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Information asymmetry, third party certification and the integration of organic food value chain in China

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Abstract

Purpose – The purpose of this paper is to discuss characteristics of organic food value chain governance and policy tools that can increase the supply of good quality of agri-products.
Design/methodology/approach – This paper discusses a national organic food supply system in China, identifying the link between an organization form with a social confidence crisis and information asymmetry as the main challenges. It develops an analytical model of the market structure of organic certification based on the contract theory, which considers the certification incentive driven by both farmers and processors. Two cases of raw milk producers and processors provide empirical data.
Findings – The argument which is brought forward is that product information asymmetry together with strict requirement for ensuring organic food integrity brings the organic milk value chain into a highly integrated organization pattern. A tight value chain is effective in the governance of organic food supply chain under third party certification (TPC), while a loose value chain discourages producing organic products because of transaction costs. TPC is found to be a positively correlation with a tight value chain, but it brings high organizational cost and it raises cost for consumers.
Originality/value – This is the first paper discussing the governance of organic food value chain in Chinese milk industry.

Keywords Organic food, Information asymmetry, Third party certification, Integration of value chain, Milk

Paper type Research paper

1. Introduction

This paper discusses organic food supply system in China by using the example of certified organic milk. It applies a mixed method approach: it presents a brief review of the Chinese organic certification standards and major trends in organic market competition using a new analytical framework, which is then tested against the empirical data from two milk producers from the Inner Mongolia and the Beijing area.

Since the late 2000s the demand for organic food in China has rapidly increased, many agri-companies consider moving into the organic food market. According to the Certification

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and Accreditation Administration of the People's Republic of China (CNCA), the number of issued organic certificates has increased from 2,688 in 2008 to 9,957 by the end of 2013 (Certification and Accreditation Administration of the People's Republic of China, 2014).

Within this fast development, the organic food value chain has become highly integrated, which is quite a different case from conventional food value chains in China. For example, according to CNCA, by the year of 2015, there were 32 dairy processing companies certificated in organic dairy industry producing 560,604.98 tons milk[1]. Among these 32 dairy processing companies, 27 have chosen a vertical integration model of production and built their own farms to produce raw milk, accounting for 84 percent of the organizational structure. The 32 dairy processing companies owned 70 processing factories and 61 of these factories use raw milk, which is produced within the production, accounting for 87 percent of the organizational structure.

As a result, the certified output of the vertically integrated companies was 97 percent of the total output. These data show that the organic milk industry in the third party certification (TPC) system has a high level of vertical integration.

In contrast, the level of vertical integration in the conventional dairy industry has increased by only 1 percent from 2010 to 2012, and it reached 24 percent degree of the integration based on the calculation of the share of main business income (Ye *et al.*, 2015), which is much lower than the vertical integration level in the organic milk industry.

According to the surveys conducted by the authors[2], a similar level of integration can also be found in the Chinese organic tea and organic wheat industries. Such observations raise the questions to explore – why the whole organic food industry is so highly integrated; and what difference lies between organic food and conventional food; and which factors make the organic food industry so different. This paper aims at explaining such difference, using the example of the organic dairy industry in China. This, in its turn, can be useful for understanding how to improve the quality of the food supply in the country, which was shaken by a major trust crisis from the melamine scandal in 2008.

2. Review of Chinese organic certification and competition in the Chinese organic market

2.1 Organic food in China: standards and certification system

2.1.1 Organic food standards. Chinese organic food adheres to the strictest national food standards (Sheng *et al.*, 2009). The state is seeking to achieve zero use of synthetic chemical inputs and genetically modified organisms by setting stringent food quality standards in response to both environmental and socio-economic issues (Guo *et al.*, 2010; Scott *et al.*, 2014). Historically, China began considering this policy option in the 1980s. The country started putting limits on chemical inputs into food production and then moved to the "closer to zero" policy in the 1990s, which was exemplified in "green food" and "hazard free food" labeling programs and which focused on residue testing and inspections. Based on the "path to zero" policy, which particularly aimed at its agricultural export, China developed its own national organic food product standards and started to align them with the international standards. In March 2012, CNCA revised its organic standards and introduced stricter regulations. These standards are summarized in Table I.

2.1.2 Organic food certification system. Organic food has a distinct character from an ordinary product. Any company that produces organic food in China must be certificated by a third party accepted by CNCA, according to the organic food standards. Information asymmetry exists in the Chinese organic food market as the process of production cannot be observed directly. Under such conditions of imperfect information, quality becomes a market tool for differentiating products and improving competitiveness (Caswell *et al.*, 1998) as well as addressing the risk that a supply chain may fail to provide safe food in the market (Grunert, 2005). Thus, in the organic food market a TPC plays a vital role in reducing information

	Organic food	Green food		Hazard-free food
Year established	2005 (national standards established time)	1990		2001
	\	AA	A	\
Permits genetically modified organisms	No	No	Yes	Yes
Permits synthetic fertilizer and pesticides	No	No (the requirement of AA green food and organic food is quite similar)	Yes (only some kinds of chemical applications are permitted and amounts are regulated)	Yes (a wide range of agro-chemicals are allowed than for green food)
Residue testing	Yes	Yes		Yes
Initial force	Market(demand driven)	Government and market		Government
Administration	Certification and Accreditation Administration of the People's Republic of China	Green Food Development Centre (agent of Ministry of Agriculture)		Center for Agri-Food Quality and Safety(agent of Ministry of Agriculture)
Costs	RMB 20–40,000 (before new regulations in 2012)	RMB 10,000		No certification free
Traceability	Yes	No		No
Period of validity (year)	1	3		3

Table I.
Comparison of organic agriculture, green food and hazard-free food in China

asymmetry and increasing signaling (Klonsky, 2000; Luanne, 1998). TPC supervises the process, monitors the credibility of organic producers, and releases that information to the public. It can also guide producers on managing quality control. In this way, certification together with national food standards also informs consumers (Roosen, 2003; Dou *et al.*, 2015). The process of organic food certification can enhance consumers trust (see Figure 1).

However, trust building and operation of the certification regime implies high costs for the state authorities, such as CNCA, as well as for TPC agencies[3] who have to pay for their accreditation to CNCA. The organic industry also relies on the certification regime: unless TPC organizations follow the regulations required, or enough applicants can pass the strict inspection, the development of the organic industry can also be affected (Shanghai Quality Management Science Research Institute, 2008; Fan, 2007).

2.2 The structure of the dairy industry in China and the melamine scandal

In 2008, the melamine scandal brought a big shock to Chinese consumers and raised consciousness about food safety. The scandal revealed low food safety control practices (Xiu and Klein, 2010). The Chinese dairy industry experienced a rapid integration leading to the establishment of mega dairy processing companies with the most advanced methods in their dairy operations. In 2007, the top four dairy companies in China produced and sold nearly half of all milk and milk products in China (Xiu and Klein, 2010). China's dairy production has surged from just 10 million metric tons in 2001 to a level of nearly 39 million metric tons in 2009. However, Chinese farmers, the raw milk producers, are not keeping up with processing companies.

The Chinese dairy industry consists of a large number of small-scale dairy farmers (subsistence farmers) and milk collection stations, which are not integrated in the supply

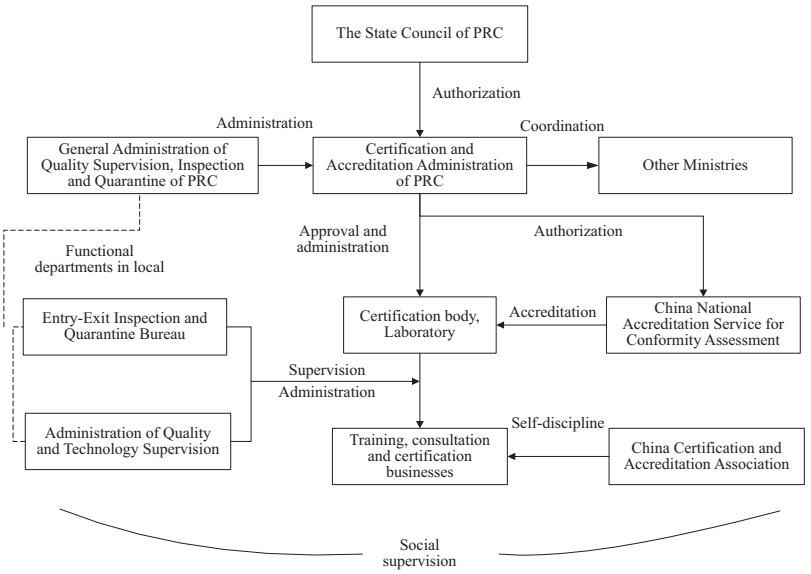

Figure 1.
The system of Chinese supervision and control of organic food certification

chain (Zhang and Aramyan, 2009). The lack of communication with farmer cooperatives is most possibly the root of the food safety problem and also makes farmers vulnerable to external shocks (Wen, 2009). Due to the financial risk in 2008 in the WTO's open market coupled with the lower price of international raw milk and the fast growth of domestically raw milk (150 percent increase from 2003 to 2006) brought a heavy loss to the Chinese smallholder farmers. To make things worse, animal feed prices in China went up after 2008 (Wen, 2009). Many farmers had to switch to cheap alternative feed to low down production costs. Melamine which raised the safety concerns in 2008 served an alternative to protein for its high content of nitrogen and low price (Sharma and Paradakar, 2010).

Following the 2008 melamine scandal, the Chinese Government instituted two main policy countermeasures against milk contamination: banning small-scale household production, and eliminating private milk collection stations (Zhong *et al.*, 2013). The market has also taken actions. After the melamine scandal, consumers were concerned with the food safety of milk (Zhou and Wang, 2011). The Organic food market has experienced fast growth after 2008 in response to this issue. This development of organic milk changes the conventional value chain, and the relationship between consumers and farmers is also under transformation.

2.3 Competition in organic market

2.3.1 Smallholder farms vs Dragon enterprises. Although the certificated organic milk market developed fast after 2008, organic certification is an expensive and bureaucratic process, which has already excluded small farmers. Furthermore, strict standards also marginalized small producers against large producers and subsidiaries of multinationals operating in developing countries are better equipped to adapt to more stringent certification requirements (Dolan and Humphrey, 2000; Anna, 2015; Van, 2006; Abdelhakim *et al.*, 2009).

Smallholder farmers were criticized for producing safe food for self-use, but selling unsafe food for the market (Zhou and Fang, 2015). They tried to improve crop yields by applying higher levels of pesticides, which created further asymmetry in the market and contributed to a food safety crisis (Veeck *et al.*, 2010). Organic market certification can address this asymmetry under certain conditions.

It can be contrasted with the experience in the USA, which organic food system is arguably more discursively rich and democratically controlled by the market and more open to smallholder farms (Nowacek and Nowacek, 2008). Some Chinese scholars, such as Shi, argue that the development of an agriculture based on asocio-ecological approach, such as Community Supported Agriculture (CSAs)[4] might be helpful (Shi, 2012). Rather than buying certified organic or green food from supermarkets, consumers have established direct marketing links with uncertified producers. Through such links, consumers and producers get closer both geographically and socially (Feagan, 2007). Consumers' participation in local markets builds trust relationship with producers (Brodt *et al.*, 2006).

2.3.2 Food value chain dominated by central enterprises. The policy choice of the Chinese government for maintaining high agricultural output and high quality food production is based upon supporting "modern," large-scale, consolidated enterprises. These are private or state-owned enterprises, which process, manufacture and market agricultural products on a large scale with high economic benefits (high profits and low debt ratio), a strong local economic capacity (integrated production–manufacturing–marketing chain with a large number of contracted farmers, a large scale of production bases), and a solid market competency (sound marketing channels and predominant status within the sector). Agricultural produce and processed food products supplied by these enterprises account for one-third of the entire food market and more than two-thirds of the vegetables in major cities, producing more than 80 percent of China's food exports. The so-called dragon-head enterprises supported by the government are also encouraged to certify their products as hazard-free, green, organic and geographical indication products.

How they make their choice of organizational structure becomes important. There are three models of relational contracts (Nie, 2013). "Farmers in market" is the first model under one period. The second model, "leading firms plus farmers," is a relational contract under one or multiple periods, which can be affected by reputation in a repeated game. The third model, "leading firm plus farm," is a vertically integrated model under multiple periods. The first model is called a commodity contract. Firms buy products from farmers in the market. The second model is based on a hybrid strategy (Williamson, 1991). The third model is called factors contract which stands for a vertical organization. Leading firms allocate farmers' land and labor (Coase, 1937; Zhou and Cao, 2002). Peterson *et al.* (2001) presents the vertical coordination continuum as five distinct groups of strategy, such as spot markets, specification contracts, relation-based alliances, equity-based alliances and vertical integration.

The organizational structure of agricultural products is essentially a contract among farmers, leading firms and intermediary organizations. However, the contract in an agricultural organization is incomplete due to complex reasons such as the uncertainty of a long production cycle, uncontrollable climate change, difficulty to standardize shape and nutrition content and the fluctuation of prices (Williamson, 1991; Li and Xue, 2012). Thus, the contracting parties can hardly cover all the uncertainty into a contract. An incomplete contract will promote a change of organization, which means a different distribution of the right of residual claimant between processors and farmers (Alchian and Demsetz, 1972). The size of leading firms, price fluctuations in raw agricultural products and food safety issues affect choices made by leading firms (Jia and Pu, 2010). Hennessy (1996) finds that information externalities arising from uncertainty concerning the nature of food quality and problems in detecting quality issues may be the reason why a vertical coordination is being used to circumvent the market place. Nie (2013) compares allocation efficiency of the three contracts. Under one-period contracts only few models can achieve the first-best efficiency due to contractual completeness and delays. Under relational contracts, there can be a "leading firm plus farmers" and a "leading firm plus farms" models, which can achieve the first-best efficiency. However, if market prices are fluctuating, a

"leading firm plus farms" option is better than a "leading firm plus farmers" one. In brief, a leading firm will change its strategy according to the institutional environment and make the optimal decision.

It has been argued that the integrated organization has a positive influence on management of food safety. Cooperatives play an essential role in food safety management of the fresh produce chains (Kirezieva *et al.*, 2016; Jin and Zhou, 2011). Jin and Zhou (2011) suggested that the Chinese agricultural cooperatives often adopt a higher food safety and quality standard. Thus, agricultural cooperatives can play an important role to improve food safety. Zhong *et al.* (2013) used the data collected from 396 households in Inner Mongolia and found that both production pattern and transaction style have significantly affected the quality of raw milk. The production pattern has a more significant effect on raw milk nutrition, while the transaction style has a more significant effect on the safety of raw milk. Wang, Xiong, Qu and Chen (2015) and Wang, Si, Ng and Scott (2015) applied a computer simulation based on Net-logo and found that the organizational structure's evolution of the supply chain can improve quality and safety of agricultural products. There are also other advantages of such integrated organization as vertically integrated companies will always produce in a large-scale pattern. Such a company will not only be good at taking advantage of capital and technology, but also at dividing the work and cooperation and, in this way, producing standard and safety products. Vertical and horizontal integration of smallholder farmers into traditional agricultural value chain activities is positive in enhancing food security and improving livelihoods (Kissoly *et al.*, 2017). Banterle and Stranieri (2008) researched the relationship between a voluntary traceability system in food organization and integration and find that firms that adopted a voluntary certification system appear to be more vertically integrated, as they want to protect their reputation and brand.

However, a large-scale industry and vertical integration can also bring problems relating to high monitoring costs with the transfer of ownership (Hansmann, 1988; Grossman and Hart, 1986). The gain from economies of scale and innovations are most likely overshadowed by costs of ownership, such as supervising hired labor in agricultural production (Lin, 1990; Ni and Cai, 2015). As the efficiency analysis not only considers t the transaction cost but also the cost of ownership, the vertically integrated organization is at last a result of trade-offs. It will appear diversity models of governance or hybrid strategy in the trade-off process.

In the next part this paper will develop an analytical framework based on three kind of market structure to explain why the integrated phenomenon happened in the organic food value chain.

3. Framework: the market structure of organic certification

3.1 Assumption

First, we assume that a raw product must be processed, otherwise, it cannot go into the market. For example, raw milk must be sent to a factory and be processed within a short period of time.

Second, information asymmetry exists between processors and producers. The quality attributes for food products are divided into food safety attributes, nutrition attributes, value attributes, package attributes and process attributes (Caswell, 1998). In the milk industry, the two most important attributes are identified as food safety attributes, such as food-borne pathogens, heavy metals, pesticide residues, food additives and veterinary residues, and nutrition attributes, such as fat content, protein content, minerals and vitamins (Zhong *et al.*, 2013). The national mandatory standard of raw milk in China (GB19301, 2010) sets the requirement of quality, including six aspects: sensory requirement, physical and chemical indicators, the maximum allowable amounts of contaminants, the maximum level of mycotoxins,

microbes, pesticide residues and veterinary residues. This mandatory standard mainly includes food safety attributes and nutrition attributes that are relatively easy to detect. Organic food is a voluntary certification product, which means that non-organic producers do not need to consider the requirement of organic food standards. Organic food production not only considers the requirement of the national mandatory standard but also addresses other attributes of food such as animal welfare and the use of biotechnology and pesticides. Organic food integrity[5] is the most important index which is used to evaluate the qualification of applicants and is based on the intention to hold an entire food supply chain accountable for the provision of food authenticity in food markets (Wang *et al.*, 2017). Thus, the key characteristic of organic production is process management, which is different from product management. However, quality attributes emphasized by organic food are difficult to test, which means that information asymmetry is high.

Third, a TPC can be effective in improving the share of good quality products and in transferring information and balancing information symmetry as shown in Figure 2.

3.2 Three types of market structures

Three types of market structures are based on the classification by Nie (2013) (i.e. "farmers in market," "leading firm plus farm" and "leading firms plus farmers"). In the market structures, organic food certification can be driven by both farmers and processors (see Figure 3). For the model driven by farmers, it is a "Farmers in market." Processors and farmers make a commodity contract, which means the farmers sell their certificated products to processors. They can build a long-term contract to consolidate their relationship and increase confidence in each other.

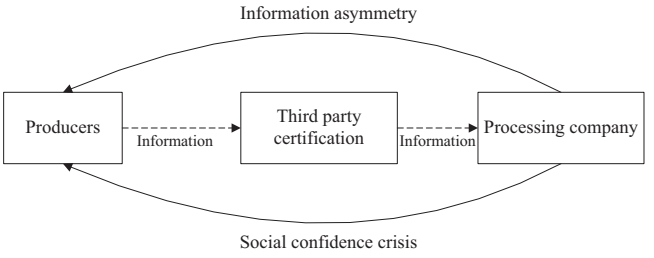

Figure 2.
Market plus third party governance under social confidence crisis

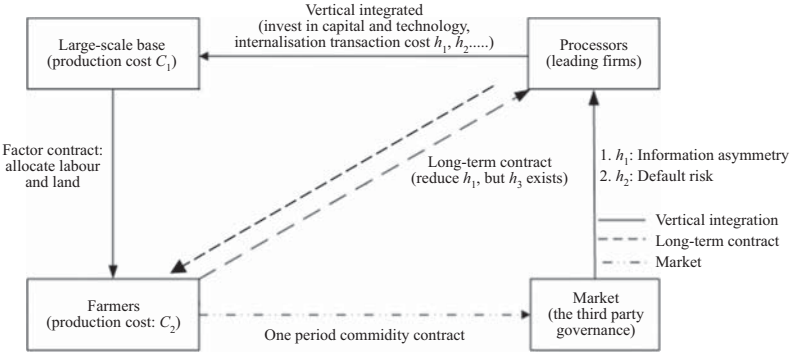

Figure 3.
A general agricultural industry organization model

The other models are driven by processors. Processors have two different choices in producing organic raw milk. First, in the "leading firm plus farm" model, they can choose a factor contract and build their own bases and hire labors to produce organic product. Second, in the "leading firms plus farmers" model, which is also a commodity contract, the relationship is much closer than in the "Farmers in market" model. In this model, processors can give farmers assistance, such as providing credit and guidance on required organic producing standards. We will discuss the difference between certification in "farmers in market" and "leading firm plus farm" model, in relation to "leading firms plus farmers," which is a hybrid strategy.

3.3 Certification driven by farmers in the outsourcing market

In this model, we are considering two types of transaction costs[6] in the market. If the cost cannot be efficiently solved, the market mechanism will fail and bad products will be derived out of good products (Akerlof, 1970). As a result, the market is in shortage of high quality products. We will discuss how the reverse encouragement can be caused by these two kinds of transaction costs.

3.3.1 Information asymmetry, uncertainty and test failure. In the example of two types of farms, A and B, A complies with high quality standards and achieves a certification, while B adheres to a lower quality standard and cannot be certificated. As a result, firms that comply with a high quality standard may produce some low-grade products. The share of low-grade output in the total output for the certified firm, denoted by t_a, is less than t_b, which is the share of a low-grade output in the total output for an uncertified firm. r is the share of the total producers that do not choose to comply with high quality standards. The share of total product of a good quality is $m_0 = (1-t_b)r+(1-t_a)(1-r)$.

In the agricultural industry chain, farmers sell their raw products to processors. Let's consider a food processor that does not observe farm-level decisions, but only the product at its factory intake. Assume the processing industry is perfectly competitive. The processor tests all products at the intake point, but, because of sampling, the limitations of non-destructive testing, and cost considerations, the tests are not completely accurate. According to statistics, there are two types of statistical errors: a share u_1 of high-grade products is identified as low grade by a minus on the test, $0 \leqslant u_1 \leqslant 1$; and a share $1-u_2$ of low-grade products is identified as high grade by a plus score on the test, $0 \leqslant u_2 \leqslant 1$. From Bayes's theorem, two equations are conducted as follows: the probability of a product of a high grade being given a quality test failure can be calculated as $\pi_1 = (u_1 \times m_0)/(u_1 \times m_0 + u_2 \times (1 - m_0))$, $0 \leqslant \pi_1 \leqslant 1$; and the probability of a product of a high grade given a quality test pass can be calculated as $\pi_2 = ((1-u_1)\times m_0)/((1-u_1)\times m_0+(1-u_2)\times(1-m_0))$, $0 \leqslant \pi_2 \leqslant 1$.

The willingness of processors to pay for a high quality is different from the demand in low quality products. Let p be the value of high quality product to the processor, while $p-\delta$ is the value of low quality product. Usually, consumers' willingness to pay for organic food is higher than that for conventional food or even hazard-free and green food (Yin *et al.*, 2017). Processors can only pay according to the results of the test. The price for a product passing the test is P_1 and the price for the one that does not pass the test is P_2. P_1 and P_2 are not consistent with P and $p-\delta$ because of the existence of statistical errors. When quality is not certain, the paid price is considered to be a probability-weighted interpolation between p and $p-\delta$. Thus, $P_1 = p\pi_2 + (p-\delta)(1-\pi_2)$ and $P_2 = p\pi_1 + (p-\delta)(1-\pi_1)$.

The quality detection failures can distort production incentives. The farm that applies high quality standard receives P_1 on the share $\omega_a = (1-t_a)(1-u_1) + t_a(1-u_2)$ of output, and P_2 on the share$1-\omega_a$ of output. Thus, the average price received by the farm A is $P_A = P_1\omega_a+P_2(1-\omega_a)$. If the information is complete, then $P_A = p-\delta t_a$. Similarly, it is found that an uncertified producer receives the average price $P_B = P_1\omega_b+P_2(1-\omega_b)$, where $\omega_b = (1-t_b)(1-u_1)+t_b(1-u_2)$. If the information is complete, then $P_B = p-\delta t_b$. The average

revenue of A is $E_A = P_A - C_A$, while the average revenue of B is $E_B = P_B - C_B$. The farm will comply with higher standards if the investment increases profits (i.e. $I_1 = E_A - E_B > 0$). If the reverse inequality holds, it will refrain from this kind of investment. Substituting equations gives the condition for investing as $I_1 = t_b - t_a(u_2 - u_1)(\pi_2 - \pi_1)\delta - (C_A - C_B)$, where $x = (u_2 - u_1)(\pi_2 - \pi_1)$ is the precise level and $t_b - t_a\delta$ is the value of marginal product. $z = (C_A - C_B)$ means the cost of investment per capital unit output. If $x = 1$, the information will be complete; if $0 < x < 1$, the test will not provide complete information.

Condition one: $dI_1/dx = (t_b - t_a)\ \delta > 0$, where $t_b - t_a > 0$. Imperfect information causes the market to insufficiently compensate for the certified farm in relation to uncertified ones. When the test is informative, the farm receives some compensation for the outlay through an increase in average price received. When the test provides no information, the investing farm receives no reward for its outlay.

Condition two: $dI_1/d\delta = x(t_b - t_a) > 0$, where $t_b - t_a > 0$. So, I_1 increases with δ. If the value of a high quality product is higher than a low quality one, producers will have more incentives to comply with high quality standards.

Condition three: $dI_1/dz = -1$. So, I_1 decreases with z. If the cost gap between A and B is bigger, then producers will have less incentive to comply with high quality standards and will invest less.

3.3.2 Asset specificity and default risk. Asset specificity is consistent with production costs, $\alpha = g(C)$, where α stands for asset specificity and C is production costs, which may increase for organic certificated producers. Certified producers must follow strict rules and invest more than conventional producers. For example, they spend three years on converting their farm from conventional agriculture into organic agriculture and in building a documentary sanitary management system. If a certified farm makes a much more specific investment, it will be held up more easily by processors than the farm which is not certified (Williamson, 1985). The instability of the contract will discourage producers to produce high quality products. In most agri- products market, traders and processing enterprises often show substantial market power (Kopp and Brümmer, 2017). Similarly, the raw milk production regions in China are usually departed and monopolized by one or two local processing enterprises. The existence of the holdup problem and the lack of pricing power of small farmers often discourage the farmers themselves to invest in producing high quality food and results in the shortage of high quality food (Hu, 2013).

According to the analysis of the previous section, if the contract is stable, the average price received by farm A and B is $P_A = P_1\omega_a + P_2(1-\omega_a)$ and $P_B = P_1\omega_b + P_2(1-\omega_b)$, respectively. Let's assume that there exists a default risk for farm A and the defaulting probability of processors is α, where $0 < \alpha < 1$.The processors can holdup A with the expected price of farm B. So, the average revenue of A will change with α, thus $E_A = (1-\alpha)P_A + \alpha P_B - C_A$. While the average revenue of B remains $E_B = P_B - C_B$. The farm will apply higher standards if the investment increases profits (i.e. $E_A > E_B$). Let $I_2 = E_A - E_B$. Substituting equations into it gives the condition for investment as $I_2 = (1-\alpha)t_b - t_a(u_2 - u_1)(\pi_2 - \pi_1)\delta - (C_A - C_B)$. In order to simplify the complexity of the analysis, let the information be complete (i.e. $\max\{x\} = 1$ and $I_2 = (1-\alpha)$ $t_b - t_a\delta - (C_A - C_B)$). As $\alpha = f(C)$, $g(C_A) > 0$. $I_2 = (1 - g(C_A))t_b - t_a\delta - (C_A - C_B)$:

$$\frac{dI_2}{dC_A} = -g'(C_A))(t_b - t_a)\delta - 1 < 0.$$

So, I_2 decreases with α and C. The producers do not have the encouragement to comply with high quality standards if the default risk is high. That means that if organic certification requires a more specific investment, producers will be discouraged from investing and underinvest in the certification.

3.4 Certification driven by vertically integrated firms

The rule for integrated firms to invest in organic certification is $t_b - t_a\delta > Z$. Their decision will not be distorted by the failure of a quality test $(u_2-u_1)(\pi_2-\pi_1)$. Vertical integration solves the problem because the firms do not need a quality test as they are renting land, hiring laborers and internalizing and controlling risk factors. This is the Coase (1937) solution to an externality (i.e. internalize it). Thus, $t_b - t_a\delta[1-(u_2-u_1)(\pi_2-\pi_1)]$ is the increase in surplus that would occur upon moving from a non-integrated industry to a vertically integrated industry. Vertical integration can also internalize the transaction costs of default. Thus, the surplus from moving from a non-integrated industry to a vertically integrated industry will increase by $t_b - t_a\delta[1-(u_2-u_1)(\pi_2-\pi_1)(1-a)]$.

3.5 Organizational cost of three structures

3.5.1 Vertical integration and high cost of ownership. While the integration internalizes all the transaction costs and enjoys the surplus from that, it has to face the rising cost of ownership including renting land, hiring labor and supervising and monitoring the production process as well as the cost of residual sharing risk (Hansmann, 1988). It must provide a model of organization (the bureaucracy model) and technologies (the information technology) that facilitates production on a large scale (Eswaran and Kotwal, 1986). If the increase in cost of ownership V becomes larger than the decrease in transaction cost, the organization will not work well and probably degrade into a hybrid contract, like outsourcing (Hansmann, 1988). Thus, the integration will appear as $t_b - t_a\delta[1-(u_2-u_1)(\pi_2-\pi_1)(1-a)] - V > 0$.

3.5.2 The outsourcing of "farmer in the market". When processors buy products from certified farmers through the market, they can choose to pay average prices. It takes the least cost of ownership, but also affects the risk of transaction cost. First, farmers have no encouragement to produce certificated organic milk under the condition of lack of an efficient quality detecting technology. As a result, processor cannot get a stable supply of raw organic milk, which means h_2 remains high. Second, big companies want to protect their reputation and address the risk of invalidity of the role of the TPC[7] and communicate information asymmetry and issues of consumers' trust to the certification authority, which plays a substitute role for the quality detecting technology, especially after the Chinese food market fell into a confidence crisis in the past years (Wang, Xiong, Qu and Chen, 2015; Wang, Si, Ng and Scott, 2015; Nie *et al.*, 2018).

3.5.3 Farming contract (rational outsourcing). Processors and producers can create a long-term contract to keep business stable. This rational outsourcing is different from spot outsourcing. Based on the third party governance, the long-term contract can further reduce information asymmetry through participating in the process of production, especially when the use of input is controlled. However, there is still a default risk from farmers. As the investment is paid by processors, farmers have the incentive to default, especially in a one period contract. Once the contract price is higher than the market price, farmers can sell their product to other processors (it is based on the condition that there are other buyers in the market.). Otherwise, processors have to pay a higher price to farmers.

3.5.4 Comparison of different organizations. The equation of organizational cost is $f = V + (h_1+h_2)$ where h_1 is the transaction cost of information asymmetry and h_2 is the transaction cost of default. Let y stand for organization structures in the agricultural industry: "Farmers in market," "leading firm plus farm" and "leading firms plus farmers" (Table II). Then the relationship between organization cost and structure is $f = F(y). = V(y) + [h_1(y) + h_2(y)]$.

Proposition. Information asymmetry caused by the nature of food quality, together with the requirement to protect organic food integrity, will result in a vertically integrated organizational governance, distinguished from the non-organic food value chains.

Deduction. A hybrid strategy exists in the organic food market affected by the trade-off between increasing organizational costs and decreasing transactional costs.

4. Empirical analysis – evidence from organic milk industry

The case study method is used to test the suggested proposition: "Information asymmetry caused by the nature of food quality, together with the requirement to protect organic food integrity, will result in a vertically integrated organizational governance, distinguished from the non-organic food value chains." We collected two case studies from different parts of China where organic milk value chains are developed, such as the Beijing area and Inner Mongolia. We use two actors in the analysis: a farmer and a processor.

4.1 The case M – a whole process quality management company (Yala et al., 2014; Jiping and Jiang, 2014)

The company M now is the biggest organic milk producer in China, which was set up in the year of 2009 in the Inner Mongolia province after the melamine milk scandal of 2008. The top manager of M has put it as, "it is hard to test the quality of the raw milk produced by scattered small dairy farmers, and you will never know whether they use the input forbidden by the rules or not." As it is hard to control farmers, M has built a big farm plant and employs farm workers to work on the dairy farm to produce raw milk according to the quality standard set by the company. In the contract with farmers, M pays salaries to farmers and gets a high quality and standardized products rather than buying what is produced according to different standards by small farmers in the competing market.

In 2011 M received an organic food certificate from the China Organic Food Certification Center and ECOCERT China, which allows its products to enter into the terminal market, such as supermarkets, as certified organic food. Before, M used to produce only raw milk. Now M is an integrational company, which runs the whole process of quality management and is completely vertically integrated. In the upstream, they plant silage corn and produce feed products themselves. The raw milk produced by M reached 94,200 tons, making up 54 percent in the organic raw milk market in 2014 in China. M also sells raw milk to other processors in the dairy industry, such as the Inner Mongolia Mengniu Dairy Group, which is the second largest processor in dairy industry in China.

In the downstream, M has built raw-milk processing plants and produces processed milk. In the whole process, M controls the quality of all inputs, inspects all the risk sectors with well-equipped monitoring aids, and gives their workers a high incentive. To achieve the integrity of raw organic milk, M had to implement inspections to the daily practice of its every producing sector in order to meet the national organic food standards and insure the

Num	Model	h_1	h_2	V	Main problem
Model1	"Farmers in market"	+++	+++	+	h
Model2	"leading firm plus farmers"	++	+++	++	h or V
Model3	"leading firm plus farm"	+	+	+++	V

Table II. Comparison of the organizational cost of the three models

Notes: h_1 and h_2 stands for the transaction cost caused by information asymmetry and investing specifical asset to produce organic food, respectively; V stands for the cost of ownership under each model. "+++," "++" and "+" show high cost, medium cost and low cost, respectively

integrity of organic milk they produce. As a result, the certificate brings much more monitoring cost in addition to the certificate's cost itself.

The quality is well controlled and the high organizational cost is compensated by a considerable market profit. As M is recognized by customers for high quality, the price of both raw and processed milk produced by M is much higher than the one for ordinary milk and brings a considerable profit. The revenue of M has increased rapidly, from 1.44bn yuan in 2013 to 2.13bn yuan in 2014. The increasing rate of revenue growth is 86.4 percent in one year. The sales in the terminal market of M reached up to 69 percent of the whole market in 2014. In July 2014, M has successfully become a listed company in Hong Kong.

4.2 The case F – a raw milk producer in Yanqing county (Jiang, 2014; Yala and Jiang, 2014)

F is located in Yanqing County in the north side of Beijing. It has been raising dairy cattle for 11 years before it was certificated in 2013 as an organic milk producer by the China Quality Certification Centre (CQC). Yanqing local government decided to promote the county as an eco-tourist destination and also saw a benefit to support organic food certification.

There are only two raw milk producers with the organic food certification by CQC in Yanqing County. F is one of them. The size of its farm is 80 acres, and 500 cows are certified. The producing ability is 1,800 tons of raw milk per year. As a certificated organic milk producer, most of its milk is sold to the Inner Mongolia Yili Industrial Group, which is the largest processor in the dairy industry of China. However, the milk can only be processed through a non-organic milk plant and sold to the terminal market as non-organic milk while the organic processed milk produced by Yili must procure the raw milk from its own farm. As a result, the price of the raw milk produced by F cannot distinguish itself from non-organic milk. The price is based mainly on the content level of protein and fat, independent from the organic certificate, due to the absence of a quality detection technology to identify organic milk. It indicates that TPC is not valid enough to solve the information asymmetry problem even under such beneficial conditions as the support of the Yanqing local government.

Under the difficulty of getting recognition in the competitive market, F finds another way to sell its products to the local market, by building confidence with consumers directly. F attracts consumers to visit the farm and taste their fresh milk. F also sells their products with simple processing through building its own shop in the county or opening a restaurant upon obtaining a special hygiene license and marketing it in Beijing. F can get a higher profit in this way, but it is difficult to expand its market, and its sales volume tends to stay low in the local market.

In addition, the production costs rise rapidly. Under the CQC inspection, F pays efforts to meet strict national organic food standards. As a result, in addition to the expensive certificate fee (32,000 yuan a year), additional monitoring cost is paid by F. F's general manager says: "It is costly to produce organic milk." As a result, F's profit is relatively lower than the conventional milk producers of same scale in Yanqing, and F decided not to apply for an organic certificate in 2016. F has indeed given up its organic certification in 2017.

4.3 Results

F represents "Farmers in market" type of organization. Even with the TPC, it still faces a lot of transaction cost. For example, its organic product is hard to be distinguished from conventional product and cannot achieve a higher market price than non-organic producers. It is almost the same at 3.4 yuan/kg and the minor premium price difference comes from the higher content of protein and fat. Furthermore, it invests specific asset to produce organic

milk, and processing enterprise sometimes defaults. The certification fee combined with minor premium price has led to the failure of F's practice in the organic business.

M is a "leading firm plus farm" and it internalizes the transaction cost $t_b - t_a\delta\,[1-(u_2-u_1)(\pi_2-\pi_1)\,(1-a)]$ faced by F. Its integration solves the information asymmetry more efficiently than TPC. M gains a premium price over conventional product, a much higher price than small farmers F, almost 5.0 yuan/kg. The good revenue from producing and selling high priced products gives M the incentive to comply with high quality standards and produce organic milk in the long term.

By comparing M and F, one can argue that it is information asymmetry that brings the organization into a high integrated pattern, and a tight value chain promotes good cooperation between farmers and processors and promotes more high quality products, while a loose value chain discourages farmers from producing high quality products because of transaction costs caused by information asymmetry and less compensation. At the same time, the highly integrated value chain takes high organizational costs and means higher prices for consumers (Table III).

5. Conclusions

Information asymmetry resulting from the nature of food quality provides serious implications to consider additional measures to protect organic food integrity in organic food production. This explains why organizational governance of the organic food industry in China is different from the conventional food industry and eventually will be vertically integrated. A tight value chain is good at managing the transaction cost caused by information asymmetry and producing high quality products, while a loose value chain will always fails even if there exists a certification system promoted by government.

A vertically integrated company has the capacity to internalize transaction costs and reduce risks. However, it may not be the optimal organizational structure since it may increase the production costs involved in supervision and monitoring, also company may struggle to survive under such high organizational costs.

Thus, the key to solving the shortage of high quality food lies in eliminating information asymmetry caused by the nature of food quality. TPC has such a function to reduce information asymmetry. If the certification authority can exploit its advantage to the fullest, it will reduce companies' organizational costs and replace the structure of vertically integrated organizations. What's more, the value chain will be more inclusive for farmers, and it will also benefit consumers (Fan *et al.*, 2017). However, the operation of TPC now is expensive, and the integration of the organic milk industry indicates that the function of TPC in reducing information asymmetry is limited. It brings high organizational costs for producers and, as a result, excludes small farmers from organic certification.

Table III. Comparison of the organic business of F and M under third party certification

Case	Model	h_1	V	Price	Third party certification	Willingness to certificate in the future
F	"Farmers in market"	+++	+	3.4 yuan/kg	Yes	No
M	"leading firm plus farm"	+	+++	5.0 yuan/kg	Yes	Yes

Notes: F and M are both located in northern production area in China. And the selling price of M and F are all collected in the in the autumn of 2015 to compare the two cases in a reasonable way. h_1 stands for the transaction cost caused by information asymmetry. V stands for the cost of ownership under each model. "+++," "++" and "+" show high cost, medium cost and low cost, respectively

Notes

1. Milk products consist of UHT milk, pasteurized milk, acidified milk and milk powder.
2. We conducted surveys on several organic products that need processing, such as milk, green tea and wheat in 2015–2017.
3. There are a total of 23 organic certification bodies and 25 organic certification consultant agencies which are accredited by CNCA.
4. CSAs are different from the Western equivalents in important ways. Most Chinese CSAs operate more closely to a dominant market approach, with producers as entrepreneurs taking the risk, consumers dictating choices, and market-based price setting. Consumers' participating in these schemes are largely concerned about protecting their own health, or merely being trendy by buying organic or green food.
5. Rules define the meaning of organic integrity (organic food standard, GB/T19630.2, 2011). All organic processing and related processes referred to in this part shall be effectively controlled to maintain the integrity of organic processing: ingredients used in product processing shall be certified organic materials, natural products or materials that are allowed by a certification body; organic products should not damage the main nutritional elements (i.e. the organic and non-organic product should be isolated in space or time) and any element in the chain that fails to observe the rules may be regarded as ruining organic integrity.
6. Frequency is not compared here because there are transactions almost for every day.
7. Certificated food market is in status of market failure. For example, Nie *et al.* (2018) find that there is no significant effects of certified food production on either chemical fertilizer or pesticide consumption among Chinese farmers due to the failure of regulation enforcement across regions and the lack of price premium.

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Further reading

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Appendix

No.	Third party certification	Processors in organic milk industry	Structure	Output (ton)/year
1	China Organic Food Certification Center (COFCC)	Ausnutria Dairy (China) Company	1	700
2	Beijing Continental Hengtong Certification Co., Ltd (CHTC)	Fening Nature Dairy Company	1	1,350
3	The Xinjiang Production and Construction Groups	Akesu New-agricultural Dairy Company	1	200
4	Organic Food Development and Certification Center of China (OFDC)	Nanjing Weihang Dairy Company	1	3.50
5	Organic Food Development and Certification Center of China (OFDC)	Shandong Yinxiang Ground Dairy Company	1	340
6	Northwest A& F University Certification (NWAFUC)	Tianshui Jiale Dairy Company	1	100
			1	800
			1	450
7	Beijing Continental Hengtong Certification Co., Ltd (CHTC)	Yucheng Dongjun Dairy Company	1	1,880
			1	1,920
8	China Organic Food Certification Center (COFCC)	Chongqing Tianyou Dairy Company	1	1,764
9	China Organic Food Certification Center (COFCC)	Tibet Yak Dairy Company	1	700
			1	300
10	China Organic Food Certification Center (COFCC)	Nuoergai Yak Dairy Company	1	120
			1	70
11	WIT Assessment	Inner Mongolia Oushi Mengniu Dairy Company Limited by Share	1	184
12	China Organic Food Certification Center (COFCC)	Inner Mongolia Knight Dairy Company Limited by Share	1	360
13	China Organic Food Certification Center (COFCC)	Inner Mongolia Mengniu Dairy Company Limited by Share	1	30,000
			1	27,600
			1	61,791
14	WIT Assessment	The Shijiazhuang Junlebao Dairy Company Limited by Share	1	30,000
15	China Quality Certification Center (CQC)	Jiangxia Sun Dairy Company	1	90
			1	800
16	Fangyuan Organic Food Certification Center (FOFCC)	Beijing Yipinnuka Dairy Company	1	154
			1	102
			1	92
			1	325
			0	5
17	Fangyuan Organic Food Certification Center (FOFCC)	China Huishan Dairy Company	0	5,000
			0	1,460
18	China Quality Certification Center (CQC)	Heilongjiang Feihe Dairy Company	1	1,500
19	ZhongAn Certification	Shandong Xianghe Dairy Company	1	1,820
			1	964
20	WIT Assessment	Jiangsu Chunhui Dairy company	1	870
21	WIT Assessment	Hongyuan Yak Dairy Company	1	572.40
			1	300

(*continued*)

Table AI. The production and organization structure of organic milk industry in China (2015)

No.	Third party certification	Processors in organic milk industry	Structure	Output (ton)/year
22	China Quality Mark Certification Group (CQM)	Xinyuan Dairy Company	1	80
23	Fangyuan Organic Food Certification Center (FOFCC)	China Huishan Dairy Company	1	1,800
24	China Quality Certification Center (CQC)	Ningbo Dairy company	1	410
			1	150
25	China Organic Food Certification Center (COFCC)	Shanghai Dairy company	1	403
26	China Organic Food Certification Center (COFCC)	Inner Mongolia Yili Industrial Group Company Limited by Share	1	156,600
			1	14,400
			1	37,800
			1	28,800
			1	5,000
			1	18,000
			1	9,000
27	Organic Food Development and Certification Center of China (OFDC)	Xilinx Hot Yili Industrial Group Company Limited by Share	1	33,431.45
		Inner Mongolia Yili Industrial Group Company Limited by Share	1	53,054.01
		TianJin Yili Industrial Group Company Limited by Share	0	6,190.30
			0	2,037.50
28	China Quality Certification Center (CQC)	Heilongjiang Wondersun Dairy Company Limited by Share	1	2,200
			1	1,000
		Heilongjiang Wondersun Dairy Company Limited by Share	1	9,000
29	WIT Assessment	Hutchsion Hain Organic Company	0	132.78
30	China Quality Certification Center (CQC)	Beijing Green Yard Company	1	60
			1	75
			1	405
			1	540
			1	120
31	WIT Assessment	Hebei Sanyuan Food Company Limited by Share	1	1,595.70
		Xinxiang Sanyuan Food Company Limited by Share	0	600
			0	1,000
			0	1,000
32	China Quality Mark Certification Group (CQM)	Nanda New-agricultural Company	1	100
			1	500
			1	130
			1	100
			1	200

Notes: 1, vertically integrated organization (factor contract); 0, outsourcing (outsourcing spots or farming contract). Data source (in the year of 2015): Food and Agricultural products Certification Information System of China, Certification and Accreditation Administration of the People's Republic of China

Table AI.

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