive advantage.

Objective 6: Provide constructive strategies to enhance competitive advantage in the coffee market from the perspective of supply chain and market risk response.

Literature Review

In recent years, supply chain management has become an important research area for enterprises to enhance their competitive advantages. Especially in a highly competitive and uncertain market environment, how enterprises can optimize resource allocation, improve operational efficiency, and enhance market competitiveness through supply chain integration (SCI) has become a focus of academic and practical attention. Existing literature shows that supply chain integration can improve

the collaborative efficiency of enterprises, reduce costs, and enhance the overall competitiveness of the supply chain (Anderson & Narus, 1990; Cao & Zhang, 2011). However, the effectiveness of SCI is often affected by internal and external factors of the enterprise, such as market uncertainty (MU) and supply chain agility (SCA). Market uncertainty refers to external environmental factors such as demand fluctuations, changes in raw material prices, and policy and regulatory adjustments (Lee, 2004; Kouvelisetal, 2006). These factors may weaken the direct effect of SCI on competitive advantage, making the effect of supply chain integration different in different market environments. On the other hand, supply chain agility, as a key capability for enterprises to respond quickly to market changes, is considered one of the core driving forces for enterprises to enhance their competitive advantage (Christopher, 2000; Swafford et al., 2006). Therefore, supply chain agility may play a mediating role between SCI and competitive advantage (CA), helping enterprises to more effectively utilize integrated resources to cope with challenges in a highly uncertain market environment.

In addition, most of the research on the relationship between SCI, SCA and CA is concentrated in the manufacturing and retail industries, while the research on agriculture and agricultural product supply chains is still relatively limited (Giovannucci & Koekoek, 2003; Ponte, 2002). As a highly globalized industry, the coffee industry's supply chain involves multiple links such as planting, processing, distribution and retail, and is greatly affected by factors such as market price fluctuations, climate change, and international trade policies. Therefore, the interactive relationship between its supply chain integration, agility and market uncertainty deserves in-depth discussion. However, current research pays little attention to how the coffee industry can improve its competitive advantage through supply chain integration and agility, especially the dynamic adjustment mechanism under high market uncertainty. Therefore, this study integrates the three dimensions of supply chain integration, supply chain agility and market uncertainty to construct a comprehensive analysis framework, in order to fill the gap in existing research and provide new theoretical support and empirical basis for supply chain management in the coffee industry.

Supply Chain Integration (SCI) refers to the establishment of a close coordination mechanism between various links in the supply chain to optimize resource allocation, improve operational efficiency, and enhance overall competitiveness (Flynn et al., 2010). The core concept of supply chain integration is to achieve smooth operation of information flow, logistics and capital flow through high collaboration within and outside the supply chain to improve the overall performance of the supply chain and ensure that enterprises maintain stable development in a highly competitive market environment (Rai et al., 2006). It covers three main dimensions: internal integration, supplier integration and customer integration, and each dimension plays a role at different levels of the supply chain (Zhao et al., 2008).

Internal Integration refers to information sharing, business collaboration and process optimization among departments within an enterprise (Flynn et al., 2010). Efficient internal integration

enables enterprises to coordinate various activities such as production, procurement, inventory and sales, reduce internal information asymmetry and improve operational efficiency. For example, in the coffee industry, coffee producers need to ensure smooth information flow between procurement, production and inventory management departments to reduce the risk of inventory backlogs and supply shortages.

Supplier ConsolidationIt refers to the establishment of long-term cooperative relationships between enterprises and suppliers to improve the collaborative efficiency of the supply chain through information sharing, joint planning and strategic cooperation (Cao & Zhang, 2011). The goal of supplier integration is to enhance the stability and flexibility of the supply chain, reduce supply uncertainty, and improve the reliability of raw material procurement. For example, coffee roasting companies can ensure a stable supply of high-quality coffee beans by establishing long-term cooperative relationships with coffee farms, while reducing supply risks caused by weather changes or market price fluctuations.

Customer Integration refers to the information interaction and collaboration between enterprises and customers to better meet customer needs and improve market response speed (Frohlich & Westbrook, 2001). Through customer integration, enterprises can use market data and consumer feedback to optimize product design, production planning and inventory management. For example, in the coffee industry, chain coffee brands can use sales data to analyze consumer preferences, adjust procurement strategies, and provide customers with more accurate products and services.

The core goal of supply chain integration is to improve the transparency and coordination of the supply chain, enable enterprises to respond to market changes more quickly, reduce supply chain uncertainty, and enhance market competitiveness by optimizing inventory management, reducing operating costs and improving product quality (Christopher, 2000). When enterprises are able to achieve a highly integrated supply chain, they can improve information visibility. Information sharing enables all links in the supply chain to obtain market changes, inventory status and production plans in real time, thereby optimizing decision-making (Lee, 2004). Reduce inventory backlogs and shortages and improve the capital turnover rate of the supply chain (Trienekens et al., 2012). Enhance supply chain flexibility, and be able to make adjustments more quickly in the face of market demand fluctuations or supply disruptions, reducing operational risks (Flynn et al., 2010). Improve supply chain collaboration efficiency, reduce waste and redundancy in the supply chain, and improve the cost-effectiveness of the overall supply chain (Ketchen & Hult, 2007).

In the coffee industry, supply chain integration is particularly important because the coffee supply chain involves multiple countries and regions. From planting, processing, transportation to final retail, the coordination of each link directly affects the stability of the supply chain and the competitiveness of the enterprise (Giovannucci & Koekoek, 2003). Coffee companies often face challenges such as supply chain complexity, unstable raw material supply, changes in international trade policies and fluctuations in consumer demand. Therefore, efficient supply chain integration can help

companies enhance their competitive advantages and ensure the smooth operation of the supply chain. For example, large multinational coffee brands such as Starbucks have established long-term cooperative relationships with coffee growers, suppliers and distributors around the world through supply chain integration to ensure a stable supply of high-quality coffee beans and optimize the global distribution network. In addition, many boutique coffee brands have also established close ties with sustainable coffee farms through supply chain integration to achieve product traceability and improve brand reputation.

On the other hand, the application of digital technology has further promoted the integration of the coffee supply chain. For example, blockchain technology makes the information between various links in the supply chain more transparent, allowing consumers to track the source of coffee beans and enhance their trust in product quality (Kim & Laskowski, 2018). Big data analysis and the Internet of Things (IoT) are also used to optimize the logistics management of the coffee supply chain and improve the accuracy of inventory forecasting (Fayezi et al., 2017).

Supply chain integration can provide enterprises with many competitive advantages, including reducing costs, improving product quality, optimizing market response speed and enhancing supply chain resilience (Lee, 2004). Studies have shown that SCI helps enterprises achieve cost leadership, reduce procurement, inventory and logistics costs through supply chain optimization, and improve corporate profitability (Barney, 1991; Porter, 1991). In addition, SCI can also enhance the differentiated competitive advantage of enterprises. Enterprises can optimize product design and improve customer experience through supply chain integration, thereby improving market competitiveness (Christopher & Towill, 2001). Especially in industries with fast-changing market demand, such as fast-moving consumer goods and food supply chains, supply chain integration can help enterprises adapt to consumer demand more quickly, improve product innovation capabilities, and increase market share (Flynn et al., 2010).

However, the effectiveness of supply chain integration is often affected by market uncertainty (MU). High market uncertainty environments (such as climate change, raw material price fluctuations, and policy and regulatory adjustments) may weaken the direct impact of SCI on competitive advantage, requiring companies to have additional strategies to cope with the challenges brought about by uncertainty (Tang, 2006). For example, the supply chain in the coffee industry is often affected by global climate change, and seasonal fluctuations in coffee planting may lead to supply chain disruptions, affecting the company's production plans and market supply (Giovannucci & Koekoek, 2003). In this case, SCI needs to be combined with supply chain agility (SCA) to improve the company's market responsiveness and ensure that it maintains competitiveness in an environment of market uncertainty (Gligor et al., 2013). Supply chain agility can help companies quickly adjust procurement, production, and distribution strategies to adapt to changes in demand and reduce the risks brought about by market uncertainty (Swafford et al., 2008).

For example, Starbucks combines supply chain integration with agility strategies in global supply chain management to ensure supply chain flexibility and improve market adaptability (Kim & Laskowski, 2018). During the COVID-19 period, many coffee brands have optimized supply chain integration, improved supply chain transparency, and adopted more flexible procurement and logistics strategies to reduce the impact of the epidemic on the supply chain (Little & Benaim, 2016). In addition, specialty coffee brands have also improved the visibility and flexibility of the supply chain through digital supply chain management to better respond to market changes and improve customer experience and brand loyalty (Ponte, 2002).

Therefore, existing research shows that supply chain integration plays a vital role in the formation of corporate competitive advantage, especially in the global market and high market uncertainty environment. SCI has become an important means for enterprises to maintain market competitiveness by optimizing operational efficiency, reducing costs, improving product quality, enhancing market responsiveness and improving supply chain flexibility (Flynn et al., 2010; Ketchen & Hult, 2007). However, market uncertainty may weaken the effect of supply chain integration, so enterprises need to improve supply chain agility to further enhance their competitive advantage (Lee, 2004). Based on this, this study further explores how supply chain agility plays a mediating role between SCI and competitive advantage on the basis of existing literature, and analyzes the moderating role of market uncertainty in this relationship, providing theoretical support and empirical basis for enterprises to optimize supply chain management in a complex market environment.

Competitive advantage (CA) refers to the unique capabilities that an enterprise has over its competitors in the market, enabling it to take the lead in terms of cost, quality, innovation, market adaptability and customer satisfaction (Porter, 1985). Supply chain agility provides important support for the formation of competitive advantage by enhancing the adaptability of enterprises in a rapidly changing environment (Gligor et al., 2013).

In the coffee industry, supply chain agility is one of the key drivers of corporate competitive advantage. Since the coffee supply chain involves multiple countries and regions, including planting, processing, distribution and retail, the volatility of each link makes supply chain management face huge challenges (Giovannucci & Koekoek, 2003). The important role of supply chain agility can be reflected in the ability of enterprises to flexibly adjust procurement strategies according to climate change, market prices and consumer demand to ensure a stable supply of high-quality coffee beans (Ponte, 2002). Improve supply chain transparency, enhance supply chain traceability through blockchain and digital management, and improve product quality and brand credibility (Little & Benaim, 2016). Accelerate product innovation. Supply chain agility enables companies to quickly launch new products that meet market trends, such as sustainable coffee, ready-to-drink coffee, etc., and improve market competitiveness (Kim & Laskowski, 2018).

Supply chain agility originated from the concept of Agile Manufacturing, which emphasizes

that enterprises can quickly respond to market demand at the lowest cost in an uncertain and rapidly changing market environment (Nagel & Dove, 1991). Subsequently, the concept was introduced into the field of supply chain management. Christopher (2000) defined supply chain agility as the ability of the supply chain to cope with demand fluctuations, market changes and environmental uncertainties, emphasizing that enterprises can quickly respond to market demand, improve supply chain flexibility, reduce inventory risks, and maintain adaptability in a competitive environment. Swafford et al. (2006) further proposed that supply chain agility involves how enterprises can achieve rapid adjustment and adaptability through supply chain optimization under the influence of market demand changes, supply chain uncertainty and competitive pressure. They believe that supply chain agility is a key factor in supply chain strategy and helps improve the market competitiveness of enterprises. In recent years, Gligor et al. (2013) have expanded the concept of supply chain agility, pointing out that supply chain agility includes not only the production and logistics flexibility within the enterprise, but also the information sharing, coordination ability and rapid decision-making mechanism between supply chain partners to ensure the overall agility and adaptability of the supply chain.

In general, supply chain agility focuses on three core capabilities (Christopher, 2000; Lee, 2004; Gligor et al., 2013): Market responsiveness: The ability of enterprises to quickly adjust production plans and supply chain operations to respond to changes in market demand. Flexibility: The ability of the supply chain to adjust in procurement, production, inventory management and logistics. Information Sharing & Collaboration: Transparency, data sharing and real-time communication among supply chain members to improve decision-making speed and accuracy.

Supply chain agility plays a vital role in the formation of competitive advantage of enterprises. It helps enterprises maintain their leading position in the fiercely competitive market environment by improving market responsiveness, reducing market uncertainty risks, enhancing customer satisfaction, optimizing cost control and promoting product innovation (Christopher, 2000; Gligor et al., 2013). In the coffee industry, supply chain agility is particularly important, which can help enterprises cope with supply chain fluctuations, optimize procurement and distribution strategies, and improve brand value. However, supply chain agility does not act in isolation, but indirectly affects competitive advantage through supply chain integration (SCI). Therefore, based on the existing literature, this study will further explore how supply chain agility plays a mediating role between supply chain integration and competitive advantage, and analyze how market uncertainty affects this relationship, so as to provide theoretical support and empirical basis for enterprises to optimize supply chain management in a dynamic market environment.

Market uncertainty was first proposed by Knight (1921) in economic research. It refers to the situation in which enterprises cannot accurately predict future changes in the market environment due to lack of sufficient information. In the field of supply chain management, market uncertainty usually refers to the information asymmetry and unpredictability faced by enterprises in the decision-making

process due to factors such as market demand fluctuations, changes in competitor behavior, supply chain disruptions, and policy and regulatory adjustments (Milliken, 1987; Kouvelis et al., 2006). Duncan (1972) defined market uncertainty as the complexity and dynamism of the external environment faced by enterprises, making it difficult to obtain or interpret key market information. Dess & Beard (1984) further linked market uncertainty to environmental instability, arguing that market uncertainty comes from unstable demand, competition intensity, and industry dynamics. In supply chain management research, Lee (2004) proposed that market uncertainty is one of the core challenges facing supply chain management, which may lead to reduced supply chain efficiency, increased difficulty in inventory management, and frequent adjustments to production and distribution plans. Tang (2006) further pointed out that market uncertainty affects enterprises' supply chain decisions, making supply chain integration, agility and resilience important strategies for enterprises to cope with market uncertainty.

Market uncertainty is a key factor affecting the supply chain management and competitive advantage of enterprises, covering demand uncertainty, supply uncertainty, competition uncertainty and policy and economic uncertainty (Milliken, 1987; Lee, 2004). Studies have shown that in a high market uncertainty environment, enterprises need to improve their competitiveness through supply chain integration, agility and resilience (Tang, 2006; Gligor et al., 2013). As the complexity of global supply chains increases, future research needs to further explore how digital technologies (such as blockchain and big data analysis) can help enterprises reduce the impact of market uncertainty. On this basis, this study will explore how market uncertainty regulates the relationship between supply chain integration, supply chain agility and competitive advantage, and provide theoretical support and empirical evidence for enterprises to optimize supply chain management in a high uncertainty environment. Therefore, when facing market uncertainty, enterprises need to adopt strategies such as supply chain integration, supply chain agility and resilience to reduce the risks brought by uncertainty and establish competitive advantages in a dynamic market environment (Christopher, 2000; Tang, 2006). Specifically, enterprises can strengthen their collaboration with suppliers, distributors, and retailers through supply chain integration to reduce information asymmetry and improve supply chain efficiency (Flynn et al., 2010). In addition, improving supply chain agility enables enterprises to quickly adjust supply chain strategies, such as flexibly changing suppliers, optimizing inventory management, and adjusting logistics plans to adapt to market changes (Gligor et al., 2013). In addition, enterprises can also improve their ability to cope with unexpected risks through supply chain resilience strategies, such as establishing a dual supplier system, dispersing production bases, and optimizing global supply chain layout to reduce the impact of market uncertainty on corporate operations (Tang, 2006). On this basis, this study will further explore how market uncertainty affects the role of supply chain integration in competitive advantage, and analyze how supply chain agility plays a mediating role in this relationship, so as to provide theoretical support and empirical evidence for enterprises to optimize supply chain management under

high market uncertainty.

Methodology

This study aims to systematically explore how supply chain integration (SCI) affects enterprise competitive advantage (CA) through supply chain agility (SCA), and how market uncertainty (MU) plays a moderating role in this relationship. With the increasing instability of the global supply chain, enterprises face many challenges such as changes in market demand, increased supply risks, and uncertainty in the competitive environment. Therefore, understanding the interaction mechanism between supply chain integration, agility, and market uncertainty is of great theoretical and practical significance for enterprises to enhance their competitiveness. In order to ensure the scientificity, rigor, and generalizability of the research results, this study adopts quantitative research methods, combined with survey research and structural equation modeling (SEM) for data analysis, to explore the causal relationship between variables and their action paths.

This study builds a theoretical framework based on the Resource-Based View (RBV) and Dynamic Capabilities Theory (DCT), emphasizing that supply chain integration is a key resource for enterprises, and supply chain agility, as a dynamic capability, plays an important role in the formation of competitive advantage. The research subjects focus on supply chain enterprises in the coffee industry, including coffee planting, processing, distribution and retail enterprises, to ensure that the research is applicable to global supply chain management practices. To improve the representativeness of the data, the study adopts purposive sampling and snowball sampling, and selects practitioners with supply chain management experience, such as supply chain managers, purchasing supervisors, and logistics managers for investigation. Data collection is mainly through questionnaire surveys, supplemented by in-depth interviews to enhance the empirical support of the research.

Based on these theories and the literature review, we propose the following hypotheses:

H1: Supply chain integration positively affects the competitive advantage of the coffee industry.

H2: Supply chain agility positively affects the competitive advantage of the coffee industry.

H3: Market uncertainty negatively affects the competitive advantage of the coffee industry.

H4: Market uncertainty moderates the relationship between supply chain integration and competitive advantage.

H5: Supply chain agility mediates the relationship between supply chain integration and competitive advantage.

The overall research targets companies related to the coffee industry supply chain, including companies in different links such as coffee planting, processing, distribution, and retail. These companies play an important role in the global supply chain system, and the integration, agility, and ability to cope with market uncertainties of their supply chain management directly affect their

competitive advantage. Therefore, the survey subjects of this study mainly include the following types of companies and their related practitioners: coffee planting and raw material suppliers (such as coffee farms, cooperatives, and raw material suppliers); coffee processing companies (such as roasting plants and coffee product processors); coffee brands and retailers (such as chain coffee shops, independent coffee shops, and e-commerce platforms); coffee supply chain logistics and distributors (such as warehousing and distribution companies, import/export traders); supply chain management-related positions (such as supply chain managers, purchasing supervisors, logistics supervisors, and operations managers).

To ensure the representativeness and generalizability of the sample, we used a simple random sampling method (Hair et al., 2019). The goal of this study was to have at least 300 respondents, based on the recommendations of structural equation modeling (SEM) analysis, which recommends a sample-to-variable ratio of 10:1 to obtain reliable statistical inferences (Kline, 2015).

Since the research population is unknown, the population distribution is unknown.

$$n=\frac{Z^2}{4e^2}$$

$$n=\frac{(1.96)^2}{4(0.05)^2}=384.16$$

Therefore, the minimum acceptable sample size is 384.

Based on these parameters, a total of 450 questionnaires were distributed and 395 valid responses were collected, representing a response rate of 87%.

The questionnaire of this study aims to collect data from enterprises related to supply chain management in the coffee industry to verify the relationship between supply chain integration (SCI), supply chain agility (SCA), market uncertainty (MU) and competitive advantage (CA). The questionnaire adopts a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) to ensure the quantitative availability of data, and is designed based on an existing mature scale to ensure reliability and validity.

Supply Chain Integration (SCI)(Source: Vickery et al., 2003) Mainly measures the degree of collaboration and data sharing between the company and its suppliers and customers. Example questions: "Our company shares real-time demand and inventory data with suppliers." "We have established an efficient feedback mechanism with our customers to continuously improve the supply chain process."

Supply Chain Agility (SCA)(Source: Swafford et al., 2006) Assess whether the company's supply chain has the ability to quickly adjust production, supply, and logistics to respond to market changes. Example questions: "We are able to quickly change our supply chain processes when the market changes." "Our supply chain shows high flexibility in responding to demand fluctuations."

Market Uncertainty (MU)(Source: Christopher & Peck, 2004) Focus on the impact of market

uncertainty on the company's supply chain, such as demand fluctuations, policy adjustments, etc. Example questions: "The volatility of market demand has a significant impact on our supply chain operations." "Competitors' supply chain strategy adjustments often affect our market decisions."

Competitive Advantage (CA)(Source: Porter, 1985; Ketchen & Hult, 2007) Evaluate the cost advantage and differentiation advantage gained by optimizing the company's supply chain. Example questions: "Our supply chain management strategy gives us an advantage over our competitors in cost control." "By optimizing the supply chain process, our product quality and customer satisfaction have been significantly improved."

The design of this questionnaire is based on a mature scale to ensure the reliability and validity of the measurement tool, and data is collected through a combination of online and offline methods to ensure the breadth and representativeness of the sample. The research results will help optimize the supply chain management of the coffee industry, improve market competitiveness, and provide theoretical support and practical guidance for companies to formulate supply chain strategies. Reliability tests (Cronbach's alpha) showed that all scales had high internal consistency ($\alpha > 0.80$).

Descriptive statistics were used to summarize the respondents' personal background and the distribution of key variables (Hair et al., 2019). The Shapiro-Wilk test confirmed that the data met the normality assumption required for parametric analysis.

Pearson correlation analysis was performed to examine the relationship between the variables. Regression analysis was used to examine the direct effect of SCI/SCA/MU on CA (Wang et al., 2024).

To examine whether SCA mediated the relationship between SCI and CA, Baron and Kenny's (1986) mediation model and structural equation modeling (SEM) were used (Kline, 2015).

To examine whether MU moderated the relationship between SCI and CA, SPSS moderation effect analysis was performed.

This approach provides a rigorous empirical framework for analyzing how innovation management practices and knowledge sharing affect competitive advantage. Through quantitative methods, validated scales, and robust statistical analysis, this study ensures valid and reliable findings that contribute to academic research and business strategy development.

Results

This chapter presents the research results based on the quantitative analysis of survey data on high-tech enterprises in Hangzhou, China. The research results are organized according to descriptive statistics, correlation analysis, regression analysis, and mediation analysis, each of which helps to verify the proposed hypotheses. Statistical techniques such as analysis of variance, independent t-test, and structural equation modeling (SEM) are used to determine the relationship between supply chain integration (SCI), supply chain agility (SCA), market uncertainty (MU) and competitive advantage (CA).

Descriptive statistical analysis shows that:

Position Distribution: There are 304 middle-level managers (77.0%) and 91 senior managers (23.0%).

Industry Type: Planting and raw material supply: 67 people (17.0%),Coffee processing companies: 135 (34.2%),Brands and retailers: 110 (27.8%),Logistics and distribution companies: 56 (14.2%),Other industries: 27 people (6.8%).

Enterprise scale: Small businesses (44.3%),Medium-sized enterprises (34.7%),Large enterprises (21.0%).

Geographical distribution: Yangtze River Delta: 164 people (41.5%),Pearl River Delta region: 146 people (37.0%),Beijing-Tianjin-Hebei region: 57 people (14.4%),Other regions: 28 people (7.1%).

Exist Supply Chain Integration to Enterprise Competitive Advantage in the regression analysis of the impact of , the adjusted R square was 0.761.Supply Chain Integration (Independent variable) can explain Enterprise Competitive Advantage(dependent variable) 76.1% of the variation. Supply Chain Integration the unstandardized coefficient is 1.017, the standardized coefficient is 0.873, and the P value is 0.000, indicating that the supply chain integration Competitive advantage for enterprises. It has a significant positive impact. Support H1.

Exist Supply Chain Agility for Enterprise Competitive Advantage in the regression analysis of the impact of , the adjusted R square was 0.435.Supply Chain Agility(Independent variable) can explain Business performance(dependent variable) 43.5% of the variation. Supply Chain Agility the unstandardized coefficient is 0.792, the standardized coefficient is 0.661, and the P value is 0.000, indicating that Supply Chain Agility for Enterprise Competitive Advantage. It has a significant positive impact. Support H2.

Exist Market uncertainty affects corporate competitive advantage in the regression analysis of the impact of the adjusted R square was 0.291. Market uncertainty(Independent variable) can explain Corporate Competition(dependent variable) 29.1% of the variation. Market uncertainty the unstandardized coefficient of-0.650, the standardized coefficient is-0.541, and the P value is 0.000, indicating that market uncertainty has a significant impact on the competitive advantage of enterprises opposite Support H3.

After performing hierarchical regression analysis on the centralized data, we can see the significance level of the interaction coefficient between the centralized independent variable (supply chain integration) and the moderating variable (market uncertainty). In this case, the significance level of the interaction coefficient between the centralized independent variable and the moderating variable is 0.042, which is less than 0.05, indicating that the coefficient is significant, that is, market uncertainty plays a moderating role in the relationship between supply chain integration and competitive advantage. H4 is supported.

In the regression analysis of the impact of supply chain integration on corporate competitive

advantage, it can be seen that the significance P value of supply chain integration on corporate competitive advantage is less than 0.01; in the regression analysis of the impact of supply chain agility on corporate competitive advantage, it can be seen that the significance P value of supply chain agility on corporate competitive advantage is less than 0.01; the absolute value of the coefficient of supply chain integration on corporate competitive advantage in Model 2 is less than the coefficient of supply chain integration on corporate competitive advantage in Model 1.Therefore, it belongs to the partial mediation effect, that is, Supply Chain Agility in the Relationship between Supply Chain Integration and Competitive Advantagehas a partial mediation effect, that is, Supply chain agility plays a mediating role in the relationship between supply chain integration and competitive advantage. Support H5In terms of inferential statistical analysis, this study used structural equation model (SEM) to test hypotheses and conducted in-depth analysis of reliability, validity, correlation and path analysis. The Cronbach's Alpha coefficients of the measured variables were all higher than 0.7, indicating that the questionnaire had good internal consistency. The results of the correlation analysis showed that there was a significant positive correlation between supply chain integration (SCI), supply chain agility (SCA) and competitive advantage (CA), while market uncertainty (MU) had a certain impact on competitive advantage. Just SEM structural equation model analysis further verifies that supply chain integration can significantly enhance the competitive advantage of enterprises, and supply chain agility plays a partial mediating role in it, that is, enterprises can enhance the impact of SCI on CA by improving supply chain agility. In addition, market uncertainty plays a role in the path of SCI's effect on CA. opposite Regulation, but in the case of a volatile market environment, the impact of SCI on CA Not necessarily Weakened, crisis and opportunity coexist.

Table 1: Summary of Hypotheses Tests

Hypotheses	Result
H1: Supply chain integration positively affects the competitive advantage of the coffee industry.	support
H2: Supply chain agility positively affects the competitive advantage of the coffee industry.	support
H3: Market uncertainty negatively affects the competitive advantage of the coffee industry.	support
H4: Market uncertainty moderates the relationship between supply chain integration and competitive advantage.	support
H5: Supply chain agility mediates the relationship between supply chain integration and competitive advantage.	support

Overall, the statistical analysis results of this study support the main research hypothesis, indicating that supply chain integration is an important factor in improving corporate competitiveness, and supply chain agility, as a mediating variable, plays an important role in the formation of competitive

advantage. At the same time, market uncertainty may weaken this effect, and companies need to adopt more flexible supply chain management strategies to cope with changes in the external environment. The research results provide empirical evidence for coffee industry companies to optimize supply chain management, and provide new theoretical perspectives and data support for future research.

Discussion

The results support H1, indicating that supply chain integration (SCI) has a significant positive impact on corporate competitive advantage (CA). This shows that in the process of supply chain integration, companies can optimize supply chain operation efficiency, reduce costs and enhance product and service differentiation capabilities by strengthening internal collaboration, supplier cooperation and customer management. This finding is consistent with the research of Flynn et al. (2010) and Cao & Zhang (2011), further verifying that supply chain integration is an important source of competitive advantage, especially in the coffee industry, where the supply chain is highly dependent on cooperation and stability.

The study found that supply chain agility (SCA) has a significant positive impact on competitive advantage (CA), supporting hypothesis H2. When companies have stronger supply chain agility, they can respond to changes in market demand more quickly, optimize inventory management, and improve logistics and distribution efficiency, thereby enhancing competitiveness. This is consistent with the research conclusions of Christopher (2000) and Gligor et al. (2013), indicating that agility is an important ability for companies to maintain competitive advantage in an uncertain market environment.

The study found that market uncertainty (MU) has a negative impact on competitive advantage (CA), supporting hypothesis H4. This shows that when market demand fluctuates greatly, supply chain is unstable, or the uncertainty of the competitive environment increases, the competitive advantage of enterprises may be weakened. This finding is consistent with the research of Lee (2004) and Tang (2006), indicating that in an environment of high market uncertainty, enterprises need to adopt more flexible supply chain management strategies to reduce the impact of uncertainty on competitiveness.

Further structural equation model (SEM) analysis shows that supply chain agility (SCA) plays a partial mediating role between supply chain integration (SCI) and competitive advantage (CA), verifying H4. This shows that supply chain integration cannot be directly transformed into competitive advantage, and enterprises also need to enhance their ability to adapt to market demand fluctuations by improving supply chain agility. This is consistent with the research of Swafford et al. (2008) and Gligor et al. (2013), indicating that when implementing supply chain integration strategies, enterprises should simultaneously improve the agility of the supply chain to maximize competitive advantage.

Finally, the results of the study verified H5, that is, market uncertainty (MU) plays a moderating role in the relationship between supply chain integration (SCI) and competitive advantage (CA).

Specifically, when market uncertainty is high, the impact of supply chain integration on competitive advantage is weakened, which means that even if a company invests more supply chain integration resources, its competitive advantage may still be affected if the market environment changes drastically. This result is consistent with the research of Ketchen & Hult (2007), indicating that under high market uncertainty, companies should rely more on supply chain agility to reduce the uncertainty risk of integration strategies.

The conclusions of this study not only expand the theoretical system of supply chain management, but also provide practical guidance for enterprises to optimize supply chain management and enhance market competitiveness. The results show that if enterprises can improve supply chain agility on the basis of supply chain integration and adopt adaptive strategies to cope with market uncertainty, they are more likely to gain long-term competitive advantages in fierce market competition. The conclusions of this study not only have important reference value for supply chain management in the coffee industry, but also provide empirical support for enterprises in other industries to formulate supply chain optimization strategies. Future research can continue to explore in a wider range of industries and market environments to promote the further development of supply chain management theory and practice.

Conclusions

This study focuses on the impact mechanism of supply chain integration (SCI) on competitive advantage (CA), and focuses on the role of supply chain agility (SCA) as a mediating variable and the impact of market uncertainty (MU) as a moderating variable. The results are verified by the structural equation model (SEM), which shows that supply chain integration can significantly enhance the competitive advantage of enterprises, but this effect is partially affected by the mediating role of supply chain agility. At the same time, market uncertainty has a significant negative impact on the competitive advantage of enterprises and weakens the direct effect of supply chain integration on competitive advantage. The results further show that in the case of a complex and changing market environment, if enterprises can improve market response speed and supply chain flexibility through supply chain agility, they can more effectively transform the advantages of supply chain integration and thus enhance market competitiveness.

First, the research results verify the direct impact of supply chain integration on competitive advantage, indicating that supply chain integration can not only optimize the internal operations of enterprises, but also improve supply chain efficiency by strengthening collaboration with suppliers and customers, thereby enhancing market competitiveness. Supply chain integration can help enterprises reduce transaction costs, improve supply chain transparency, and enhance market adaptability, enabling enterprises to maintain a stable competitive advantage in a highly competitive market environment. In addition, the study found that supply chain integration can not only improve the cost control ability of

enterprises, but also improve the product quality and market responsiveness of enterprises by optimizing production and logistics links, thereby enhancing the differentiated competitive advantage of enterprises. This result is consistent with previous studies, further proving that supply chain integration is one of the important strategies for enterprises to gain long-term competitive advantages.

Secondly, this study further found that supply chain agility plays a partial mediating role between supply chain integration and competitive advantage. This shows that supply chain integration cannot be directly transformed into competitive advantage, but needs to improve market adaptability through supply chain agility. Supply chain agility can help enterprises quickly adjust production and inventory plans when market demand fluctuates greatly, improve the resilience of the supply chain, and reduce the risk of supply chain disruption. If enterprises can further improve supply chain agility on the basis of supply chain integration, such as strengthening information sharing, optimizing logistics distribution, and improving the flexibility of production and inventory management, they are more likely to achieve sustainable competitive advantage. In addition, supply chain agility can also enhance the ability of enterprises to respond to sudden market changes, enabling enterprises to maintain strong adaptability and competitiveness in a market environment with fierce competition and unstable demand.

In addition, the results also show that market uncertainty has a negative regulatory effect on the relationship between supply chain integration and competitive advantage, that is, when market uncertainty is high, the role of supply chain integration in promoting competitive advantage will be weakened. This shows that even if companies invest more resources in supply chain integration, they may find it difficult to obtain the expected competitive advantage when demand is unstable, supply chain risks are intensified, and the competitive environment is drastically changing. This result suggests that when facing a high market uncertainty environment, companies cannot rely solely on supply chain integration. They also need to combine more flexible and responsive supply chain management strategies to reduce the impact of market uncertainty on corporate competitiveness. For example, companies can introduce digital supply chain management systems to improve supply chain visibility and enhance their ability to predict market fluctuations, thereby reducing the operating risks brought about by market uncertainty.

This study has made important contributions at the three levels of theory, practice and policy. At the theoretical level, based on the resource-based view (RBV) and dynamic capability theory (DCT), this study constructed a theoretical framework between supply chain integration, supply chain agility, market uncertainty and competitive advantage, and verified the influence relationship between the variables through empirical analysis. In particular, the study revealed the role of supply chain agility as a mediating variable, indicating that if enterprises can improve supply chain agility while integrating the supply chain, it will be more helpful to enhance their competitive advantage. In addition, this study also incorporated market uncertainty as a moderating variable into the research framework, analyzing its impact on the relationship between supply chain integration and competitive advantage under

different market environments, providing a new theoretical perspective for supply chain management research.

At the practical level, this study provides specific optimization strategies for supply chain companies in the coffee industry. The results show that when implementing supply chain integration strategies, companies cannot rely solely on information sharing and collaboration, but should simultaneously improve supply chain agility to ensure competitiveness in a rapidly changing market environment. Therefore, this study recommends that companies should strengthen the collaboration between upstream and downstream supply chains, optimize data sharing mechanisms, and enhance the flexibility of logistics and inventory management to further improve the resilience of the supply chain. In addition, in situations of high market uncertainty, companies need to combine supply chain agility strategies to reduce the adverse effects of market fluctuations and ensure the stability and competitiveness of the supply chain. Through these optimization strategies, companies can not only reduce supply chain risks, but also improve overall supply chain efficiency, thereby achieving a more lasting competitive advantage.

At the policy level, this study provides a reference for the government and industry associations in supply chain management and industry policy formulation. The results show that market uncertainty has a significant impact on corporate competitiveness. Therefore, the government and industry organizations should promote supply chain collaboration policies, promote supply chain digital transformation, and encourage enterprises to adopt intelligent supply chain management systems to reduce the impact of market uncertainty on industry development. The government can encourage enterprises to invest in supply chain digital technology through policy support, improve information transparency and supply chain traceability, thereby enhancing the overall supply chain competitiveness and sustainability of the industry.

Although this study provides a systematic analytical framework and empirical support, it still has certain limitations. First, the limitations of the data source may affect the wide applicability of the research conclusions. This study mainly focuses on supply chain companies in the coffee industry, and in the future, it can be further expanded to other agricultural product supply chains, fast-moving consumer goods industries or manufacturing industries to verify the universality of the research conclusions. Secondly, this study uses cross-sectional data for analysis and cannot track the long-term impact of corporate supply chain integration strategies on competitive advantage. Therefore, future research can use longitudinal studies to observe the long-term dynamic relationship between supply chain integration, agility and competitive advantage. In addition, this study mainly focuses on demand, supply and competitive uncertainty. Future research can further explore the impact of external environmental factors such as policy changes, economic fluctuations, and technological innovation on supply chain management.

Finally, this study uses the structural equation model (SEM) to verify the hypothesis. Future

research can combine case studies or experimental studies to explore the adaptability of different supply chain strategies in different market environments to further improve the supply chain management theory. In particular, in the future, it can combine emerging supply chain management models such as supply chain digitization, intelligent supply chain, and blockchain technology to explore how to optimize supply chain integration and agility in an uncertain market environment, thereby enhancing corporate competitiveness.

References

Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Cao, M., & Zhang, Q. (2011). Supply chain collaboration: Impact on collaborative advantage and firm performance. *Journal of Operations Management, 29*(3), 163–180. https://doi.org/10.1016/j.jom.2010.12.008

Christopher, M. (2000). The agile supply chain: Competing in volatile markets. *Industrial Marketing Management, 29*(1), 37–44. https://doi.org/10.1016/S0019-8501(99)00110-8

Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *International Journal of Logistics Management, 15*(2), 1–14. https://doi.org/10.1108/09574090410700275

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal, 21*(10–11), 1105–1121. https://doi.org/10.1002/1097-0266(200010/11)21:10/11<1105:AID-SMJ133>3.0.CO;2-E

Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management, 28*(1), 58–71. https://doi.org/10.1016/j.jom.2009.06.001

Frohlich, M. T., & Westbrook, R. (2001). Arcs of integration: An international study of supply chain strategies. *Journal of Operations Management, 19*(2), 185–200. https://doi.org/10.1016/S0272-6963(00)00055-3

Gligor, D. M., & Holcomb, M. C. (2013). The role of logistics capabilities in achieving supply chain agility and performance. *International Journal of Logistics Management, 24*(3), 469–491. https://doi.org/10.1108/IJLM-02-2013-0015

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(S2), 109–122. https://doi.org/10.1002/smj.4250171110

Ketchen, D. J., Jr., & Hult, G. T. M. (2007). Bridging organization theory and supply chain management: The case of best value supply chains. *Journal of Operations Management, 25*(2), 573–580. https://doi.org/10.1016/j.jom.2006.05.010

Kouvelis, P., Chambers, C., & Wang, H. (2006). Supply chain management research and production and operations management: Review, trends, and opportunities. *Production and Operations*

Management, 15(3), 449–469. https://doi.org/10.1111/j.1937-5956.2006.tb00257.x

Lee, H. L. (2004). The triple-A supply chain. *Harvard Business Review, 82*(10), 102–112.

Pfeffer, J., & Salancik, G. R. (1978). *The external control of organizations: A resource dependence perspective*. Harper & Row.

Porter, M. E. (1985). *Competitive advantage: Creating and sustaining superior performance*. Free Press.

Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review, 68*(3), 79–91.

Rai, A., Patnayakuni, R., & Seth, N. (2006). Firm performance impacts of digitally enabled supply chain integration capabilities. *MIS Quarterly, 30*(2), 225–246. https://doi.org/10.2307/25148729

Sharifi, H., & Zhang, Z. (1999). A methodology for achieving agility in manufacturing organizations: An introduction. *International Journal of Production Economics, 62*(1–2), 7–22. https://doi.org/10.1016/S0925-5273(98)00217-5

Sheffi, Y., & Rice, J. B., Jr. (2005). A supply chain view of the resilient enterprise. *MIT Sloan Management Review, 47*(1), 41–48.

Swafford, P. M., Ghosh, S., & Murthy, N. (2008). Achieving supply chain agility through IT integration and flexibility. *International Journal of Production Economics, 116*(2), 288–297. https://doi.org/10.1016/j.ijpe.2008.09.002

Tang, C. S. (2006). Robust strategies for mitigating supply chain disruptions. *International Journal of Logistics Research and Applications, 9*(1), 33–45. https://doi.org/10.1080/13675560500405584

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and micro foundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319–1350. https://doi.org/10.1002/smj.640

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509:AID-SMJ882>3.0.CO;2-Z

Vickery, S. K., Jayaram, J., Droge, C., & Calantone, R. (2003). The effects of an integrative supply chain strategy on customer service and financial performance: An analysis of direct versus indirect relationships. *Journal of Operations Management, 21*(5), 523–539. https://doi.org/10.1016/j.jom.2003.02.002

Williamson, O. E. (1985). *The economic institutions of capitalism*. Free Press.

Yusuf, Y. Y., Gunasekaran, A., Adeleye, E. O., & Sivayoganathan, K. (2004). Agile supply chain capabilities: Determinants and performance implications. *International Journal of Production Research, 42*(6), 965–979. https://doi.org/10.1080/00207540310001639932