

Food Safety Concerns and Changing Procurement Arrangements by Food Processors: A Conjoint Analysis

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1. Introduction

As the links between diet and health become more evident, modern consumers value more on food nutrition and safety attributes. A series of recent outbreak of food-borne diseases and controversial release of genetically modified organisms (GMOs) have intensified food safety concerns both at home and abroad. On the other hand, breakthrough of multilateral trade agreements on agriculture has led to lower tariff barriers, higher trade volumes and dramatic structural adjustments in both importing and exporting countries. The affected interests groups lobby hard for more technical barriers as alternative means of trade protection. The pressure from both consumers and interests groups has significant impacts on the related regulations and legislations in many countries. There have been global changes in food grades and standards, extending from performance criteria to process criteria. The farm to table approach, such as hazard analysis critical control point (HACCP), has been required.

Food quality and safety assurance typically incurs additional transaction costs, arising from asymmetric information, moral hazards and monitoring activities (Unnevehr et al. 1999). It could have significant implications for the organization and competitiveness of agri-food systems (Caswell et al. 1998). This raises a question of how to save transaction costs while ensuring food safety at acceptable level. This issue is challenging both agribusinesses and governments in the developing countries, where exporting fresh and processed food represents an important opportunity to gain from trade liberalisation, and where the marginal

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costs to improve food quality and safety are higher than the developed countries (Unnevehr 2000).

Since the late 1990s, China's horticultural sector has been developed into one of the largest horticultural sectors in the world. Although the growing domestic market has absorbed majority of the products, this sector has still become China's largest exporting agri-food industry. Pesticide residue in horticultural products is a typical food safety concern. The incidence of Chinese spinach in Japan has triggered significant trade barriers to major agri-food products from China. This study investigates how food processors react since the emergence of food safety concerns by a case study of vegetable industry in Shandong Province, the largest horticultural producing and exporting region in China. The study focuses on the changing procurement arrangements by food processors. Based on the survey data from Laiyang City of Shandong Province, conjoint analysis was conducted to identify the relative importance of concerned factors in the context of trade liberalisation and agricultural transformation.

Next section discusses theoretical relationships between transaction costs and vertical coordination. The method of conjoint analysis is briefly introduced in section 3, and applied to the procurement channel decisions in section 4. Based on the results of conjoint analysis, section 5 further discusses the related issues of changing vertical coordination in the Chinese agri-food system. The paper ends up with conclusions.

2. Transaction Costs and Vertical Coordination

The literature on vertical coordination suggested that; there exist a variety of determinants of vertical coordination. The neoclassical approach focused on market structure, the transaction cost approach focused on specific assets, while the competence-based approach focused on competences or capabilities. These determinants may individually or in combination influence boundaries of the firm. This study adopts the transaction cost approach to understand why

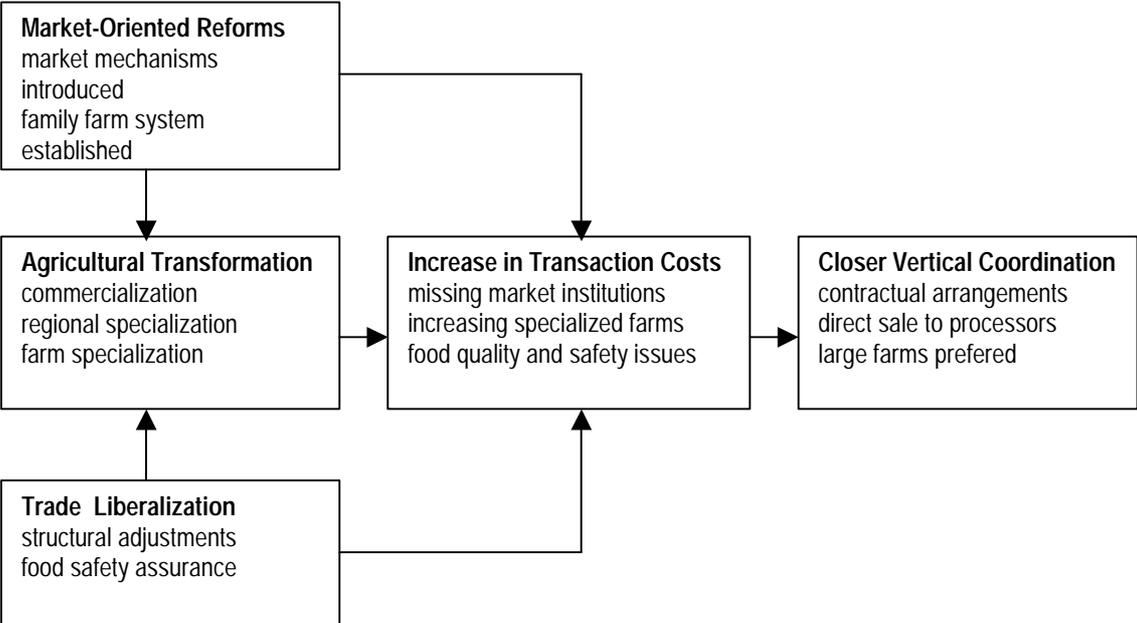
transaction costs in the Chinese agri-food system remain at high level and why closer vertical coordination can save transaction costs in this system, which is characterized with increasing agricultural transformation, institutional transition, and trade liberalization.

During agricultural transformation, a traditional agriculture evolves into a relatively modern and commercialized agriculture; the operations originally integrated within farms are disintegrated gradually into the related agribusinesses. At the meantime, interdependence between on-farm and off-farm operations becomes increasingly important (Davis and Goldberg 1957). The advances in agricultural commercialization and specialization require favourable market conditions. Transaction costs are important determinants of this process, in addition to the extent of market identified by Stigler. To large extent, the process is determined by the trade-off between the economies of specialization and transaction costs. The improved infrastructure and the advances in transaction technologies could raise transaction efficiencies, leading to lower transaction costs. Industrialization and urbanization can stimulate the integration of agriculture with the rest of national economy, which can save the transaction costs of agri-food products. All of these favourable conditions will further promote agricultural commercialization and specialization to realize the economies of scale and specialization in agri-food system.

Agricultural transformation in China has been seriously hindered by the centrally planned economy and the collective farming system. It was the market-oriented reforms that triggered the current process of agricultural commercialization and specialization. Two decades after the gradualist approach to market economy, China at last joined the World Trade Organization (WTO), and started to liberalize its food market to the world. Chinese agriculture has been increasingly integrated with the rest of national economy, and further integrated with the world food market. The increasing market integration made Chinese farmers increasingly depend on market transactions.

However, transaction costs in the Chinese agri-food system are very high due to missing marketing institutions and infrastructure, emerging specialized farms, and food quality and safety requirements. Missing marketing institutions and infrastructure are the common phenomena in developing and transition economies. Emerging specialized farms are the results of agricultural transformation. And the issues of food quality and safety are highly related to trade liberalization. As a result, closer vertical coordination has emerged as one of the responses by private business to this dynamic institutional and business environment. The causal relationships are described in the analytical framework (see Figure 1).

Figure 1 Dynamic Environment, Transaction Costs and Vertical Coordination



2.1 Missing Market Institutions

In transition economies, missing market institutions and infrastructure are common. Before the transition, the state farms or collective farms need not to concern about procurement of farm inputs or marketing farm outputs, because all of transactions were closely controlled by the administrative means, not by market mechanism. In that case, transaction costs in agri-food systems were low (but institutional costs were high). After the market-oriented reforms, farms and agribusiness firms became relatively independent entities. Transactions have to rest

on market exchanges, no longer on the command. The efficient market operations then become critical determinants of the organization of agri-food systems. However, market efficiencies are seriously affected by missing market institutions and infrastructure, which constituted the major sources of transaction costs in transition economies.

Missing market institutions and infrastructure may be even worse in China because it adopted a gradualist approach to market economy. In the agricultural sector, the price discovery mechanism has not well established yet; some commodity markets, such as grain market, are still regulated; some factor markets, such as farm credit and rural employment, are almost totally missing; farm service markets, such as market information and technological extension, are difficult to be established due to their public goods in nature; legal regulation and enforcement system is imperfect either. Too many small contracting parties made the enforcement costs too high, which in turn, induced even more contract breaching and hold-up occurrences. Market risks and uncertainties in the agri-food system are very high.

According to Williamson (1979), high degree of market risks and uncertainties is necessary but not sufficient condition leading to high transaction costs. Another necessary condition is transaction-specific investments made by one trading party or by both parties. It is specific asset that creates the dependence or even bilateral monopoly between the trading parties. Specific assets are in variety of forms, including physical, human, site-specificity. In some agri-food industries, site-specificity is significant because the products are highly perishable and bulky; their transportation costs are high while shelf life is short. The performance of such agri-food industries highly depend on market operational efficiencies, thus, more sensitive to missing market institutions and infrastructure.

2.2 Increasing Specialized Farms

The market-oriented reforms and trade liberalization have promoted agricultural commercialization and specialization. Farmers' input and output decisions have increasingly

based on the principle of profit maximization. Specialization at both regional and farm levels have emerged especially in horticultural and livestock industries. However, specialized farms may face higher market risks and uncertainties, and then depend on their first handlers or food processors, particularly when products are with significant site-specificity, such as vegetables. Specialized farms tend to have contractual arrangements with their first handlers or food processors. By doing so, they may avoid certain degree of market risks. But this can be achieved only at the expense of weaker bargaining power, considering the small scale of farms and dependence on their trading parties.

2.3 Food Quality and Safety Assurance

As the links between diet and health become more evident, modern consumers value increasingly on food quality, particularly nutrition and safety attributes. The food safety concerns have been intensified due to the recent outbreak of food borne diseases, and further complicated by the controversial release of GMOs. As a result, the issues of identity preservation, labelling and traceability have been raised to ensure food quality and safety, and niche markets for organic or green food have also emerged as the richer consumers are willing to pay premium for higher quality food. On the other hand, the breakthrough of multilateral trade agreements on agriculture has led to lower trade barriers, higher trade volume and painful structural adjustments in both developed and developing countries. The interests groups lobby for more technical barriers as means of protection of trade. The pressure from both consumers and interests groups has significant impacts on the regulations and legislations. And the regulations of grades and standards on food quality and safety have been used as so-called “green barriers”.

In order to get access to foreign markets, food quality and safety assurance becomes a necessary condition. However, food quality and safety assurance typically incurs additional transaction costs arising from asymmetric information, moral hazards and monitoring

(Unnevehr et al. 1999). Usually, food safety attributes are credence in nature; consumers have significant difficulties or cannot assess the attributes even after their consumption of the food. Such measurement difficulties and asymmetric information between sellers and buyers may lead to the failure of the market for food safety (Caswell and Mojdzuska 1996). For ensuring food quality and safety, government interventions and quality signalling mechanisms are introduced, such as grades and standards regulations, informational labelling, third-party certification, and vertical integration. These public and private actions have important implications for the organization, productivity and competitiveness of agri-food industries.

Food quality and safety assurance could be more expensive in China because of the extremely small operational scale of the family farms, which averaged only half hectare of arable land per household. The quality and safety attributes of final products are determined over the food supply chains, including the first link of the chains: farm production. The extreme small scale of family farms leads to too costly testing fees or monitoring costs. Food processors have to pay much more on the controlling or monitoring farm production than ever before.

2.4 Vertical Coordination in China

As Menard (2000) stated that, inefficient governance structures will be eliminated if the economic agents obtain the freedom to choose from alternative coordination mechanisms. The institutional transition has provided such opportunities for the Chinese farmers. The institutional and organizational innovations have emerged firstly in the horticultural sector since the mid-1990s in Shandong province, the largest horticultural producing and exporting province in China. The model has been called *Nongye chanye hua* (means agroindustrialization in Chinese), which mainly refers to encouraging regional specialization and establishing channel captains to exploit external economies of scale in the condition of the small family farm system. Closer vertical coordination between farmers and channel captains are the core component of this model (Zhang 1997). There are currently more than

4000 channel captain food processors, coordinating 40 percent of farm households and 50 percent of arable land in this province (Wu 2002).

A task force has been set up under the Ministry of Agriculture (MOA) by the end of 1996 to supervise agroindustrialization. Promotion of agroindustrialization has been suggested as a national strategy for rural development by the 15th Central Committee Meeting of Chinese Communist Party. Since then, there have been increasing vertical coordination. According to the survey by MOA, there were 39 million rural households (15 percent of national total rural households) got involved in agroindustrialization in 1998 (Wan 2000). The coordination mechanisms include contractual arrangements (accounting for 80 percent), cooperative shareholdings (11 percent) and cooperatives (9 percent). Until 2000, 59 millions rural households have joined in agroindustrialization, accounting for 25 percent of the national total rural households (Du 2001).

3. Method of Conjoint Analysis

As more processed and semi-processed horticultural products are demanded by both domestic and foreign markets, food processors become increasingly important players in horticultural supply chains. They usually behave as channel captains along food supply chains. They can buy fresh vegetables from alternative supply channels and sell their processed products through alternative marketing channels. They can purchase fresh vegetables from middlemen, from wholesale markets, or directly from farmers. Their choice among the alternative supply channels mainly depends on the following considerations. Firstly, whether the channel can keep stable supply of vegetables, which is essential for the capacity utilization and the scale economies of the processors. Secondly, whether the channel is characterized with low transaction costs, which is particularly important for horticultural products due to the high proportion of transaction costs in the retailing prices. Thirdly, whether the channel is able to

guarantee food quality and safety, which is critical in the context of globalisation and fierce international competition.

Just as goods and services can be viewed as bundles of attributes (Lancaster 1966), vegetable procurement channels also display different attributes or characteristics. From the perspective of transaction costs, some attributes are transaction costs generating while other attributes are transaction costs saving. Food processors have to trade-off the attribute levels to minimize transaction costs and to maximize the total utility obtained from the channels. From this perspective, conjoint analysis can be used to identify the relative importance of these attributes.

Conjoint analysis is a multivariate technique for finding out how buyers make trade-offs among competing products or suppliers (Green et al. 2001). Using conjoint analysis, researchers can answer such questions as what product attributes are important and what levels of the product attributes are the most desirable. Researchers can further predict how the buyers will choose from the alternative products and suppliers with the help of choice simulator. This kind of simulation is particularly useful to understand the buyers' reactions to and evaluations of pre-determined attribute combinations that may represent potential products and services (Hair et al. 1995).

Conjoint analysis has evolved from the seminal work by psychometric researchers (Luce and Tukey 1964). The approach then has been successfully applied in marketing research since 1970s (Green and Srinivasan 1978, 1990; Carroll and Green 1995; Green et al. 2001). Facilitated by the widespread introduction of computers and by the availability of conjoint softwares, this approach has been widely used for commercial purposes in the United States and Europe (Cattin and Wittink 1982; Wittink and Catin 1989; Wittink et al. 1994). Over the last three decades, thousands of applications have been carried out, the majority of which focused on new product evaluation, competitive analysis, and market segmentation. There

were also some applications in marketing channel choices and supply chain designs (Hobbs 1996).

Conjoint analysis is a decompositional approach to finding out how consumers make trade-offs among competing products with multi-attributed characteristics. The basic assumption of this approach is that consumers evaluate the total utility (total worths) of a product by combining the separate part utility (part-worths) for attribute levels of that product. Researchers at first develop a set of alternative products (real or hypothetical) in terms of bundles of attributes through fractional factorial designs. These real or hypothetical products are then presented to the consumers during the survey. And the consumers are asked to rank, order or rate these alternatives. Because the products are represented in terms of bundles of attributes at mixed “good” and “bad” levels, the consumers have to evaluate the total utility from all of the attribute levels simultaneously to make their judgements. Based on these judgements, the researchers can estimate the part-worths for the attribute levels by assuming certain composition rules. Then the part-worths are used to calculate the relative importance of each attribute and formulate the consumer-choice simulator for prediction purpose (Green and Srinivasan 1990; Hair et al. 1995; Green et al. 2001). Conjoint analysis is usually composed of the following steps:

3.1 Selection of Attributes and Levels

Both economists and psychologists suggest that products can be defined as bundles of attributes (Lancaster 1966; Fishbein 1967). While consumers may have heterogenous preferences over these attributes, the same decision issue facing all of consumers is how to trade off the possibility that product X is better than product Y on attribute A, while product Y is better than product X on attribute B (Green et al. 2001). A consumer’s decision to choose product X over product Y is determined by his/her underlying preference structure. The purpose of conjoint analysis is to reveal the consumer’s preference structure, and then use this

empirical information to simulate how consumers will react to the bundles of attributes, which may represent potential new products.

Any product may be represented by lots of attributes; depending from which perspective, you view. Therefore, the selection of attributes and levels for a product is basically determined by the specific purpose of the research. The researchers must first be sure to define the total worth of the product. And all of the selected attributes and levels should have significant impacts on the consumer choice decision. The selection of attributes and levels must satisfy several general requirements, such as, actionable and communicable attributes, balanced and reasonable ranges of attribute levels, avoidance of inter-attribute correlation (Hair et al. 1995).

3.2 Fractional Factorial Design

The products are described in terms of combinations of attributes at mixed levels in conjoint analysis. These combinations are also called profiles or experimental stimuli. The consumers are asked to rank, order or rate these alternative profiles during the survey. However, the number of possible combinations of the attributes is usually too large for the consumers to make meaningful judgement. Therefore, the researchers need to reduce the number of profiles presented to the consumers while still maintaining orthogonal among the part-worth estimates. Fractional factorial design is used for this purpose, which produces only subsets of complete possible combinations of the attributes. Such kind of subsets is called orthogonal arrays, in which only main effects are considered while interactions are assumed negligible.

3.3 Data Collection by the Survey

In conjoint analysis, the independent variables and their values are predetermined by the researchers during the conjoint experimental designs. These independent variables are non-metric or categorical variables. The dependent variable is the consumer choice decision or the consumer overall evaluation on the alternative profiles. The researchers present the profiles to

the consumers during the survey to ask the consumers to rank, order, or rate these alternative profiles. The results of the ranking, ordering or rating by the consumers constitute the observation data for the dependent variable—the only data needed to collect for conjoint analysis. The survey for conjoint analysis could be conducted by personal interviews, by mails, or by phone.

3.4 Estimation of Conjoint Model

During the survey, the consumers are asked to provide only their overall evaluations on the alternative profiles by ranking, ordering, or rating. Unlike the expectancy-value model (a compositional approach in nature), conjoint analysis is a decompositional approach. The consumers do not need to tell the researchers anything else, such as, how important is the specific attribute level to the consumer, because the researchers have constructed the real or hypothetical products in a specific manner, so that the part-worths for attribute levels and the relative importance of each attribute can be inferred from the consumers' overall evaluations in terms of ranking, ordering or rating.

In order to estimate the conjoint model, researchers have to assume the composition rule and have to specify the types of the part-worth relationships. The most often used compositional rule is additive rule, which assumes the consumer just “add up” the part-worths for attribute levels to calculate the total worths of a product. There are four types of the part-worth relationships between the consumer preference and the attribute levels: linear, quadratic, part-worth, and mixed model. The linear relation indicates that the consumer preference increases or decreases with increasing value of the attribute. The quadratic relation assumes that the preference is maximal at the ideal and then decreases when moving away from it. The part-worth relation assumes each level of the attribute has a unique part-utility relationship associated with it. The mixed model just combines all of the above three types of relationships (Green and Srinivasan 1978).

3.5 Consumer Choice Simulation

The results of conjoint estimation are traditionally applied in three major fields: market segmentation, competitive analysis, and choice simulation. The part-worths estimates can be used to formulate the consumer-choice simulator to predict how consumers might react to the bundles of attributes, which represent potential new products. The choice simulation follows three-step process: (1) estimate and validate conjoint model for each consumer; (2) select the sets of stimuli to test according to possible competitive scenarios; (3) simulate the choices of all consumers for the specified sets of stimuli and predict market share for each stimulus by aggregating their choices (Hair et al 1995). There are four alternative rules to be selected for simulation purpose: (1) maximum utility; (2) Bradley-Terry-Luce (BTL); (3) logit, and (4) alpha.

4. Application of Conjoint Analysis

The choice decision reflects food processors' preference structure and their trade-offs among the attributes. In the context of speeding farm specialization and trade liberalization, saving transaction costs and guaranteeing food quality and safety are essential for maintaining or gaining the competitive advantage, which significantly influence food processors' choice of supply channels. This study has selected four attributes with vegetable supply channels, that is, testing fees for pesticide residues in vegetables; traceability from processors to vegetable growers; trust between food processors and vegetable growers; and how difficult for food processors to monitor vegetable growers. The survey for this conjoint analysis was conducted in Laiyang city, Shandong province.

The two basic assumptions for conjoint analysis are: (1) a product can be perceived as a bundle of attributes; (2) a consumer evaluates the total utility of a product simply by combining the separate part utility for the attributes of the product. Hobbs (1996) argued that a supply channel could be also viewed as a bundle of attributes, just similar to a product. A

food processor evaluates the total utility of a supply channel by combining the separate part utility for the attributes of the channel. The food processor's choice among the alternative supply channels depends on his overall evaluation of the alternative channels, and fundamentally determined by his preference structure. Conjoint analysis can empirically reveal his preference structure.

To conduct this conjoint analysis, the total utility function for the food processor should be defined firstly. In this study, we assume that transaction costs and quality assurance are the major determinants of the total utility with supply channels. This assumption can be justified by the fact that transaction costs account for the majority of retailing price of horticultural products, any significant reduction of transaction costs in horticultural marketing and distribution means the improved firm profitability. On the other hand, quality assurance is becoming the priority of food processors in the context of increasing concerns about food quality and safety from both domestic and foreign consumers. The quality assurance and the corresponding organizational innovations may trigger the relative changes in transaction costs with the alternative supply channels. The stricter quality control could mean higher transaction costs spent on the supply chains. Both transaction costs and quality assurance are the significant determinants of the competitiveness of a food processor. Trade-offs must be made by food processors during their decisions on supply channel choices. Which attributes are more emphasized by food processors in the context of speeding agricultural commercialization and trade liberalization? Conjoint analysis could help to answer such kind of questions.

4.1 Selection of Attributes and Levels

Once the total utility function for food processors has been defined, all of those factors, which significantly influence transaction, costs and quality assurance should be included in the bundle of attributes. Among these attribute levels, some are transaction costs generating,

some are transaction costs saving, the former creates the negative utility, the latter brings positive utility for the food processor. Food processors choose among the alternative channels in order to maximize their total utility with the supply channels, that is, to minimize the transaction costs while assuring the quality and safety of their food products.

Many factors affect transaction costs and quality assurance with supply channels. Transaction cost economics has identified information costs, negotiation costs, and monitoring costs as the major sources of transaction costs. The organization of a supply channel has significant impacts on the types and levels of transaction costs with the channels. It also influences the capability for a food processor to control the quality and safety of his final food products through these channels. Considering the restrictions on the numbers and other general requirements on the attributes and levels, we have selected 4 attributes with 2 balanced levels characterized with a supply channel, that is, test fees for pesticide residue in vegetables per unit of product; traceability from the processor to the vegetable growers; trust between food processors and vegetable growers; difficulty for the food processor to monitor their customer farmers. All of these attributes are transaction costs related.

The first attribute is test fees for pesticide residue in vegetables. From the food processors' perspective, test fees are quite different and can be distinguished among the alternative supply channels. For the supply channel via middlemen, the test fees at each unit of vegetables are very high because of small batch of transactions with small households. In contrast, if the processor procures from wholesale markets or from large farms, the test fees at each unit of products are much lower thanks to the large transaction quantity each time.

The second attribute is traceability from the processor to the vegetable growers. In the context of emerging concerns about food quality and safety, food processors do care about how fresh vegetables are procured, because it affects the quality of their final products. In order to encourage high quality suppliers and avoid low quality suppliers, food processors must get to

know who is the original producer for this batch of vegetables. If food processors can easily trace back to the original producers, they can screen out the quality suppliers at low information costs. Apparently, it is very difficult to trace back with spot market, and quite easy to trace back with direct marketing.

The third attribute is trust between food processors and the vegetable growers, which is a particularly important factor in the context of transition economies, where missing market institutions are popular and hold-up between food processors and farmers prevails. When the market price is higher than the contract price, farmers may breach their contracts and sell their vegetables to the market, not to the contractors. In contrast, if the market price is lower than the contract price, food processors may also breach their contracts and procure the vegetables from the market at cheaper price. Lack of trust could be a disaster not only for food processors, but also for farmers. Trust between food processors and farmers could greatly save transaction costs, and reduce the uncertainty of their exchanges. Therefore, the supply channel, which characterized with high trust, is, of course, desirable.

The last attribute is the level of difficulty for food processors to monitor their client farmers. In contract farming, food processors have some management powers. This is different from the classical market contract, which defines only buying and selling relations. As vertical coordination becomes more advanced, farmers delegate more powers to food processors, and consequently, food processors will supervise or monitor the activities of farm production in terms of technical promotion or even direct control of farm operational decisions. This kind of contract is becoming popular as food quality and safety issues emerge. As for vegetables, pesticide residue and planting schedule are typically concerned by food processors, because food processors need balanced vegetable supply to keep their capacity usage at high level, which requires farmers to plant their vegetables scheduled by food processors.

According to Hair et al. (1995), balanced levels are preferred in conjoint analysis, especially for the estimation of the relative importance of the attributes. Hence, two balanced levels are assigned to each attribute in this study: “high” and “low” for the test fees; “difficult” and “easy” for the traceability; “bad” and “good” for the trust; and “difficult” and “easy” for the monitor.

4.2 Fractional Factorial Design

The complete factorial combinations for four attributes with two levels are 16 ($2^4 = 16$). It is difficult for the food processor to rank, order or rate all of these combinations meaningfully during the survey. For this reason, fractional factorial design is used to generate orthogonal arrays—subsets of all possible combinations of the attribute levels, which consider only main effects of the factors. The selected orthogonal array in this study has been produced with SPSS software (see Table 1). The chosen orthogonal array contains 10 combinations (profiles), the first eight of them are for conjoint estimation, and last two combinations are holdout for model validation purpose.

These combinations are not the exact proxies of the real supply channels, but the attributes are abstracted from the real supply channels. Take the first combination as an example: **low test fees** for pesticide residue in vegetables per unit of product may indicate that the quantity of each transaction is large. The possible trading parties with food processors in this case may be large scale farmers or wholesalers; **difficult traceability** to the original producers may be represented by spot market, such as the channel via wholesalers, who can transform small transactions into large transactions, but they are difficult to trace back the original producers; **Good trust** existing between food processors and sellers implies that the specific investments for the transactions are significant. This could be the highly specialized vegetable grower. High specialization in perishable vegetable production has made them more vulnerable and

dependent on food processors. Thus, they value the relationships with food processors. And they are more **easily monitored** by processors.

Table 1 Orthogonal Design for Conjoint Analysis

Case	Test fees per unit of product	Traceability to original producers	Trust between processors and farmers	Ability to monitor farmers' activities
1	Low	Difficult	Good	Easy
2	High	Easy	Bad	Easy
3	High	Difficult	Good	Difficult
4	Low	Easy	Good	Difficult
5	Low	Easy	Bad	Difficult
6	Low	Difficult	Bad	Easy
7	High	Difficult	Bad	Difficult
8	High	Easy	Good	Easy
9 (H)	High	Easy	Good	Difficult
10(H)	High	Difficult	Good	Easy

4.3 Data Collection by the Survey

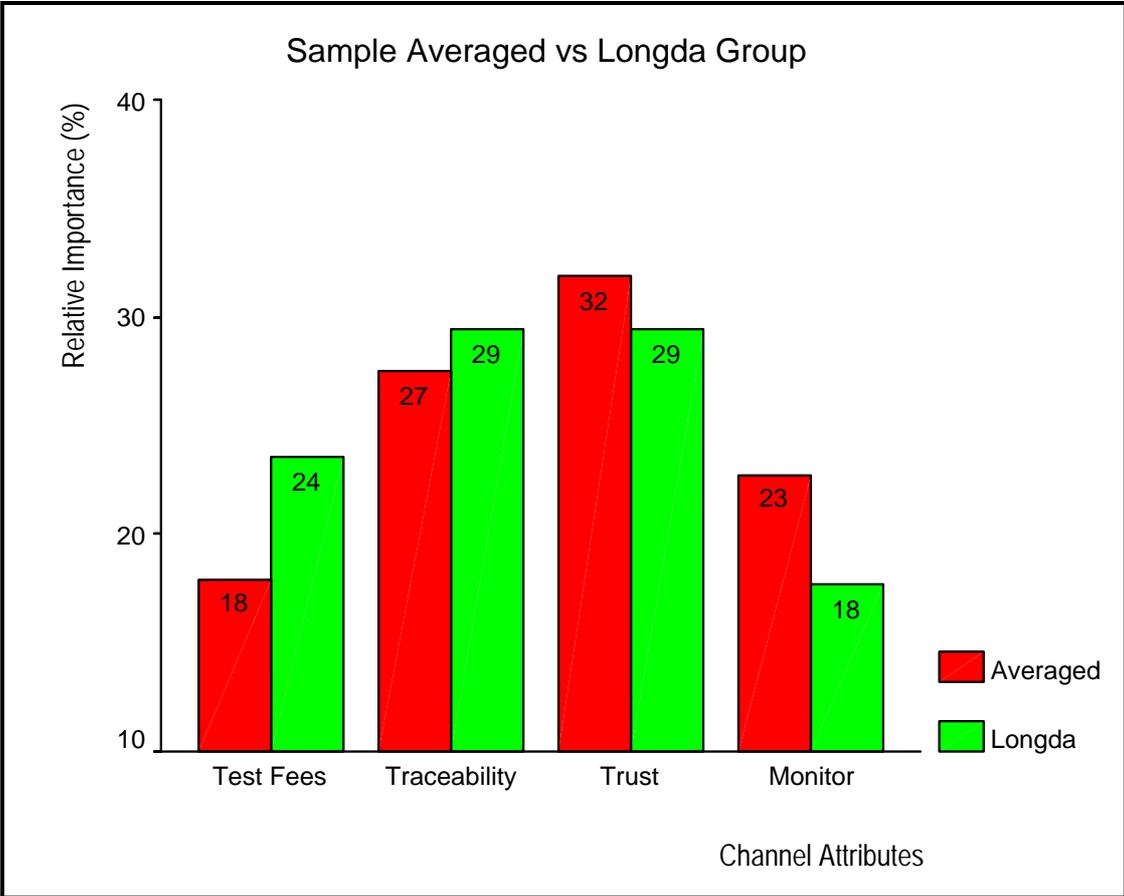
To collect data for the conjoint analysis, the survey has been conducted in Laiyang city, Shandong province. The survey covered almost all of formal food processors in this City. Although the sample size is small, the sample is quite typical for the region where increasingly specializes in producing and exporting horticultural products. The farm specialization and trade liberalization have significantly influenced the organization of agri-food systems in such kind of regions. The survey questionnaire for food processor is based on the above orthogonal design (see Appendix A). Food processors are asked to rank the 10 combinations. The most preferred combination ranks 1, while the least preferred combination ranks 10. There are some notes for the questionnaire: (a) test fees are the fees spent on testing

pesticide residue in vegetables per unit of product; (b) traceability refers to the ability for food processors to trace back original producers; (c) trust is mutual creditability between food processors and vegetable growers; (d) monitor refers to the ability for food processors to monitor farmers' activities.

4.4 Estimation of Conjoint Model

In order to estimate the conjoint model, firstly we have to assume the composition rule and the types of relationships between preferences and the attribute levels. In this study, the additive rule and the linear relationships between the preferences and the attribute levels have been assumed. SPSS software has been used to estimate the part-worths for the attribute levels and the relative importance of the attributes. The results of conjoint analysis are reported in Figure 2 and Table 2.

Figure 2 Relative Importance of Four Attributes with Vegetable Supply Channels



The part-worths for the eight attribute levels have been estimated for the 52 food processors respectively. But Table 2 only reports the estimates for the sample average and a typical large food processor—Longda Group. The estimates are normalized, and they can be compared each other. For all of the negative attribute levels, the part-worths are assigned as zero. For the positive attribute levels, the larger the coefficients, and the more important this attribute is for channel choice decision. It can be seen that the trust is the largest coefficient, which implies that the trust is the most emphasized factor for the sample average. In contrast, large food processors are more emphasize the traceability factor. The part-worth estimates for the traceability and the trust are just the same for Longda Group.

Table 2 Results of Conjoint Analysis: Sample Averaged and Longda Group

Attributes and Levels	Utility (Part-Worths)		Relative Importance (%)	
	Sample Averaged	Longda Group	Sample Averaged	Longda Group
Test Fees			17.93	23.53
High	0.00	0.00		
Low	0.8413	2.00		
Traceability			27.47	29.41
Difficult	0.00	0.00		
Easy	2.1490	2.50		
Trust			31.86	29.41
Bad	0.00	0.00		
Good	2.4760	2.50		
Monitor			22.74	17.65
Difficult	0.00	0.00		
Easy	1.7837	1.50		
Constant	0.8678	0.250		
Pearson's R	0.990	0.945		
Kendall's tau	1.000	0.857		
Kendall's tau (holdout)	1.000	1.000		

Based on the part-worth estimates, conjoint procedure can further deduce the relative importance of each attribute in the choice decision. The results of conjoint analysis demonstrate that trust and traceability are the dominant factors among the four attributes concerned in this study. For the sample average, the most important attribute is the trust between food processors and the vegetable growers, which accounts for 31.86 percent among the total importance. The second important attribute is the traceability from food processors to the vegetable growers, accounting for 27.47 percent. The third attribute is the ability for food processors to supervise and monitor farmer's activities (22.74 percent). And the last attribute is the fees spent on testing pesticide residue in vegetables (17.93 percent). In comparison with the sample average, large food processors emphasize more on the traceability and the test fees, because they are usually export-oriented food processors, and more concern about the emerging food quality and safety issues. For example, Longda Group values traceability 2 percentages higher, and values the test fees 6 percentages higher than the sample average.

Pearson's R and Kendall's tau have been reported in Table 2 for the sample average and Longda Group respectively. These correlation coefficients demonstrate that the fitness of the model is excellent. Furthermore, two holdout combinations are specifically designed for model validation purpose. The high values of Kendall's tau for holdouts confirm the validity of the model.

4.5 Channel Choice Simulation

The estimated part-worths for the attributes can be further used to formulate the channel choice simulator to predict how food processors will choose among the potential alternative supply channels, which may have some useful policy implications. In this study, we assume three possible alternative vegetable supply channels for simulation purpose. The first supply channel is with all negative attribute levels: high test fees per unit of product; difficult to trace back the quality and safety; no trust between the trading parties; and difficult for food

processors to monitor the farm activities. This kind of supply channel can represent spot market, particularly small diversified farmers via middlemen. The second channel is with all positive attributes except for high test fees for pesticide residue, which could represent large farmers via few agents. And the third channel is with all positive attributes, which may be represented by direct marketing channel from large organic farms to processors.

Table 3 Results of Conjoint Simulations

	Channel 1	Channel 2	Channel 3
Channel Characteristics			
Test Fees	High	High	Low
Traceability	Difficult	Easy	Easy
Trust	Bad	Good	Good
Monitor	Difficult	Easy	Easy
Preference Scores			
Whole Sample	0.90	7.30	8.10
Longda Group	0.30	6.70	8.70
Probabilities Chosen			
Max Utility	0.00	13.46	86.54
BTL	5.27	44.66	50.07
Logit	0.21	31.67	68.11

The simulations tell us if food processors have opportunities to choose from these three alternative supply channels, what decision they possibly make. The choice simulator is based on the above conjoint analysis. Three choice rules are adopted for the simulations: maximum utility, BTL and Logit. The simulation results in Table 3 show that among three alternative channels, almost no food processor likes to choose the first channel (spot market). For the second channel, the results are somewhat inconvergent, arranging from 13.46 to 44.66 percent of food processors may choose this channel, depending what choice rule adopted. For the third channel, 50 to 86.5 percent of food processors possibly choose this channel.

5. Further Discussions

In this conjoint analysis, the four attributes concerned are all related to the transaction costs with vegetable supply channels. The alternative combinations of the attribute levels may represent the different levels of transaction costs. If the preferences given by food processors are consistent with the levels of the transaction costs with these combinations, our hypothesis in this study—the food processor choose among the alternative supply channels to minimize the transaction costs—can be confirmed. The conjoint simulations can provide us with preference scores for the alternative combinations, which is an excellent proxy of the preferences by food processors. The difficult issue is the measurement of transaction costs with the alternative combinations. However, we only need to rank the levels of transaction costs with these combinations. Thus, the indirect approach would be enough for this purpose.

Conjoint simulations demonstrate that the preference scores given by sample average for channel 1, channel 2, and channel 3, are 0.9, 7.3 and 8.1 respectively. Preference scores given by Longda Group for these three channels are 0.3, 6.7 and 8.7 respectively. Among these three alternative channels, preferences by food processors are quite clear: channel 3 is most preferred, channel 1 is least preferred, and channel 2 is suboptimal channel with relatively high preference scores.

What about the relative levels of transaction costs with these three alternative supply channels? The test fees for pesticide residue in vegetables are the sources of information costs. The ability for the food processor to trace back and monitor the vegetable growers affect the monitoring costs. Lack of trust and potential hold-up are the direct sources of transaction costs. The transaction costs are necessarily high for the supply channel with such characteristics as high test fees, difficult traceability, lack of trust, and difficult to monitor the contract producers. On contrary, if the supply channel is characterized with low test fees, easy traceability, trust, and easy monitoring, such as channel 3, the transaction costs must be low.

Among the three alternative channels, channel 2 is the same as channel 3 except the high test fees. We can conclude that the relative level of transaction costs with these three channels: channel 3 < channel 2 < channel 1. This ordering is just the same as that of the preference scores given by food processors in the conjoint simulations.

The conjoint simulations predict the probabilities for food processors to choose from alternative channels. The probability for food processors to choose channel 1 is nearly zero. In contrast, the probability for food processors to choose channel 3 is very high, 86.5 percent if the utility maximum rule is used, 68.1 percent, if the Logit rule is used, and 50 percent if BTL rule is used. Apparently, food processors will choose channel 3 against channel 1. However, the choice between channel 3 and channel 2 is not so clear if BTL rule is used: the probabilities to choose channel 3 is 50 percent, while the probabilities to choose channel 2 is 44.7 percent. If the utility maximum rule or the Logit rule is used, food processors significantly prefer channel 3 against channel 2.

From the results of conjoint simulations and the above analysis, we can conclude that our hypothesis is confirmed in this study. Food processors prefer the supply channel with low transaction costs. Even if the food quality and safety issues have been emerging recently, food processors are still seeking to save transaction costs while maintaining the assurance of food quality and safety.

Food processors prefer channel 3 because of the low transaction costs associated with it. The existing direct marketing channel from large organic farms to food processors is similar to channel three. However, does this kind of channel dominate in future China? This question cannot be answered simply by conjoint analysis; it should be discussed in the context of the business and institutional environments in China. If this kind of supply channel is only used for organic foods, then, the popularity of this kind of channel will be restricted by the market demand both at home and overseas. If extended to general foods, then, large farm size is not

realistic in near future, because the small households dominate in the Chinese agri-food system. For practical consideration, farm size is necessarily small in China even if the existing land tenure system reformed to allow certain land concentration. The small farm size makes it difficult for food processors to trace back and to monitor the contract farmers, which lead to the high monitoring costs. And the test fees per unit of product are also high. That is why currently the large exported-oriented food processors are not willing to deal with small farmers. During the survey, we found that some food processors proposed that their customer farmers must be large enough (at least 2 hectares of land for vegetable production). Clearly, it is difficult to increase farm size significantly in near future.

Farm size is only one of the important determinants; farm specialization and trust between food processors and vegetable growers are more important factors in channel choice for both farmers and processors. The potential hold-up is the major source of transaction costs. The conjoint simulations show that food processors value the trust as the most important attribute with a supply channel. If food processors could trace back and monitor easily their contract farmers, the monitoring costs are low. If there exists the trust between food processors and the vegetable growers, the transaction costs are low. The preference scores are still quite high for the supply channel with high test fees, but with easy traceability and monitoring, as well as with trust, such as channel 2. The conjoint simulations show that the preference scores for channel 2 is 7.3 given by the sample average, and 6.7 given by Longda Group. There is 44.7 percent possibility for food processors to choose channel 2 if based on the BTL rule.

6. Implications and Conclusions

The recently emerged food quality and safety issues are the important sources of transaction costs in the Chinese agri-food system. Food processors imposed the food quality inspection, which induced farmers to shift their marketing channel to avoid the refusal of their products. At the same time, food processors also incurred much more transaction costs in inspecting,

monitoring and tracing back the contracting farmers. This kind of transaction costs mainly arises from the principal-agent issues—asymmetric information, asymmetric incentives and measurement difficulties. Saving transaction costs while still maintaining food quality and safety becomes a challenging task, particularly in the condition of the small family farm system. Both private and public actions are needed.

6.1 Private Actions

There is a variety of strategies to deal with the food quality and safety issues, such as, closer vertical coordination, third-party verification, and branding and reputation strategy (Sporleder and Goldsmith 2001). Vertical integration has been approved effective in reducing pesticide residues in horticultural products (Kilmer et al. 2001). But it is not possible to adopt this strategy to control the whole process of food production from farm to table, because the management costs with this strategy is usually too high, and then very few successful cases existed in the history. An alternative mechanism is strategic alliances or cooperative arrangements along food supply chains, usually called food supply chain management. Supply chain management emphasizes information flows and cooperation between upstream and downstream firms, but it is still mainly based on market transactions. Hence, this strategy can effectively save transaction costs as well as bureaucratic costs along food supply chains. When agribusiness firms adopt the differentiation strategy through branding and reputation to signal the product quality to the consumers, they usually have to implement food supply chain management to enhance the credibility of their branded names.

6.2 Public Actions

Only very few multinationals have the capabilities to develop their own private grades and standards. Agribusiness firms usually have to adopt the public grades and standards. In China, farmers and food processors are very small, the differentiation strategy through branding and reputation is usually not feasible for them. Therefore, third party verification and public

regulations on grades and standards become very important for these small agribusiness firms to deal with food quality and safety economically. To implement public grades and standards system, government certification and testing centres are necessary institutions and infrastructure.

In addition, informational labelling can also reduce measurement costs and lower transaction costs with the contracting parties. According to (Caswell and Mojuszka 1996), food safety and nutrition are largely credence attributes where the consumer has significant difficulty or cannot assess quality even after consumption. As a result, the informed consumer and reputation models do not apply to food safety and nutrition. Quality signalling may be still used, but a reputable certification agent is required. The government is such an agent who can make it practicable for consumers to assess food quality by requiring informational labelling. The mandatory label that discloses the information about the nature of product and process of production can transform credence attributes into search attributes where consumers can determine the quality of this product before they buy it by examining or researching the product. Pesticide residue in vegetables is a credence attribute. Unless mandatory informational label is provided, vegetable consumers cannot make judgement about the quality of vegetables.

6.3 Conclusions

This study explored how food processors choose their vegetable supply channels in the context of emerging food quality and safety issues based on the conjoint analysis. The hypothesis is that food processors choose among the alternative channels so as to minimize the transaction costs associated with the channels. The conjoint simulations provided us with preference scores for the concerned channels, which are the excellent proxies of preferences. The indirect approach was used to order the relative level of the transaction costs with alternative channels. The study confirmed that food processors shift their supply channels to

save transaction costs while maintaining food quality and safety. The most important attribute with supply channel is the trust between the trading parties. The second important attribute is traceability, which is particularly important for exported-oriented food processors. Although farm size is an influential factor for testing fees and traceability, farm specialization and trust are more critical.

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