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# Identifying Processors' Procurement Preferences: Implications for Developing a Forward Contracting Scheme in China's Beef Industry<sup>1</sup>

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Beef processors' procurement channel selection is a critical element of a successful supply chain in addressing challenges of food safety from consumers. However, preference-based studies of cattle procurement methods in China are scarce. In this study, the conjoint modelling approach is used to determine processors' perceptions of various procurement channels.

Initial results based on a survey of 43 beef processors suggest that the beef processing industry is still at the early stage of development and processors place most value on regular suppliers and good trust. Findings will be used in developing policies that encourage forward contracting between producers and processors.

**Keywords:** Beef industry, procurement preference, forward contract, conjoint modelling.

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## **1. Introduction**

In China, processors and abattoirs play a significant role in procuring, slaughtering and processing cattle, then packaging or even delivering semi-processed or processed beef products to consumers. Over the past several years, consumers have become increasingly concerned about food quality and safety. Thus more pressure will impact on the processing linkage. Therefore, understanding processors' attitudes to the supply chain may be vital to determining the nature of the coordination and competitiveness of the industry.

Beef processors can purchase cattle from middlemen, from the spot markets, or directly from farmers (at the farm gate or by contract). Their choice among the alternative supply channels depends on the several features. First, whether the channel can provide a regular supply of consistent products to keep their processing equipment at a normal capacity utilisation. Second, whether the channel can satisfy the demand for food quality and safety, which is crucial in the situation of severe competition between other beef products and other substitute meat products. Third, whether the channel incurs low transaction costs will be important for the supply chain.

Although many studies have used attitude surveys, to our knowledge there have not been any preference-based surveys of cattle procurement methods in China (i.e., surveys measuring utilities based on economic theory). There are a number of techniques, such as the analytic hierarchy process, conjoint analysis (Satty 1980) and multi-dimensional scaling (Shepard 1964) which have been used to measure human perceptions and preferences. In this study, conjoint analysis is employed to gauge the attitude of beef processors. It has a number of advantages including ease of use and the quality and nature of the data that can be obtained. By using a conjoint study, researchers can gain a better understanding of the real value processors attach to certain attributes when making cattle purchasing decisions. The analysis is based on the premise that a supply chain can be viewed as a bundle of attributes or characteristics, just as goods and services by some economists (Lancaster 1996). A processor's preference for a supply chain channel is determined by

the particular bundle of attributes which characterise that channel (Hobbs 1996; Sang 2003; Stanford *et al.* 1999).

Given the nature of the issue, conjoint analysis is appropriate for this study. In the next section, the method of conjoint analysis is explained, followed by the materials and methods employed in the study. Then a summary of the results obtained from a field survey is presented. The summary and conclusion are included in the final section.

## **2. Methodology**

Conjoint analysis has evolved from the seminal work by mathematical psychometric researchers (Luce and Turkey 1964). Since the 1970s, conjoint analysis has been widely used in several fields of economics as well as in marketing research (eg. Adamowicz *et al.* 1994; Green and Srinivasan 1978; Orme and Huber 2000). The application of conjoint analysis has been widely adopted in the United States and Europe (Hair *et al.* 1998, p. 338). Based on an understanding of market preferences, the primary focus of the analysis is to predict consumers' choice for new alternatives (Oppewal and Vriens 2000), to provide answers for strategic marketing and selling decisions (Schutte 1999, pp. 90-92) and to segment the market according to the consumers' most preferred product among other substitutes or competitive products (Wyner 1995).

As Green and Wind (1975) stated, conjoint analysis should not be limited to consumer application, as "evaluations of supply alternatives by an organisational buyer are similar to benefits sought by the consumer". In this study, each supply chain channel is viewed as a bundle of attributes, as it could be for a product or service (Hobbs 1996; Sang 2003; Stanford *et al.* 1999). Procurement channel selection decisions can reflect beef processors' preference structure and their trade-offs among the attributes. The total worth of the product is known as the overall preference for a product. The general an additive model can be denoted as:

Total worth of a product  $_{ij:n}$  = part-worth of level  $i$  for attribute 1+  
 part-worth of level  $j$  for attribute 2+ ...

part-worth of level n for attribute m

(Equation 1)

where the product (service/procurement channel, etc.) has m attributes, each having two or more levels. Each scenario consists of level i of attribute 1, level j of attribute 2 and so on, up to level n for attribute of m (Hair *et al.* 1998).

### **3. Materials and methods**

#### **3.1 Selection of attributes and levels**

Clearly, many factors affect the cattle-purchasing decision of processors. Within a transaction costs approach to supply channels, these factors have been classified as information costs, negotiation costs and monitoring costs. Based on reviews of other researchers' work (Hobbs 1996; Sang 2003) and discussions with industry experts, four characteristics each with two levels related to beef processors' procurement choices were selected to be included in the conjoint study. These were: continuity of supply to processors; traceability from processors to cattle farmers; trust between processors and cattle farmers; and how difficult it is for food processors to monitor cattle farmers.

The first attribute is continuity of supply for beef processors. Cattle may be purchased from long-term, regular suppliers or short-term, occasional suppliers. The choice between them implies different information costs and monitoring costs. When processors procure cattle from long-term regular suppliers through contracts or middlemen, there will be lower information costs, as costs for searching out new suppliers are saved. In contrast, if cattle are procured from markets, which can be characterised as short-term occasional suppliers, the information costs for discovering prices and suitable suppliers may be higher. Simultaneously, purchasing from regular suppliers can reduce monitoring costs because the consistency in the quality of cattle is much more guaranteed. Moreover, the nature of the regular suppliers may allow processors the scope to manage throughput well.

The second import attribute is traceability from the processor to cattle farmers. With emerging concerns about food quality and safety from consumers, beef processors have to control the process of procurement, as the quality of raw

product (cattle) will ultimately have an impact on the final product (beef). Processors want to know about the original producers and their on-farm production practices. If cattle are marketed by contract farmers, then the processors can easily screen-out suppliers underperforming. Moreover, monitoring costs will be higher for processors who purchase cattle through the market or through middlemen.

Third, trust between beef processors and the cattle farmers is included because it is important to avoid opportunistic behaviors for both trade parties. We would expect specialised cattle farmers to choose a closer vertical coordination to avoid spatial monopoly and opportunistic behaviours. Processors will face the same situation when market price is higher than the contract price, and farmers have an incentive breach their contracts and sell their cattle to the market, instead of to the contractors. Trust could greatly reduce the uncertainty of the exchanges and save negotiation costs and monitoring costs, especially when the market as an institution is incomplete at this stage in China. There will be more trust between partners if cattle are purchased by contract or middlemen than through other channels.

Finally, the level of difficulty of monitoring farmers is identified as an important influence on the selection of procurement. Processors prefer to supervise or monitor the practices of cattle farm production so as to keep a good management of upstream contracted farmers. With specified technology for feed and farm operations, the quality of cattle can be reasonably well controlled.

To maintain a balanced approach for avoiding biasing the results, two levels are assigned to each attribute in this conjoint analysis. They are, 'regular' and 'occasional' for supplier type; 'difficult' and 'easy' for traceability extent; 'bad' and 'good' for trust; and difficult and easy for monitoring ability.

### **3.2 Fractional factorial design**

Based on the previous analysis, with four attributes and two levels for each attribute, the full stimuli are calculated as 16 ( $2^4=16$ ). This was considered too many for respondents to evaluate reasonably during the survey. Therefore, an orthogonal array was created by the orthogonal design procedure in SPSS.

Eight scenarios plus two hold-out scenarios were generated, which provided a total of ten profiles in the survey (Table 1).

Table 1 Orthogonal Design for Conjoint Analysis

Case	Types of cattle suppliers	Traceability to cattle producers	Trust between processors and farmers	Ability to monitor farmers' production activities
1	Regular	Easy	Bad	Difficult
2	Regular	Difficult	Good	Difficult
3	Occasional	Easy	Bad	Difficult
4	Regular	Easy	Good	Easy
5	Occasional	Easy	Good	Easy
6	Regular	Difficult	Bad	Easy
7	Occasional	Difficult	Good	Difficult
8	Occasional	Difficult	Bad	Easy
9 <sup>a</sup>	Occasional	Difficult	Bad	Difficult
10 <sup>a</sup>	Occasional	Easy	Good	Difficult

<sup>a</sup> cases are holdouts.

These profiles are abstracted to describe the characteristics of the cattle procurement channels. For example, profile 4:

- Type of supplier – regular
- Traceability to cattle producers – easy
- Trust between processors and farmers – good
- Ability to monitor farmers' production activities – easy

These attributes provide a general description of a supply chain by which processors may purchase cattle directly from contacting large farmers.

### 3.3 Survey data collection

The research data were collected by means of a traditional personal interview to improve the opportunity for feedback to and from the respondents. A pilot questionnaire was handed out to the beef processors. Random sampling was used based on the companies' database from the local government livestock and husbandry office. In the questionnaire, beef processors were asked to rank the 10 profiles on a scale of 1 to 10, where 1 is least preferred and 10 is most preferred. The survey was conducted between January and December 2004 with 43 abattoirs. They were located in the Inner Mongolia Autonomous

region (16), *Anhui* province (12), *Jilin* province (1), *Hebei* province (1), *Shanxi* province (1) and *Shandong* province (12).

## **4. Results**

### **4.1 Estimation of conjoint model**

Before estimating the model, we have to make an assumption about the composition rule and the types of relationships between preferences and attribute levels. In this study, it was assumed that there is an additive rule involving part-worth relationships between the preferences and the attribute levels. The SPSS (version 14.0) computer program makes provision for simulation choice models. The part-worth utility and relative importance of attribute evaluations are displayed in Table 2.

There were 344 observations in the data set because 43 respondents each provided eight observations (the two hold-out scenarios were not used to estimate the model). The model was estimated for the whole sample and for a selected large abattoir sample. Those estimated were normalised so that they could be compared with each other. For all the attribute levels, the larger the coefficients, the more important this attribute is for channel decision. The evaluation of the part-worths of the attributes showed that, for the sample average, trust is the attribute that had the largest value (1.058), and the attribute of traceability has the lowest score of 0.116. In contrast, large abattoirs paid more attention to the type of supplier, followed by monitoring, trust and traceability.

The results of relative importance of the various attributes of the supply channel are presented in Table 2 and Figure 1. The type of supplier was the most important attribute of the supply channel (38.46%), while the trust from processors to cattle farmers was the second most important attribute (31.53%), followed by the traceability (19.73%). The attribute of the ability for processors to monitor farmers' activities was deemed least important relative to the other three attributes (10.28%). Conversely, large abattoirs placed more emphasis on the supplier type and the ability to monitor farmers' activities. These results seem logical. The increased importance of supplier type indicated that large processors prefer to be in a regular supplier relationship



that includes buying cattle from not only contracted farmers, but also ‘fixed’ dealers. Obviously, this would reduce information and monitoring costs for buyers. As there is growing competitiveness in the market, sourcing cattle is a major task, especially for large abattoirs. They might welcome the choice of buying cattle from dealers. Besides, the increasing importance on monitoring indicated that they have more interest in the long-run development of their supply chain relationships, which would foster consistency of supply and product quality.

Table 2 Results of Conjoint Analysis: Whole Sample and A Large Abattoir\*

Attributes and levels	Utility (part-worth)		Relative importance%	
	Sample averaged	A large abattoir	Sample averaged	A large abattoir
Supplier			38.46	57.14
Regular	0.907	2.000		
Occasional	-0.907	-2.000		
Traceability			19.73	7.14
Easy	0.116	0.250		
Difficult	-0.116	-0.250		
Trust			31.53	14.29
Good	1.058	0.500		
Bad	-1.058	-0.500		
Monitor			10.28	21.43
Easy	0.233	0.750		
Difficult	-0.233	-0.750		
Constant	4.500	4.500		
Pearson's R	0.967	0.964		
Kendall's tau	0.857	0.857		
Kendall's tau for Holdouts	1.000	1.000		

\* A large cattle abattoir with annually processing capacity of more than 60,000 head.

Person's R and Kendall's tau were also reported for the sample average and the large abattoir group. These correlation coefficients demonstrated the good fit of the model. Moreover, the high value of Kendall's tau for two holdout scenarios confirmed the validity of the model.

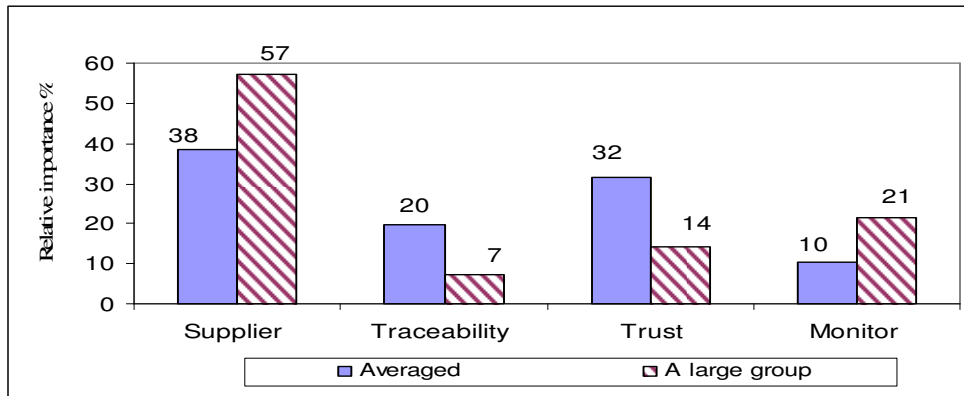


Figure 1 Whole Sample vs the Large Abattoir Group

The results indicated that the ideal supply chain is consistent with *a priori* assumptions. Long-term supply relationships, good trust, easy traceability, and ability to monitor would be the preferred characteristics of the supply channel. However, the existing Chinese supply chain is not constituted in this way. These results reflect the fact that the supply chain channels are at a relatively early stage of a vertical or horizontal coordination. Most processors felt it hard to monitor the farmers' activities, as cattle sales through animal markets and at the farm gate were predominant. Although the large processors made improvements by emphasising supplier type and monitoring ability, they were still weak in traceability and trust. Not many sales came through contracted farmers. In order to predict the possibilities for processors to choose these alternative supply channels, a simulation was completed.

#### 4.2 Channel choice simulation

The estimated part-worth of the attributes can be further used to formulate any attribute combination. Three new choice simulators were selected. The first simulated supply chain channel was constructed with all positive attribute levels of supplier and trust, but with difficult traceability and difficult monitoring. This simulation was designed to represent procurement from dealers. The second channel is with all positive attribute levels: regular supplier; easy to trace back the quality; good trust between the trading parties; and easy to monitor farm activities. This simulation was designed to represent procurement from contracted farmers. In contrast, the third scenario contained

a combination of all negative attributes, which may be procurement through live animal markets.

Conjoint simulation predicted that the preference scores given by the sample average for channel 1, channel 2 and channel 3, were 6.35, 6.58 and 2.42, respectively. It is clear that on average, processors mostly preferred channel 2, followed by channel 1 and channel 3. When applied to large processors, the results seemed to be similar to the sample average but with more emphasis, with preference scores for these three channels: 6.0, 8.0 and 1.0 respectively.

Furthermore, the conjoint procedure can estimated for different choice models the probabilities of food processors choosing from these three alternative scenarios. Three choice models were adopted: the maximum utility, the Bradley-Terry-Luce (BTL) model and the Logit model. The simulation results are summarised in Table 3.

**Table 3 Results of Conjoint Simulations**

	Channel 1	Channel 2	Channel 3
Channel Characteristics			
Supplier	Regular	Regular	Occasional
Traceability	Difficult	Easy	Difficult
Trust	Good	Good	Bad
Monitor	Difficult	Easy	Difficult
Preference Scores			
Whole sample	6.349	6.581	2.419
A large group	6.000	8.000	1.000
Probabilities Chosen			
Max Utility	38.4	59.3	2.3
Bradley-Terry-Luce	41.0	43.1	15.9
Logit	42.6	54.1	3.3

In these different models, probabilities for channel choices varied. Channel 3 would have the least share of procurement among the three channels. For the second channel, representing procurement from regular suppliers, between 43.1 percentage and 59.3 percentage of processors would prefer that. For the first channel, procurement from dealers, 38.4 to 42.6 percent of processors preferred this channel. Hence, all three models confirm that cattle procurement for processors from contracted farmers is the most preferred, followed by through dealers and through markets.

## 5. Summary and Conclusion

This paper analysed the processors' preferences across procurement channels using conjoint analysis. Four attributes related to transaction costs with cattle supply channels were combined to represent different channels. The results for the average whole sample and for the selected large abattoir group were both presented.

For the whole sample, supplier type was found to be the most important transaction cost attribute, followed by the trust level, traceability and monitoring ability. A simulation of procurement method in which the supplier type was regular long-term; with easy traceability from processors to cattle farmers; trust between processors and cattle farmers; and easy monitoring of farm activities, had a high preference score and a large share of procurement among all the scenarios. This scenario represented contacts directly with farmers. Meanwhile, a simulation of the channel with all negative attributes (which approximately stands for sale through markets), had the least preference score and hence least possibilities to be selected. If the supply channel is characterised with two positive attributes (supplier type and trust) and two negative (traceability and monitor), which may represent procurement from dealers, it had a predicted preference score in the middle between the previous two.

Compared with the sample average, the analysis of the sample selected from the large abattoirs group revealed a change in the priority of rating of the attributes. Except for the attribute of supplier type which was selected as the most important by both groups, monitoring of the farm became more important for large abattoirs and was the second most important attribute, while traceability and trust tended to be less important than for the average sample. This suggests that large abattoirs tend to prefer supply stability rather than traceability and trust. When facing a cattle shortage<sup>2</sup>, to keep a regular supply and monitor farm activities is more important. Clearly, the quality requirement from customers was not pressuring processors to improve the ability to trace back to farmers. Thus, this will challenge the policy makers to

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<sup>2</sup> During the survey, medium and large processors commented that they had difficulties in procuring cattle locally in 2004 due to the prices being at a historical high over recent years.

carry out measures to encourage activities such as forward contracting between producers and processors to ensure food safety and quality of products.

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