Determinants of the competitive advantage of dairy supply chains: Evidence from the Chinese dairy industry

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Determinants of the competitive advantage of dairy supply chains: Evidence from the Chinese dairy industry

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Abstract: In this study, we use an evidence-based approach to examine the factors that determine the competitive advantage of dairy supply chains using evidence from the Chinese dairy industry. We focus on the quality assurance of dairy products, which is considered one of the fundamental influential factors. We investigate interrelationships among the identified determinants, which include dairy production behavior, dairy cow culture model, government regulations, corporate social responsibility, and quality assurance, and examine how these determinants influence the competitive advantage of dairy supply chains. We employ the structural equation modeling approach in which grouped observable variables that represent the identified determinants are extrapolated from primary data collected through a questionnaire survey. Our key findings show that by mediating the effects of dairy production behavior and the dairy cow culture model, government regulation and corporate social responsibility significantly affect the quality assurance of dairy products. In turn, dairy production behavior and the dairy cow culture model significantly affect the competitive advantage of the dairy supply chain via the fully mediated effects of the quality assurance of dairy products. Specifically, the dairy cow culture model helps ensure the safety and quality of milk supply, allowing core dairy firms to control product quality throughout the dairy supply chain. Our empirical study shows that the identified determinants interact to assure the quality of dairy products and enhance the competitive advantage of the dairy supply chain in China.

Keywords: dairy, supply chain, competitive advantage, quality assurance, structural equation model

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1 Introduction

The issue of food supply chain quality and risk has received significant attention in recent years, especially in emerging markets (Chen et al., 2014). In the dairy industry, quality and safety issues occur more frequently upstream of the supply chain, such as at the milk sources. The quality and safety of dairy products directly affect consumer health and safety, product brand image, and the competitive advantage and sustainable development of the dairy supply chain. The increased public awareness regarding food safety has impelled the dairy industry to improve the safety and image of dairy products (Pant et al., 2015; Valeeva et al., 2007).

In China, in recent years, dairy quality and safety have emerged as crucial issues because of the lack of quality control and assurance at the milk source, thus causing consumers to lose their confidence in the domestic dairy industry. For example, in the 2008 adulterated milk incident, the original response of the Sanlu Group, the company that produced dairy products that were highly adulterated with melamine, and Fonterra, Sanlu's New Zealand partner, was to blame the milk farmers and dealers who had allegedly sold adulterated milk to Sanlu (Financial Times, 2008). This incident drastically degraded the brand image of domestic dairy firms in China and had a long-term negative effect on the domestic consumer market. In addition to the repercussions of this incident, imports from international dairy firms intensified market competition.

International competition and the effects of domestic incidents on the Chinese dairy market have impelled domestic dairy firms to focus on safety and quality to enhance their competitive advantage from the whole supply chain perspective. The importance of raw milk supply in the dairy industry underlines the need for a farm-level system that ensures the quality and safety of the supplied milk (Valeeva et al., 2005). The pasture and manufacturing sectors are the main components that ensure the safety and quality of the final products of the vertically integrated dairy industry (Dornom, 2011). An integrated chain approach to improve food quality and safety throughout the entire chain ("farm to table") must be established (Valeeva et al., 2004), and the primary responsibility for food quality and safety at all stages of the supply chain, including the source of raw milk, should be emphasized. Sanlu's case is an unforgettable example for other Chinese dairy firms. To regain consumers' trust, Chinese dairy firms should restructure their raw milk supply system by focusing on assuring the quality and safety of dairy products through the integration of dairy supply chains.

Considering product quality assurance as the foundation of the competitive advantage of the dairy supply chain, our present study is an empirical investigation of the determinants that enhance the sustainability of the dairy chain in China. We aim to gain insight into the interrelations and interactions among these factors that affect product quality assurance and support the sustainability of the domestic dairy supply chain. Our research makes practical and theoretical contributions to the literature.

For the sustainable development of the competitive advantage of the dairy supply chain, the important issues that require dairy firms' attention are 1) the quality assurance of the milk source in the upstream of the supply chain; 2) safe production behaviors in the midstream of the supply chain; and 3) information transparency regarding dairy product safety and quality that reflects legislation enforcement and corporate social responsibility (CSR) awareness in the downstream supply chain. These issues raise the following questions: How can quality and safety incidents in dairy production be prevented from view of dairy supply chain? What are the crucial internal and external factors that impact the quality of dairy products throughout the dairy chain, and how are these factors interrelated and affect the enhancement of the competitive advantage of the dairy supply chain based on product quality assurance? These issues are closely related to interactions among the management processes of dairy supply chains, which involve managing the complete process from the raw milk source in the upstream to customer delivery in the downstream.

The existing literature has not yet given sufficient attention on the interactive effects among multiple influencing factors, dairy product quality assurance, and their impacts on the sustainable competitive advantage of the dairy supply chain. Prior research on food/dairy product supply chains has mainly focused on supply chain cooperation, including individual behavior, quality control, price transmission, cost control, and benefit distribution (Henson, 2005; Hingley, 2005; Taylo, 2005). Published studies have also focused on food safety and quality assurance from the perspectives of individual firms and supply chains (Pant et al., 2015; Ivano, 2004; Ufuk, 2008; Joseph et al., 2006). However, quantitative research studies on the interrelations of multiple determinants and their interactive impacts on the product quality, sustainability, and competitive advantage of the dairy supply chain remain rare. Therefore, we conducted an empirical investigation to fill the research gap on the interactive relationships among the determinants that emphasize dairy quality assurance. Such an investigation, however, is highly challenging given the complexity of

assuring dairy product quality and safety throughout the entire chain, including the long-term management of "farm to table."

In this study, we aimed to empirically test a framework to identify the relationships among the competitive advantage of the dairy supply chain and its determinants. We collected primary data via a questionnaire survey. We identified five determinants: government regulation, CSR, production behavior, dairy cow culture model, and product quality assurance. Building upon the existing literature, we extend the research by utilizing structural equation modeling to investigate the interactive impacts of these determinants, such as enforcement of government regulations and increased awareness of CSR, on the sustainable competitive advantage of the entire dairy chain. We also investigated interactive behaviors among dairy farmers, milk station and production, and customer delivery. Our main contribution to the literature is the development of a quantitative framework for characterizing the determinants of sustainable competitive advantage of the dairy supply chain based on quality and safety assurance. Our empirical study encompasses the identified influencing factors and their interrelated impacts and sheds a new light on the theoretical and practical aspects of cognizing and managing their interrelationships. By providing empirical evidence of the impact of dairy quality assurance on the competitive advantage of the dairy supply chain in the Chinese context, our research offers useful guidance for the practical management and implementation of the determinants of the domestic dairy chain.

The remainder of this paper is organized as follows. Following the introduction, a review of the related literature is provided in section 2. The proposed hypotheses, which describe the interrelations among the determinants, product quality assurance, and sustainable competitive advantage of the dairy supply chain, are presented in section 3. The framework that incorporates the determinants of the competitive advantage of the dairy supply chain is formulated using the structural equation model and is presented in section 4. The results of the empirical study are provided in section 5. The discussion, conclusions, and further research directions are provided in the final section.

2 Literature review

Roth et al. (2008) developed a conceptual framework for the identification of key elements—traceability, transparency, testability, time, trust, and training— critical to the preservation of public welfare through a safe food supply. In the context of a food supply chain, these key elements may be interpreted as follows: the identification of quality and safety defects at the supply source; the enforcement

of government regulations; the consciousness-raising of social responsibility; the fulfillment of quality and safety standards in production via a quality assurance system; effective transportation for the timely delivery of food products; brand image developed from consumers' trust with better quality of products; and the enhancement of business performance through learning and innovation. Based on this conceptual framework, in this study, we focus on the roles played by these key elements within the context of the dairy supply chain in China and investigate the impacts of their interrelationships on the competitive advantage of dairy supply chains.

Through interviews with dairy firm managers and academicians, our study identified five interactive determinants of competitive advantage of the dairy chain in China: government regulation, CSR, production behavior, dairy cow culture model (milk source), and product quality assurance. Based on their experiences, dairy firm managers and academicians provided the following insights regarding the competitive advantage or sustainability of the dairy supply chain: dairy quality assurance is fundamental, dairy production behavior and milk source supply have more direct effects of role-playing, and government regulations and social responsibility may have indirect rather than direct effects and are intuitively explicable.

Our literature review will examine the background and relationships of the identified determinants.

Food supply chain and dairy supply management

Denouden & Zuurbier (1996) first developed the concept of the food supply chain. Later on, Henson (2005), Hingley (2005), and Taylo (2005) classified the complete chain of producing, processing, circulation, and consumption as the agricultural product chain. With respect to dairy quality from milk supply management, Dervillé and Allaire (2014) discussed the concepts of quality control in the dairy market and analyzed how farmers mobilize collective coordination capacities to face changes in supply quality. They suggested that to become effective market participants, farmers should operate at large territorial scales and participate in the management of the milk supply chain (volume and quality). Quality assurance programs in different production chains have been installed by the dairy industry to counteract the problems that are occurring. However, quality control at the dairy farm level goes beyond the quality control of the product alone (Noordhuizen and Metz, 2005).

The issue of food supply quality and risk has received significant attention. In particular, issues on quality and safety in China's dairy industry have emerged in recent years because of the lack of quality

control and assurance of the milk source. The 2008 adulterated milk incident in China has been separately reported in various industry reports and articles with different focuses, such as business ethics (DeLaurentis, 2009; Song, 2009), agricultural economics (Gale and Hu, 2009), and actionable legitimacy (Petrun and Sellnow, 2010). Lu et al. (2009) presented a comprehensive learning case regarding corporate crisis management based on the incident. They emphasized the responsibility for assuring dairy product quality and safety at all stages of the dairy chain, including the source of raw milk supply. Tse and Tan (2012) proposed and demonstrated a marginal incremental analysis justification approach to managing product quality risk, evaluating supply chain visibility, and designing multi-sourcing strategy in a multi-layer environment.

Numerous research studies have mainly focused on dairy supply chain cooperation, including individual behavior, quality control, price transmission, cost control, and benefit distribution. Nevertheless, the interrelations among the determinants of dairy product quality and the competitive advantage of the dairy supply chain have not received sufficient attention. Research that investigates the determinants of dairy product quality and competitive advantage of the dairy supply chain in developing countries where the increased attention on quality and safety of food products reflects issues of business ethics in fast progressing economic development, such as China, remains lacking.

Quality and safety of dairy products

Aung and Chang (2014) analyzed a food supply chain from the perspectives of safety and quality. The quality and safety of dairy products directly affect the health and safety of consumers, the brand image of the product, and the competitive advantage and sustainable development of the dairy supply chain (Pant et al., 2015). Ivano (2004) and Ufuk (2008) considered that the raw materials and production conditions of dairy products are the key factors for ensuring the quality and safety of dairy products. Joseph et al. (2006) deemed that key issues in dairy safety and quality control stem from dairy cow breeds, pasture management, dairy processing to dairy testing, dairy packaging, quality control, and transportation. Food safety, alongside food quality, remains a primary concern of both consumers and those along the entire food supply chain, leading to regulation by the government alongside private third-party certification. All stakeholders recognize the need for decreasing duplication in legislative requirements for food hygiene and farm assurance audits and for delivering food safety by combining the key elements of regulatory and

assurance systems with the improved communication of food safety and quality to the final consumer (Bailey and Garforth, 2014; Beulens et al., 2005).

International competition and the effect of domestic incidents on the market have impelled dairy firms in China to focus on quality and safety throughout the supply chain to enhance their competitive advantage. In this study, we aimed to empirically investigate the determinants of the competitive advantage of the dairy supply chain in China and their logical relationships. Our investigation emphasized dairy product quality assurance.

Government regulation

Government regulation includes promulgated relevant laws and legislations for ensuring dairy quality and safety and the prompt execution of power and law enforcement transparency. Governments assure the quality and safety of dairy products by implementing regulations throughout the dairy supply chain. Caswell (1998) established a model to measure the benefits and costs of improving food safety and nutrition in the context of a regulatory environment and provided suggestions on whether quality assurance is best provided voluntarily by companies or mandated by government regulation. Buzby and Frenzen (1999) compared food safety regulations, criminal law, and standards in food safety cases from the UK and US. They deemed that the product liability system provides weak incentives, including current legal incentives, expected monetary compensation, indirect incentives, confidential settlements, and insurances, to US firms to produce safer food. They suggested that more research is needed to understand the strengths, weaknesses, and relative impact of each country's legal system on incentives to produce safer food. Starbird (2000) utilized comparative statistics to examine the effects of the interaction between penalties with inspection policies on food processor behavior. They reported that internal penalties are more economically efficient for motivating processors than external penalties. Henson and Reardon (2005) briefly introduced the evolution and nature of private food safety and quality standards, highlighted the resultant impacts on food policy and the agri-food system, and explored the interactions and interrelationships between private and public standard-setting. Schlippenbach and Teichmann (2011) theoretically analyzed retailer quality choice and its implications in market structure and social welfare. They revealed that retailers use private quality standards to improve their bargaining position in the intermediate goods market. This strategy, however, is detrimental to social welfare.

In terms of government regulation, Lankveld (2004) pointed out that milk safety and quality have become serious issues in Poland, Romania, and Bosnia since their accession as EU countries, wherein the farm-to-market milk supply chain is stringently regulated. Gorris (2005) deemed that through horizontal regulation, such as establishing sound laws and regulations, and enforcing the management of executive organization via vertical regulation, dairy products could be supervised and controlled in all domains. Charlier and Valeschini (2008) suggested that the dairy safety regulatory agency in the UK should play an important role in the dairy industry chain. In addition, they suggested that government agencies should form a downstream dairy industry chain that constrains the upstream dairy industry chain to ensure that dairy product sales enterprises positively affect the safety of dairy processing enterprises. Thus, the ultimate goal of standardizing behavior will become more logical. Konuspayeva et al. (2007) pointed out two types of dairy safety models in developed countries: the US Model, with management as the key point, and the Europe Model, with regulation as the key point. They pointed out that the latter model is more suitable for developing countries. Akiyama (2011) validated the effectiveness of the tag monitoring system implemented by the Japanese government. Ortega (2011) proposed that for Chinese consumers, government regulation is an important demand attribute of dairy product safety. Chen et al. (2014) presented a mutually supporting analytical model and case study to investigate the managerial and policy issues related to quality control in the management of the food supply chain, and pointed out that the reason for the 2008 adulterated milk incident is the poor vertical control strategies for managing the quality and risk of the supply chain. Bailey and Garforth (2014) examined industry perceptions of the regulatory and assurance systems in the dairy sector of England and Wales. They concluded that decreasing duplication in food hygiene legislative requirements and farm assurance audits, not a more rigorous system, is needed for the better communication of food safety and quality to the final consumer. Agenbag et al. (2009) suggested that urban health services should routinely assess the local government controllability of milk production hygiene. In addition, the national and provincial governments must provide urban health service managers with the appropriate authority and clearly defined functions in this regard.

Corporate social responsibility (CSR)

Having learned from the far-reaching effects of CSR, companies have focused on the social and ecological impacts of their operations. CSR refers to the ethical principle that an organization should be responsible for the societal and environmental effects of its behavior (Jobber et al., 2012). CSR is a form

of corporate self-regulation integrated in a business model. CSR policy functions as a self-regulatory mechanism wherein a business monitors and ensures its active compliance with the spirit of the law, ethical standards, and national or international norms (Rasche et al., 2017). The social responsibility of dairy firms directly affects the responsiveness of stakeholders, such as corporate reputation, word of mouth, faith, and culture. Chen et al. (2014) used the exploratory case study of the 2008 adulterated milk incident in China to investigate practical issues in product quality and safety assurance in the management of the food supply chain. They discussed other important managerial and policy insights and implications regarding supply chain design, informational visibility, CSR, and regulatory action in managing the quality and risk of the global food supply chain. Kong (2012) found that firms, particularly those in the food industry, can obtain long-term benefits by strengthening their CSR-related activities.

Dairy production behavior

Dairy production behavior refers to production activities and their tendency to support quality and safety assurance in production, including the controllability of the milk source and processing sectors. Dairy production behavior is a crucial determinant of the quality of dairy firms, and the safety and quality of dairy products (Hennessy et al., 2001). Dornom (2011) held that the dairy industry is vertically integrated. Therefore, as the main components of the dairy supply chain, the pasture and manufacturing sectors should ensure product quality and safety. Noordhuizen and Metz (2005) suggested that dairy farms should adopt Hazard Analysis and Critical Control Point, a system that helps dairy business managers handle the entire manufacturing process and avoid immature risk, thus ensuring the consistent safety of their products. Schoder et al. (2013) used hygiene checklists and milk sampling to investigate milk quality and safety at various stages of milk production. A progressive decrease in microbial quality along the milk production chain resulted from departures from traditional production methods, inadequate milk containers, long transport distances, lack of cooling, and lack of a basic understanding of hygiene.

Control of the milk supply source

The milk source should receive particular attention in decreasing the safety risk of dairy production. The milk source supply is controlled following the dairy cow culture model, which provides a dairy farm environment that is based on self-built pastures and that integrates dairy farming with breeding technologies, services, and mechanisms. In China, most domestic dairy firms have lost effective control over the quality of their milk sources given the lack of self-built pastures. This is most recognizable lesson

from the 2008 adulterated milk incident. Self-built pastures control the dairy production process and directly decrease the safety risk posed by the milk source supply. Moreover, it facilitates the implementation of standardized operations and management processes for the safety assurance of the milk source.

To improve the safety of their products, dairy manufacturers must evaluate their entire processing operations at all points, including the reception of raw milk (Boor, 2001). Valeeva et al. (2005) determined the relative importance of the attributes of food safety improvement in the stages of pasteurized milk production, including "feed" (compound feed production and its transport), and "farm" (dairy farm). Benson et al. (2001) investigated the effects of postruminal fat infusion on intake, feeding behavior, and milk production of dairy cows at two stages of lactation. Cows at the early stage of lactation and that are fed with diets comprising only fermented grass silage and a cereal-based concentrate suffer from limited amino acids and glucose supplies (Vanhatalo et al., 2003).

Sustainability of the dairy supply chain

With the development of ecological economics, sustainability has become a key determinant of the competitive advantage of the dairy supply chain. Augustin et al. (2013) deemed that the need for more sustainable milk production methods would alter on-farm practices. Therefore, integration across the farm–factory interface is essential for a globally competitive and sustainable dairy industry in the future. The dairy factory of the future will extend its boundary to benefit from the whole supply chain. Maglaras et al. (2013) utilized key indicators related to efficiency, flexibility, responsiveness, and product quality to evaluate the sustainability and individual performance of the Greek dairy chain. Their findings showed the critical role of large dairy manufacturers, which are the "sustainability performance champions" in the Greek dairy chain and are the driving force for the implementation of numerous sustainability initiatives. Bourlakis et al. (2014) used key indicators related to product quality to evaluate the sustainability performance of the whole supply chain. They proposed that large dairy manufacturers drive the implementation of sustainability initiatives. Glover et al. (2014) applied the Institutional Theory to explore sustainable practices across dairy supply chains and collected data via telephone interview with various stakeholders. They suggested that the government should encourage sustainable practices, including investment and financing practices, under the dominant logic of cost reduction and the powerful position of supermarkets.

Research method

Many scholars have utilized different approaches to investigate the quality and quantity of food products. Maze et al. (2001) analyzed the relationships among the quality, safety, and management structure of agricultural products in Europe. They proposed the rational use of the game theory to enhance the quality of agricultural products. Consumers often find food safety and quality difficult to ascertain. Given this asymmetrical information characteristic, Vetter et al. (2002) used the game theory to verify that the vertical integration of the food supply chain presents a moral hazard problem. They also recommended that the contract cooperative game theory of food supply chain be theoretically and empirically analyzed in detail (Hudson, 2001; Weaver and Kim, 2001). Hennessy et al. (2001) considered that modern food production involves many interacting stages with numerous decision-makers. They proposed that leadership by two or more firms through communicating actions may mitigate incentive problems and increase overall food quality. This suggestion is worthy of reflection on the determinants of the demand and supply of leadership in their system.

With respect to food supply chain design, Garcia-Flores et al. (2015) reviewed operational research and logistics studies for agribusiness supply chains and presented them by food sector. Through mathematical and stochastic programming, data envelopment analysis, and simulation, they showed that the food supply chain could be optimized via multi-criterion decision-making activities, such as scheduling operations, assessing sustainability, reducing waste, designing transportation networks, and planning the infrastructure of food supply chains. Using a multi-stage survey methodology, Dries et al. (2008) deemed that vertical coordination benefits small dairy farms in several countries with policy reforms and is important to develop “win-win” solutions for companies and farmers. Velthuis et al. (2009) developed a Monte Carlo simulation model of a farm-to-consumer supply chain to investigate the relationship between time and direct recall costs. They showed that the distribution of direct recall costs along the milk chain can support the development of chain monitoring schemes.

Several studies have utilized structural equation modeling. For example, Juneho et al. (2017) investigated the relationships between product variety management and supply chain performance. They developed a conceptual model that links management strategies for product variety with supply chain responsiveness and that relates supply chain responsiveness to cost and customer service. They found that a management strategy for product variety influences supply chain cost and customer service performance

only when mediated by internal and external responsiveness. Grekova et al. (2016) explored the potential of collaboration with suppliers and customers for environmentally sustainable improvements. They claimed that environmental collaboration could directly or indirectly enhance the performance of the focal firm by stimulating the focal firm to implement more environmentally sustainable processes that subsequently contribute to the firm's performance. Li et al. (2006) developed five dimensions of SCM practice. These dimensions include strategic supplier partnership, customer relationship, level of information sharing, quality of information sharing, and postponement. In addition, they tested the relationships between SCM practices, competitive advantage, and organizational performance. Their results indicated that high levels of SCM practice could enhance competitive advantage and improve organizational performance. Questionnaires are the most commonly used method of data collection in field research (Hinkin, 1995).

As shown by previous research, managing the quality and safety of the food supply, especially those of the dairy supply chain, in today's competitive global business environment requires an integrated strategy that addresses issues in supply chain design, traceability and informational visibility, regulatory environment, and coordination and cooperation. Although empirical research on the quality or safety issues in the management of food supply chains continues to grow, only a few studies have modeled the competitive advantage of the dairy supply chain based on quality and safety assurance. The competitive advantage of the supply chain could be enhanced based on a complex chain system that contains multi-stage, multi-subject, and multi-variable direct and indirect relationships among the determinants of the competitive advantage of the dairy supply chain. Given that these determinants are linked to the interests of stakeholders at all stages of the dairy supply chain and to consumer trust, their relationships require further investigation. Based on the concept that dairy quality assurance is a primary prerequisite for the competitive advantage of the dairy supply chain, we identified the determinants that affect the quality assurance of dairy products at all stages of the entire dairy chain. We built a structural equation model to present the interrelations among the determinants with the competitive advantage of the dairy supply chain. In this study, we investigated the determinants of the competitive advantage of the dairy supply chain, employed the structural equation model to analyze the interactive relationships among these determinants, and provided insights into the effects of the determinants (influencing factors) on the competitive advantage of the dairy supply chain.

3 Research model and hypotheses

In this section, we analyze the determinants of the competitive advantage of the dairy supply chain and their logical relationships, with an emphasis on dairy quality assurance. We also present the relevant hypotheses for our empirical study of the Chinese dairy industry.

The theoretical framework of the present study is grounded in the relational, business capability, and resource-based views. Collectively, they underpin hypotheses that link government regulation, CSR, dairy production behavior, dairy product quality assurance, and competitive advantage. The business capability and resource-based views originated as an attempt to identify factors that explain the business performance of a firm. Business resources and capabilities that are heterogeneous across firms generate above-normal profits and a sustained competitive advantage if they are valuable, rare, imperfectly imitable, and non-substitutable (Barney, 1991). For over a decade, research focus has gradually shifted from the individual firm level toward collaboration in supply chains and networks (Reed, 2008; Sarkis et al., 2011). The relational view (Dyer and Singh, 1998) conceptualizes interrelations within a supply chain as a source of competitive advantage. Relational profits are derived by combining complementary and related resources and capabilities, earning, and knowledge sharing (Grekova et al., 2016). The competitive advantage generated by supply chain collaboration has multiple dimensions, including innovation, quality, process efficiency, flexibility, and other business synergies (Cao and Zhang, 2012).

The relational, business capability, and resource-based views have important implications for our research: the determinants that impact the competitive advantage of the dairy supply chain are multidimensional and interactive. Through inter-stage resource coordination and business capability enhancement, the interactive relationships of these determinants are directly and indirectly linked to the competitive advantage of the dairy supply chain. Empirical studies on this aspect are rare. Therefore, the interactive impacts of these determinants on the enhancement of competitive advantage of the dairy supply chain in the global competitive environment require further study.

We constructed a structural equation model to present and analyze hypotheses relevant to the determinants of the competitive advantage of the dairy supply chain and their relationships. We conducted a questionnaire survey to collect data for model evaluation. The questions for the survey were developed based on the hypothesized relationships between the identified determinants and the competitive advantage of the dairy supply chain. The latent variables and statements that measure questionnaire items are outlined in the Appendix. The research model and hypotheses are developed in the following sections.

3.1 Modeling the competitiveness of the dairy supply chain by emphasizing dairy quality assurance

By analyzing the determinants and their relationships with the competitive advantage of the dairy supply chain as well as by emphasizing dairy quality assurance, we constructed a structural equation model that depicts the relationships of the competitive advantage of the dairy supply chain (dependent) and its determinants (independent). To obtain a simplified, systematic, operational, and scientific design, the specific contents of the constructs in the structural equation modeling of the dairy supply chain are presented in terms of latent variables and their observable variables. In our model, the latent variables (determinants) include exogenous variables, such as government regulation and CSR, and endogenous variables, such as dairy production behavior, dairy cow culture model, and dairy product quality assurance. We identified determinants by reviewing the related literature (Charlier and Valeschini, 2008; Schlippenbach and Teichmann, 2011; Kong, 2012; Hennessy et al., 2001; Dornom, 2011; Pant et al., 2015; Ivano, 2004; Ufuk, 2008; Joseph et al., 2006) and through a questionnaire survey given to relevant respondents. As seen in our structural model (Figure 1), dairy quality assurance is explicitly considered as the fundamental determinant of the interrelationships among determinants and the competitive advantage of the dairy supply chain. We considered safety as a basic standard for dairy production and supply and as an inherent and basic element of product quality. We thus explicitly focused on dairy quality assurance in the model.

Our model (Figure 1) provides an overview of the hypotheses that link the determinants and their interactive relationships with the competitive advantage of the dairy supply chain. In the model, the sub-Hs present the possible mediated effects. The model was generated in accordance with the hypotheses that the model framework presents the interrelationships among the constructs (latent variables) representing the determinants and the competitive advantage of the dairy supply chain. The definitions of the model constructs are given in Table 1.

(Insert Figure 1 here)

Figure 1: Structural equation model of the competitive advantage of the dairy supply chain

Table 1 Model constructs and their definitions

Constructs (latent variables)	Definitions
Government regulation	Promulgated relevant laws and legislations that ensure

	dairy quality and safety and the prompt execution of law enforcement transparency.
Corporate social responsibility (CSR)	Ethical principle that a business organization should be responsible for how its behavior might affect society and the environment.
Dairy production behavior	Production activities and the inclination of a dairy business to assure quality and safety in the production processes and the controllability of the milk source supply.
Dairy cow culture model	Dairy farming environment in self-built pastures, which integrates dairy farming scale, breed technology and service, and breeding mechanism to control dairy quality risk.
Dairy quality assurance	Quality management mechanism that provides confidence that quality requirements will be fulfilled.
Competitive advantage of the dairy supply chain	Attribute that allows a supply chain to outperform its competitors in the dairy industry.

3.2 Hypotheses

The following sections will elaborate on the concepts and the proposed relationships of the above determinants.

3.2.1 Government regulations/policy and dairy quality assurance

Government regulations include promulgated relevant laws and legislations for ensuring dairy quality and safety and the prompt execution of power and law enforcement transparency. The enforcement of government regulations can directly affect the product quality assurance and production performance of the dairy firms (Charlier and Valeschini, 2008; Petrun and Sellnow, 2010). In contrast, governments aim to support firm development by issuing relevant policies. For instance, dairy firms are encouraged to build their own pastures to enhance their capability of assuring product quality starting from the raw milk source. Such a relevant policy plays a key role in perfecting the overall strategy and improving the competitive advantage of the dairy supply chain. On the other hand, governments play the role of governance to assure the quality and safety of dairy products by implementing regulations throughout the supply chain. The competitive advantage of the dairy supply chain can be enhanced with the prompt implementation of regulations and the transparency of production behaviors that are enforced in compliance with regulation

standards (Bailey and Garforth, 2014; Beulens et al., 2005). However, the literature on the impact of government regulation and policy on dairy quality assurance remains unclear (Caswell, 1998; Buzby and Frenzen, 1999; Starbird, 2000; Henson and Reardon, 2005; Schlippenbach and Teichmann, 2011). The lesson from the adulterated milk incident in China motivates the investigation of the effect of government regulations on dairy quality assurance in the domestic dairy industry. Therefore, we hypothesize the following:

H1: Government regulations/policies and dairy quality assurance are positively correlated.

H1a: Dairy production behavior mediates between government regulations/policies and dairy quality assurance.

H1b: Dairy cow culture model mediates between government regulations/policies and dairy quality assurance.

3.2.2 CSR and dairy quality assurance

The responsiveness of stakeholders, such as corporate reputation, word of mouth, faith, and culture, is directly affected by the capability of dairy firms to fulfill social responsibility (Roth et al., 2008). CSR performance includes the following: quality–safety consciousness, frequency of quality and safety incidents, quickness of handling quality and safety incidents, and frequency of charitable activities (Meiying, 2009). The aim of CSR is to increase long-term profits and stakeholder trust through positive public relations and high ethical standards to reduce business and legal risks by impelling companies to take responsibility for corporate actions. CSR strategies encourage the company to positively affect the environment and stakeholders, including consumers, employees, investors, and communities (Rasche et al., 2017). A strong sense of CSR reflects better product safety and quality assurance (Lu et al., 2009; DeLaurentis, 2009; Song, 2009). The stronger the sense of CSR, the better the dairy production behavior and the stronger the motives for increasing the capability to manage the dairy supply chain upstream by building self-run pastures. Self-run pastures, in turn, enhance the safety and quality of dairy products, implying that CSR also indirectly affects dairy quality assurance through dairy production behavior and the dairy cow culture model (Kong, 2012). Therefore, the following assumptions are made:

H2: CSR and dairy quality assurance are positively related.

H2a: Dairy production behavior mediates between CSR and dairy quality assurance.

H2b: Dairy cow culture model mediates between CSR and dairy quality assurance.

3.2.3 Dairy production behavior and the competitive advantage of a quality–safety-based dairy supply chain

Dairy production behavior refers to production activities and their tendency to assure the quality and safety of dairy production processes, including the controllability of dairy processing, raw milk source supply, and control system for production management. Production behavior is a crucial factor that determines the quality level of supply chain firms and the safety and quality of products (Hennessy et al., 2001; Noordhuizen and Metz, 2005; Schoder et al., 2013). While dairy product quality directly affects the competitive advantage of the dairy supply chain, dairy production behavior indirectly influences the same variable by assuring dairy product quality. Therefore, the following assumptions are made:

H3: Dairy production behavior is positively related with the competitive advantage of the dairy supply chain.

H3a: Dairy quality assurance mediates between dairy production behavior and the competitive advantage of the dairy supply chain.

3.2.4 Dairy cow culture model and the competitive advantage of a quality–safety-based dairy supply chain

Quality–safety incidents mostly occur in the upstream supply chain, such as the milk source (Boor, 2001; Noordhuizen and Metz, 2005; Chen et al., 2014). There is a generally accepted rule saying “Person Holding Milk Source Wins the World” among China’s dairy industry, further the significance of the milk source. Thus, implementing a formal and scientifically and technically supportive dairy cow culture model, a key determinant of the competitive advantage of the dairy supply chain, should be the top priority in the supply-side reform of the dairy industry (Ivano, 2004; Joseph et al., 2006; Ufuk, 2008; Dornom, 2011). Moreover, the innovation of the dairy cow culture model directly affects dairy product quality, and indirectly increases the competitive advantage of the dairy supply chain by accordingly improving dairy quality assurance. Therefore, the following assumptions are made:

H4: The dairy cow culture model and the competitive advantage of the dairy supply chain are positively related.

H4a: Dairy quality assurance mediates between dairy cow culture model and the competitive advantage of the dairy supply chain.

3.2.5 Dairy quality assurance and the competitive advantage of a quality–safety-based dairy supply chain

Dairy product quality is the foundation of the competitive advantage of the dairy supply chain (Pant et al., 2015). Mentioning competitive advantage without product quality is absurd. Dairy product quality is observable from the business ethics, production behavior, and product taste of an enterprise. The controllability of the dairy product quality could be enhanced by business and production behaviors that manage safety and quality risk in food production. These behaviors include introducing and strictly implementing advanced quality management systems, as well as conducting quality tests with standards higher than national standards. A fully integrated assurance system, with effective controls applied at all stages, is ideal (Desmarchelier et al., 2007; Maglaras et al., 2013; Aung and Chang, 2014). In addition, although consumers are unlikely to bring devices for the inspection of dairy products, they can perceive the high quality of a dairy product. In turn, dairy product quality reflects quality controllability. Thus, dairy quality controllability and product quality level directly affect the competitive advantage of the dairy supply chain. With this consideration, the following assumption is made:

H5: Dairy quality assurance and the competitive advantage of the dairy supply chain are positively correlated.

3.3 Construction of the measurement model

The latent variables for structural equation modeling cannot be directly measured; thus, they need to be estimated by measuring the relevant observable variables (Hinkin, 1995). Therefore, we first identified 24 observable variables based on literature review, the features of the dairy industry, and interviews with dairy firm managers in a pre-test survey. The identified variables are presented in Table 2. Quantifiable and observable variables were linked to the hypotheses by representing the latent variables.

In this study, government regulation is represented by legislation on dairy quality and safety and its transparent enforcement; CSR by product safety awareness, common activities, and handling of dairy safety incidents; dairy production behavior by a safe production and processing system and controlled milk source; dairy cow culture model by farming scale and environment, breeding technology and service, and mechanism for quality risk control; dairy quality assurance by quality management and control system, quality and safety standards, and quality stability; competitive advantage of the dairy supply chain by brand image, consumer trust, risk resistance, coordination, and sustainability.

Table 2 Latent and observable variables of dairy supply chain

	Latent variables (hypotheses)	Observable variables
Competitive advantage of dairy supply chain emphasizing quality assurance	Government regulation ξ_1 (H1, 1a, and 1b)	Legislation on quality and safety Y1
		Execution of laws on quality and safety Y2
		Transparent execution of quality and safety laws Y3
		Supportive policy Y4
	Corporate social responsibility (CSR) ξ_2 (H2, 2a, and 2b)	Frequency of dairy safety incidents Y5
		Handling of dairy safety incidents Y6
		Commonweal aid activities Y7
		Dairy product safety awareness Y8
	Dairy production behavior η_1 (H3 and 3a)	Milk processing X1
		Control of milk source X2
		Safety of the production system X3
	Dairy cow culture model η_2 (H4 and 4a)	Dairy farming scale X4
		Breeding technology and service X5
		Dairy farming environment X6
		Breeding mechanism X7
	Dairy quality assurance η_3 (H5)	Advanced quality management system X8
		Strict quality control measurement X9
		High quality standards X10
		Perceivable and continually stable quality level X11
	Dairy supply chain competitive advantage η_4	Brand image X12
		Consumer trust X13
		Risk resistance capacity X14
		Sustainability X15
		Supply chain coordination X16

Using these identified latent and observable variables, we constructed the measurement model to represent the relationships between observable variables and latent variables. The model is shown in Figure 2. In this figure, latent variables are represented by circles. Government regulation (ξ_1) and corporate social responsibility (ξ_2) represent exogenous latent variables. Dairy production behavior (η_1), dairy cow culture model (η_2), dairy quality assurance (η_3), and the competitive advantage of the dairy supply chain (η_4) represent endogenous latent variables. Rectangles represent quantifiable (observable) variables. Exogenous and endogenous latent variables are denoted by Y_i (i =1, 2,…, 8) and X_i (i = 1, 2,…, 16), respectively. We

used these to quantify the related latent variables. We used at least three or more observable variable to comprehensively represent one latent variable (Hinkin, 1995) to ensure measurement reliability. As shown in Figure 2, the first 8 items, Y1−Y4 and Y5−Y8, represent the observable variables for the exogenous latent variables ξ_1 and ξ_2, respectively. X_i (i =1, 2,…, 16) represent the observable variables for endogenous latent variables, where X1−X3 for η_1, X4−X7 for η_2, X8−X11 for η_3, and X12−X16 for η_4.

(Insert Figure 2 here)

Figure 2: Measurement model of the competitive advantage of the dairy supply chain emphasizing quality and safety assurance

4 Methodology

4.1 Data collection

We designed the questionnaire items based on the above measurement model. The questionnaire included questions on potential relationships among the identified observable variables. Following the questionnaire design, we collected empirical data to test the research model via a semi-structured survey method. We surveyed respondents who have years of working experience in business organizations. Most of these respondents are former graduate students. Data for the questionnaire were collected through a two-stage sampling survey. In the pre-pilot study, the items for the determinants generated based on previous literature were reviewed by five academicians and also through structured interviews with three managers in the dairy industry. The managers were asked to comment on the appropriateness of the research constructs. Based on the feedback from the academicians and managers, redundant and ambiguous items were modified or eliminated. New items were added when deemed necessary.

Considering the knowledge skills related to the respondents' educational background and work experience required to comprehend the questionnaire content, we selected respondents who had obtained a master's degree in business administration and those who are middle managers and senior managers in dairy firms as our survey objects. The respondents were contacted by phone or Wei Chat (the most popular communication application for smart phones) to explain the research objective. Upon expressing willingness to participate, the respondents received a Wei Chat message with a cover letter and a link to the online-based questionnaire. The cover letter explained the purpose of the survey and ensured the anonymity of the respondents. To ensure the reliability of the questionnaire feedback, the respondents were requested to fill in the questionnaire conscientiously. The questionnaires were distributed in person through personal

connection to 1) participants of executive training programs in universities in the Inner Mongolia Province, where the dairy industry is a pillar sector and 2) MBA graduates who have worked for dairy firms for years and who hold business or technology management positions. The questionnaires were also sent through the email contacts of dairy firms to 3) respondents who are connected with the research group through the network. Questionnaire distribution and collection followed the principle of "put quality before quantity" to ensure the response quality of the questionnaires. A total of 400 questionnaires were distributed, among which 270 were returned, 245 were valid, and 25 invalid ones were excluded.

4.2 Measures and data processing

Our model adopted the five-stage assessment method. During the pre-test, the respondents indicated that a 5-point scale could better capture the degree of impact relationship. Therefore, we designed our response format as a 5-point Likert scale whose range was as follows: 1 = minimal, 2 = fairly small, 3 = common, 4 = fairly large, and 5 = maximum. Each point was labeled with words, not numbers, to avoid ambiguity, increase precision, and facilitate response (Krosnick, 1999). To avoid all possible contingencies during the survey and to ensure that the survey questions reflect the context of the dairy industry, secondary indices were investigated through several different questions. In addition, we pretested the questionnaire with dairy firm managers.

4.3 Reliability and validity of the questionnaire

The reliability and validity of the measurement data were analyzed and validated via SPSS. We conducted confirmatory factor analysis (CFA) to determine measurement reliability in terms of composite reliability (CR), convergent validity, and discriminate validity. The CFA results are shown in the Appendix. We analyzed the reliability of the questionnaire, which contained 24 observation variables that consisted of 47 questions. The results of the analysis are shown in Table 3. The reliability of the questionnaire as a whole was assessed based on a Cronbach's alpha of 0.956. This value is greater than 0.80 and was thus considered highly acceptable. The questionnaire was validated via the KMO and Bartlett detection of exploratory factor analysis. Table 4 shows their results with a value of 0.954, which is considered highly acceptable. In the model framework, factor analysis was conducted using the 24 items that measure the six dimensions. Further analysis of the reliability of the questionnaire through measurement items revealed that the factor loadings of Y2 for the government regulation construct and X5 for the dairy cow culture model construct were less than the recommended value of 0.5; thus, these factors were removed (Hair, 2010). All

items were loaded on their respective factors, with most loadings above 0.70. Factor loadings and CR were used for reliability and AVE for convergent validity. As shown in the Appendix, CR values are above the established threshold of 0.8 (Nunnally, 1978), except for a small deviation in the construct of the dairy cow culture model given its loading factor of dairy farming scale. The latter was considered acceptable given its small deviation, which is close to the threshold of 0.7 recommended for exploratory research. Convergent validity was established given that all AVE values exceeded 0.5 with the exception of the small deviation of the dairy cow culture model. Discriminate validity refers to the conceptual and empirical distinctiveness of constructs (Anderson and Gerbing, 1988). We constructed the structural equation model to compare the different relationships and correlation between constructs. The model structure means that correlations between the constructs are significantly different from unity, thus fully supporting discriminate validity. Our data analysis revealed that the small deviations of the dairy cow culture model did not affect model fit. In addition, the cumulative variance explained by the questionnaire was 73.522%, indicating the reliability of the questionnaire data. Data reliability and validity were tested, and each indicator reflected the reality of the interviewees.

Table 3 Reliability statistics

Cronbach's Alpha	Number of items
0.956	24

Table 4 Validity test using KMO and Bartlett detection

Kaiser–Meyer–Olkin measurement	0.954
Degree of sphericity detection chi-squared approximations	4538.21
Degree of freedom	276
Sig. ($p < 0.001$)	0

5. Empirical results

In this section, we present our empirical study on the interactions among the competitive advantage of the dairy supply chain and its determinants. Following data collection and processing, the structural equation model was run in AMOS 21.0 software and then modified to obtain the logical relationships among the determinants and competitive advantage of the dairy supply chain. The model results of the empirical study were then analyzed.

5.1 Structural model results

The model fitting results are shown in Table 5. As in Table 5, the normal chi-square (x^2/df) value is 2.070, which is close to 2. The x^2/df value, however, is affected greatly by the sample size. The larger the sample size, the greater the x^2/df value. This study had a sample size of 245, which is a large sample size. Therefore, we consider the x^2/df value as acceptable. As for other model fit indictors, the RMSEA value is 0.063, which is less than 0.08 and indicated that the model has satisfactory goodness of fit. The SRMR value is 0.0438 and is less than 0.05, indicating the good fit of the model. The values of the other indicators (i.e., NFI, IFI, and CFI) are greater than 0.9, except that of GFI, which was less than (but close to) 0.9. Collectively, these results indicate the structural model satisfactorily fits the data.

Table 5 Model fitting results

Fit Index	x^2/df	RMSEA	SRMR	GFI	NFI	IFI	CFI
Whole Model	2.070	0.063	0.0438	0.884	0.910	0.952	0.951

5.2 Hypotheses testing of the model variables

We conducted hypothesis testing to make prior assumptions on the overall number of quantitative attributes or distribution form, and to determine the soundness of the original hypotheses in accordance with the sample information. Hypothesis testing is characterized by the use of reductio ad absurdum based on the statistical principle of small probability. A mediating effect means that the relationship among the causality variables is indirect and is exerted through one or more variables. Thus, these variables are referred to as “mediator variables.” The mediating effect can be tested via three test methods: causal steps, products of coefficients, and difference in coefficients. In this study, we adopted the causal step method (Baron and Kenny, 1986; Rungtusanatham et al., 2014) by conducting regression analysis in SPSS. The test results are shown in Table 6. In this table, the second column presents the hypotheses that are assumed to have either direct or mediating effects among the latent variables. As shown in Table 6, all 11 hypotheses passed the test. All of the mediated effects exert full mediation except for the dairy cow culture model, which has a partial, rather than full, mediatory effect between government regulation and dairy quality assurance and between CSR and dairy quality assurance.

Table 6 Hypothesis testing

	Hypothesis	Standardized path coefficient	C.R. figure	P figure	Sobel	Hypothesis test result

Hypothesis 1	Government regulation →Dairy quality assurance (Right)	0.86	1.709	***		Pass
Hypothesis 1a	Government regulation →Dairy production behavior →Dairy quality assurance (Medi-)	0.84 0.70	9.833 3.823	***		Pass (Full)
Hypothesis 1b	Government regulation →Dairy cow culture model →Dairy quality assurance (Medi-)	0.91 0.68	8.145 2.316	*** 0.021	2.299	Pass
Hypothesis 2	Corporate social responsibility →Dairy quality assurance (Right)	0.83	6.876	***		Pass
Hypothesis 2a	Corporate social responsibility →Dairy production behavior →Dairy quality assurance (Medi-)	0.89 0.83	7.782 3.187	0.683		Pass (Full)
Hypothesis 2b	Corporate social responsibility →Dairy cow culture model →Dairy quality assurance (Medi-)	0.91 0.68	6.815 2.160	*** 0.31	2.006	Pass
Hypothesis 3	Dairy production behavior →Supply chain competitive advantage (Right)	0.78	8.829	***		Pass
Hypothesis 3a	Dairy production behavior →Dairy quality assurance →Supply chain competitive advantage (Medi-)	0.91 0.97	10.096 2.822	*** 0.542		Pass (Full)
Hypothesis 4	Dairy cow culture model →Supply chain competitive advantage (Right)	0.69	8.192	***		Pass
Hypothesis 4a	Dairy cow culture model →Dairy quality assurance →Supply chain competitive advantage (Medi-)	0.66 0.77	8.570 6.571	*** 0.104		Pass (Full)
Hypothesis 5	Dairy quality assurance →Supply chain competitive advantage (Right)	0.85	10.816	***		Pass

Note: Medi-: there is a mediated effect between the two variables; Right: there is a direct effect between the two variables; ***$p < 0.001$.

5.3 Findings

The collected data were imported and the structural equation model was run using Amos 21.0. The results of each path coefficient of the structural model are shown in Figure 3.

(Insert Figure 3 here)

Figure 3 Structural model results

The hypothesis testing results shown in Table 6 revealed that dairy quality assurance has a full mediatory effect between dairy production behavior and the competitive advantage of the dairy supply chain. The same determinant has the same effect on the relationship between dairy cow culture model and the competitive advantage of the dairy supply chain. Thus, only the full mediatory effects of dairy production behavior and dairy cow m culture model on the competitive advantage of the dairy supply chain are considered here rather than direct effects. This result actually explains the absence of the direct effects of dairy production behavior and dairy cow culture model on the competitive advantage of the dairy supply chain from Figure 3. The relationships between the variables and the structural model results are discussed based on the results exhibited in Figure 3 and the output of the hypothesis test summarized in Table 6.

(1) Government regulation and the competitive advantage of the dairy supply chain with emphasis on quality assurance

The analytical results of the model implied that government regulation effectively assures the quality and safety of dairy products via effects on dairy firms, and positively promotes the competitive advantage of the dairy supply chain via the enhancement of dairy quality assurance. Therefore, hypothesis 1 is supported. The three observation variables for government regulation (Y1= 0.80, Y3 = 0.72, and Y4 = 0.70) showed that the prompt and transparent implementation of laws and regulations facilitate the following positive interactions: control of dairy production behavior, increased consumer trust in the dairy supply chain, and easy access to dairy information flow. These interactions improve dairy safety and quality. Meanwhile, supportive government policies encourage dairy firms to build self-run pastures to improve the dairy supply system and ensure dairy quality starting from the raw milk source. Subsequently, the competitive advantage of the dairy supply chain is effectively enhanced. Therefore, hypotheses 1a and 1b are supported. Note that more than 80% of the respondents strongly consider that policy enforcement and transparency are directly related to the level of consumer trust in domestic dairy firms. They also believe that the media, the public, and other stakeholders, together with the government and dairy firms, should make a concerted effort to handle the trust crisis and restore the brand image of the dairy industry in China.

(2) CSR and competitive advantage of the dairy supply chain with emphasis on quality assurance

The results of the model analysis revealed that the level of social responsibility affects the quality and safety of dairy products and thus the competitive advantage of the dairy supply chain. Therefore, hypothesis 2 is supported. Through the mediating effect of dairy production behavior, dairy firms that

exhibit high-level social responsibility will be able to assure dairy product safety and improve dairy product quality by reinforcing the management of the dairy production process and controlling safety production activities. Therefore, hypotheses 2a and 2b are supported. The four observation variables for CSR (Y5 = 0.85, Y6 = 0.62, Y7 = 0.88, and Y8 = 0.54) indicated that dairy firms that exhibit social responsibility ensure that responsibility is included in their business philosophy and that quality and safety are controlled by following regulations. These companies execute considerate measures, including timely charitable activities, to address incidents and to give back to society. CSR is the coordinate value of enhancing business competitiveness, the guide to action, and the secret to maintaining the vitality of business organizations.

(3) Production behavior and competitive advantage of the dairy supply chain with emphasis on quality assurance

Based on the analytical results, dairy production behavior affects the competitive advantage of the dairy supply chain through the full mediation of dairy quality and safety assurance. Thus, hypotheses 3 and 3a are supported. The three observation variables for dairy production behavior (X1 = 0.82, X2 = 0.75, and X3 = 0.76) indicate that controlling milk source and production directly affects quality and safety assurance. Real evidence shows that controlling the milk source is more crucial than processing milk. Therefore, the non-scale, non-canonical circumstances upstream of the dairy supply chain can seriously affect the quality and safety of dairy products. More than 90% of the respondents believe that the effective control of the quality and safety of dairy products should be emphasized in the supervision of the upstream dairy supply chain to control the quality and safety of the milk source.

(4) Dairy cow culture model and supply chain competitive advantage with emphasis on quality assurance

The recent dairy quality and safety incidents in China were caused by the contamination of the raw milk source. In addition to the raw milk source, dairy farming scale, dairy farm environment, and breeding mechanism affect dairy product quality and safety by different manners and degrees. Therefore, the effective control of the raw milk source is a crucial issue that has attracted the attention of dairy firms and that demands an urgent solution. The modeling results implied that by effectively controlling the raw milk source, the dairy cow culture model positively affects the competitive advantage of the dairy supply chain through the full mediation of dairy quality and safety assurance. Thus, hypotheses 4 and 4a are supported.

The three observation variables for the dairy cow culture model (X4 = 0.43, X5 = 0.75, and X6 = 0.74) indicated that: 1) the timely supply of high-quality raw milk to meet market demand depends on the pasture scale of the dairy farm; 2) the breeding mechanism that integrates the dairy supply chain and facilitates dairy business behavior is the core of dairy firms and enhances the controllability of the raw milk supply; 3) the dairy farm environment provides a safe, contamination-free condition with natural resources, dairy processing, breeding technology, and service. Notably, only the factor loading of dairy farming scale (X4 = 0.43) is less than the recommendable value of 0.5 (Hair, 2010), which may imply that the respondents or interviewees have a mixed sense of dairy farming scale that considers the complex capacity requirements for coordinating dairy process and milk source supply with dairy quality controllability. Dairy firms need to rationalize the economic scale of the self-built pasture for compatibility with their production capacity from the views of economic scale and dairy quality assurance. Perfecting the dairy cow culture model will improve the performances of dairy firms by assuring dairy product quality and safety through controlling the raw milk supply, and will further enhance the competitive advantage of the dairy supply chain.

(5) Dairy quality and safety assurance and the competitive advantage of the dairy supply chain

Approaching the downstream dairy supply chain, the model results implied that dairy quality assurance directly and strongly affects the competitive advantage of the dairy supply chain, as is intuitively true. Thus, hypothesis 5 is supported. The four observation variables for dairy quality assurance (X8 = 0.73, X9 = 0.78, X10 = 0.69, and X11 = 0.83) indicated that an advanced quality management system, strict quality control, high quality standard, and consistent quality level are the recognized quality and safety assurance measurements in practice. These measurements ensure the high quality of dairy products, the foundation of the competitive advantage of the dairy supply chain. On the other hand, the five observation variables for the competitive advantage of the dairy supply chain (X12 = 0.90, X13 = 0.84, X14 = 0.76, X15 = 0.78, and X16 = 0.77) indicated that brand image and consumer trust, which are both grounded on good dairy product quality, are crucial in enhancing the competitive advantage of the dairy supply chain from the market perspective. Moreover, good product quality assurance reflects the dairy firms' good risk resistance capacity and supports their business sustainability. The high level of dairy product quality assurance is impossible without joint efforts on strengthening effective coordination among dairy firms.

6. Discussion and conclusions

In this study, we investigated the interactive relationships between the competitive advantage of the dairy supply chain and its determinants. Our study obtained several crucial findings, as follows.

(1) Core role of dairy quality assurance

As is common in food supply chains and intuitively true, our results indicated that product quality and safety are the foundations and premise that dairy firms must ensure to gain consumer trust and to achieve business success. The competitive advantage of food supply chains is significantly affected by the consumer perception of product quality and safety. The same is true for the Chinese dairy supply chain. Our questionnaire survey of dairy firm managers revealed that the comprehension of dairy product image comprises two interrelated components: product quality and safety. Particularly, as the primary element of quasi-public goods, such as food products, the safety standard is the top priority because it is the basic element of product quality. The managerial implication is that assuring dairy safety is the primary element that must be completely fulfilled without any excuses. Product safety is the basic requirement for entering the market and acts as the bottom line for gaining consumer trust, which in turn supports the competitive advantage of the food supply chain. Product safety is the primary basis of good product quality. As the quality and safety of dairy products directly affect consumer health, government intervention is necessary to provide guidelines that regulate the transparency of food/dairy quality and safety standards and to avoid market failure caused by the profit-driven nature of business.

As one of our most important findings, the quality assurance of dairy products is the foundation of the dairy supply chain and has direct and strong effects on the competitive advantage of the dairy supply chain. The model results showed that for every 1% increase in dairy quality, the competitive advantage of the dairy supply chain proportionally increased by 0.91 %. The results also showed that other determinants (latent variables), such as government regulation, CSR, dairy production behavior, and dairy cow culture model, affect the competitive advantage of the dairy supply chain by mediating dairy quality assurance. These results emphasize the critical role of dairy quality assurance. Like water without a source or a tree without roots, dairy supply chains will have no future without dairy safety and quality assurance.

(2) Significance of managing milk source supply

Domestic dairy firms in China have developed rapidly over the past two decades. Given that these firms supply dairy products to a large population, potential safety hazards have to be prevented with extreme caution. Our research findings showed that the dairy cow culture model significantly affects the

competitive advantage of the dairy supply chain by fully mediating dairy quality assurance. The full mediated effect of dairy quality assurance implies that the dairy supply chain integration via self-built pastures can prevent quality and safety incidents by controlling the milk source. Ensuring product safety and quality at the upstream dairy supply chain is essential in enhancing the competitive advantage of the dairy supply chain. This relationship is logical given that the information transparency associated with the well-controlled milk source of self-built pastures with guaranteed dairy safety and quality will gain consumer trust. The model results validated that the effective control of the milk source is crucial to assure the quality and safety of milk production. The milk source should receive particular attention to decrease the safety risk of dairy production. However, unlike in New Zealand, Australia, and other countries, most dairy firms in China have lost effective control of the quality of their milk sources because they do not have their own pastures. This condition is the most important lesson that Chinese dairy firms have learned from the 2008 adulterated milk incident. In response to this lesson, some well-known Chinese dairy firms, such as Mengniu, Yili, and Sanyuan, have allocated their strategic management resources to self-built pastures to ensure the quality and safety of their dairy products. The establishing self-built pastures could effectively assure dairy quality and safety through the integration of the upstream dairy supply chain, in turn enhancing the competitive advantage of the dairy supply chain in China.

Our research findings also showed that the dairy cow culture model has a partial mediated effect on supporting the impact of the government regulation and policy on dairy quality assurance. This effect is evidenced by government regulations and policies that impel domestic dairy firms to develop self-built pastures, which integrate and coordinate the dairy production process with the milk source supply and accordingly ensure dairy quality assurance. Moreover, from the alternative view of managerial implication and as evidenced by interviews with dairy firm managers, the interrelations among the partial mediated effect of the dairy cow culture model and government regulation and policy are logical in the sense that, in practice, given the complexity of business interests of different parties in a dairy industry government regulation and policy need to be properly implemented at an acceptable level by societies to balance firms' behaviors, business ethics, and stakeholders' interests.

(3) Importance of perfecting dairy production process

Our research findings showed that in addition to its significant impact on the competitive advantage of the dairy supply chain through the full mediating effects of dairy quality assurance, dairy production

behavior also fully mediates the significant impacts of government regulation and CSR on dairy product safety and quality assurance. The managerial implications of such a relationship are two-fold. On the one hand, embedding a highly functioning quality management system in the dairy production process, which is supported by controlling the milk source, can directly decrease safety risk and quality problems, thus enhancing the competitive advantage of the dairy supply chain. Moreover, this relationship facilitates the implementation of standardized operations and management processes that ensure the safety of the milk supply. On the other hand, we found that the full mediating effect of government regulation and policy on dairy quality through dairy production behavior is unintuitive. However, this finding is significant and logical in a real context. In reality, dairy production activities are governed by regulations and need to comply with safety and quality regulations to ensure dairy product safety and quality.

(4) Role of CSR

We found the nontrivial results showing that between CSR and dairy quality assurance, dairy production behavior has a full mediated effect and the dairy cow culture model has a partial mediated effect. The managerial implications of these relationships are twofold. Dairy firms with a strong sense of CSR often emphasize on providing better product safety and quality assurance through better dairy production behavior through the implementation of a functional quality management and control system, thus gaining consumers' trust and upgrading their brand image. Dairy production behavior is internally controlled with less uncertainty, implying its fully mediating effect on supporting the impact of CSR on dairy quality assurance. Regarding the dairy cow culture model, dairy firms with a stronger awareness of CSR and impelled by government policy are motivated to build self-run pastures that integrate the raw milk supply in the upstream dairy supply chain, thus ensuring dairy product safety and quality. Unlike in the case of dairy production behavior, integrating an externally managed milk source involves coordination between a core dairy firm and multiple raw milk suppliers (dairy farmers), thus involving more uncertainties that influence the coordination process and implying a partial mediated effect in the dairy cow culture model.

(5) Competitive advantage and sustainability of the dairy supply chain

Our findings also indicated that a multilateral collaboration should be conducted to dispel the negative effects of the credit crisis on the domestic dairy industry because of the incident that happened in China. The competitive advantage of the dairy supply chain could only be improved in this way. Research conducted after the 2008 adulterated milk incident in China showed that 93.1% of Chinese mothers

consider imported brands of infant milk powder as more trustworthy than domestic brands, and only 6.9% of Chinese mothers believe that foreign dairy brands are not distinctly different from domestic dairy brands. Unfortunately, almost no one believed that domestic dairy quality is completely safe. Evidence shows that the domestic dairy industry in China is facing a credit crisis; in other words, the brand images of domestic dairy firms have been seriously impaired. The domestic dairy industry faces a complex business environment in which social factors are interconnected with the credit crisis incurred by dairy quality and safety incidents. Another important issue should attract managerial attention: as evidenced by the 2008 adulterated milk incident, dairy quality and safety incidents badly impair product brand image, cause a dramatic loss of consumer trust, and decrease competitive advantage. Even worse, the negative impact of incidents lasts longer than the time needed to regain product quality levels. In addition, businesses require considerably more time to recover than to be established. In short, a multilateral collaboration is required among government agencies, the dairy industry, dairy supply chain firms, the media, consumers, and experts from various fields, among others. Nevertheless, regaining consumer trust requires continuous effort.

Our findings provided implications for business processes of dairy firms, with an emphasis on quality assurance throughout the supply chain. The upstream, midstream, and downstream of the dairy supply chain should be integrated and the collaborative management of dairy quality assurance through coordination among dairy firms should receive special focus to provide mutual benefits to stakeholders and businesses (Dries et al., 2008; Augustin et al., 2013). As our findings revealed, the effects of the identified determinants on the performance of the dairy supply chain are mediated by quality assurance, implying that dairy quality assurance is the foundation of the dairy supply chain. Therefore, quality assurance should be performed throughout the entire dairy chain to improve the competitive advantage of the dairy supply chain. The quality control of raw milk source is a prerequisite for assuring quality controllability throughout all stages of dairy production. Therefore, domestic milk source supplies should be integrated. This suggestion is logical as evidenced, for instance, in the Chinese context. As consistent with observations from reality, our empirical results showed that dairy production behavior fully mediates the impacts of government regulation and CSR on dairy quality assurance. The managerial implication of this relationship is that dairy firms should improve the quality management and control system embedded in the dairy production process to guarantee the quality and safety of their products, thus enhancing their competitive advantage. In

particular, domestic dairy firms whose businesses were affected by the 2008 adulterated milk incident should take responsibility for assuring the quality and safety of their products by perfecting their production behavior. The idea that "Every single dairy product represents the conscience of a dairy company" is a lesson that every dairy firm should learn. To survive and thrive, dairy firms should never cross the moral baseline of social responsibility, ethics, integrity, and conscience, the basic concepts for gaining consumers' trust and restoring their brand image. Moreover, dairy firms should realize that sustainable development should be pursued under the premise of quality and safety and that dairy quality and safety are the central elements that connect consumers with the livelihood of dairy firms.

Exogenous determinants—enforcement and transparency of government regulations and enhancement of CSR—are interrelated on the grounds of setting dairy quality and safety standards and motivating social responsibility awareness. The results of our model showed the important roles of these determinants in assuring the quality and safety of dairy products. On the one hand, the transparency of government regulations is the key to informing consumers about positive messages whenever the government makes public strategies and measurements for implementation upon supervision. Through these information flows, consumers are informed about the due diligence of the government in protecting them against unsafe dairy products and other foods. On the other hand, dairy firms perform their social responsibility in response to governmental regulations; this is reflected in their production behaviors that comply with regulatory standards. These behaviors, in turn, contribute to assuring the quality and safety of dairy products throughout the whole supply chain and help in the recovery of consumer trust. As perceived in reality, quality is the essence that is required depending on the nature of consumers' preferences. To fulfill the safety standard, the rule "high quality asks for high price" is generally accepted. In this sense, the acceptance of product quality level varies in accordance with the various preferences of consumers in a specific target market. Product quality is interconnected with the quality preferences of the target consumers and the capability of the dairy supply chain to satisfy consumer demands, thus reflecting the relative competitive advantage of the dairy supply chain.

In conclusion, as evidenced in China, the assurance of dairy quality and safety is the foundation and prerequisite for the sustainable development and the competitive advantage of the dairy industry. As validated by the model results, the high performance of quality assurance throughout all stages of the dairy chain helps dairy firms gain consumers' trust and enhances risk resistance capability. Additional attention

should also be paid to enhancing the sense of social responsibility of dairy firms. Actively responding to stakeholders through CSR-related activities reflects the social responsibility consciousness of dairy firms and helps obtain long-term benefits. Urged by governmental regulations and media supervision to work hard on improving dairy quality and safety, domestic dairy firms will be able to restore their brand image by regaining consumers' trust by improving their business performance.

Some limitations of this study provide avenues for future research. First, we focused on empirical evidence in the domestic context. To evaluate the effects of business factors on the performance of the dairy supply chain in an international context, future comparative studies could consider differences in cognizing and identifying the determinants of dairy businesses in different countries. Second, conditions and pathways for collaborations among dairy supply chain firms to improve dairy quality assurance and their competitive advantage should be further examined. For example, from the view of the whole supply chain, our study addressed dairy quality associated with milk source from upstream. By explicitly considering consumer trust or brand image as an influencing factor, future studies could extend the model framework to integrate the downstream dairy supply chain to investigate the market impacts of the competitive advantage of the dairy chain.

Appendix: CFA results: descriptive scales, constructive reliability, and convergent validity measures

Latent variables	Questionnaire items	Mean	SD	Loading	Cronbach's alpha	Composite reliability	AVE
Government regulation ξ1 (H1, 1a, and 1b)	Legislation on quality and safety Y1	4.1833	.77645	0.81	0.816	0.8077	0.5838
	Execution of laws on quality and safety Y2	4.2296	.79441	Removed			
	Transparent execution of quality and safety laws Y3	4.2815	.75812	0.73			
	Supportive policy Y4	4.0907	.78680	0.75			
Corporate social responsibility (CSR) ξ2 (H2, 2a, and 2b)	Frequency of dairy safety incidents Y5	4.3926	.71465	0.85	0.825	0.8612	0.6152
	Handling of dairy safety incidents Y6	4.3037	.78697	0.82			
	Commonweal activities Y7	4.2944	.73632	0.88			
	Dairy product safety awareness Y8	3.7704	.97222	0.54			
Dairy production behavior η1 (H3 and 3a)	Milk processing X1	4.2593	.73255	0.82	0.846	0.8205	0.6042
	Control of milk source X2	4.2704	.68481	0.75			
	Safety of the production system X3	4.4759	.66955	0.76			
Dairy cow culture model η2 (H4 and 4a)	Dairy farming scale X4	3.7741	.94695	0.43	0.768	0.6838	0.4317
	Breeding technology and service X5	3.9722	.82264	Removed			
	Dairy farming environment X6	3.8907	.82711	0.75			
	Breeding mechanism X7	4.0259	.81874	0.74			
Dairy quality	Advanced quality management system X8	4.3407	.73836	0.73	0.865	0.8443	0.5766

assurance η3 (H5)	Strict quality control measurement X9	4.3481	.82991	0.78			
	High quality standards X10	4.1741	.88107	0.69			
	Perceivable and continually stable quality level X11	4.3185	.81484	0.83			
Dairy supply chain competitive advantage η4	Brand image X12	4.3741	.68091	0.90	0.888	0.9058	0.6589
	Consumer trust X13	4.3667	.81048	0.84			
	Risk resistance capacity X14	4.2630	.79574	0.76			
	Sustainability X15	4.2481	.79584	0.78			
	Supply chain coordination X16	4.2111	.79255	0.77			