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Does Market Upgrading Benefit Farmers? Market Differentiation, Contract Farming, and Professional Cooperatives in China's Pork Processing Industry

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August 2016

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Keywords: pork processing industry, differentiated demand estimates, value chain, contract farming, farmers professional cooperatives

JEL classification: Q13 L22 O13

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Abstract

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Keywords China, pork processing industry, differentiated demand estimates, value chain, contract farming, farmers professional cooperatives

JEL Classification Codes Q12 L22 O13

1 Introduction

This study attempts to establish whether market differentiation benefits farmers. Whether differentiation and upgrading of the market benefits farmer is a classical and important problem in the literature.This study contributes to this field by extending empirical analysis to capture the structure of demand.

In order to protect the interest of farmers and raise their income, farmers' professional cooperatives (FPCs) have been promoted by the Chinese government. In additon, the World Bank has cooperated to develope the design of the institution (World Bank, 2006: Xu et.al 2013). Theoretically, securing the rights of farmers and integrating their transactions might strengthen farmers' bargaining power on transactions and is expected to improve their income and production. Does this really occur in China?

Substantial volumes of fieldwork and surveys on the impact of FPCs have accumulated (Zhang, 2001: Guo, 2005: Han, ed. 2007: Ikegami et.al 2009: Zhao and Yuan, 2014). The case studies and surveys essentially report favorable results on FPCs in which collaboration between firms and farmers generates win-win relationships. Cooperative membership raised the icome of apple farmers in China. This is confirmed by an endogenous switching regression model (Ma and Awudu, 2016). A case study on the internal management mechanism of FPCs in Hebei Province implies that FPCs are induced to rationalize resource allocation in the village studies. This could imply that FPCs improve the efficiency and value of transactions (Yamada, 2016).

Contract farming is another institutional arrangement expected to enhance the bargaing power of farmers. Contract farming prevails through the initiatives of agro-industry firms. This arrangement exists to improve quality or procurement certainty for firms' production. In addition, it presumably improves the bargaining power of farmers and improves the value of agro-products. Furthermore, it enhances the benefits of trade and improves the income of farmers and the profits of firms (Miyata, 2009: Abebe et.al, 2013). Due to lack of effective public enforcement mechanisms, contract fulfillment is substantially affected by types of private enforcement mechanism between firms and farmers. Agro-firms are cautious about opportunistic behavior of farmers in China (Guo and Jolly, 2008). This environment may substantially affect bargning power between firms and farmers in China.

The pork-processing industry in China experienced a drastic structural change in the mid 2000s mainly due to shortage of rural labor. Farmers preferred working in the non-agricultural sector in urban area over breeding hogs in backyards. The industry underwent a shift from backyard hog farms to intensive commercialized farm alongside with rapid growth in production volumes and specialization. At the same time, the costs for environmental protection of the industry increased drasctically (Zhao and Han 2014 : Jia 2012). Chinese Academy of Agricultural Science (CAAS) surveys, which this study use, also captures a drastic entry and exit numbers as described in Appendix A.

This study aims to quantitatively capture the distribtion of profit between firms and farmers. We first estimate consumer welfare by types of transaction, such as contract farming or FPCs, and then, we statistically tests whether the institutions improved the welfare of farmers. We find that contract farming and FPCs improved economic value of transaction, but do not raise the income of farmers. The approach we employ enables us to capture the whole distribution of the value among the participants of the value chain, that is, firms, consumers and farmers. The case studies or descriptive statistics analysis cannot depict the whole picture of the value distribution. Our approach can complement previous studies' findings.

The rest of this paper proceeds as follows. Section 2 describes the framework and estimation procedure. Section 4 reports the results of demand function estimation and detailed descriptive statistics on the estimated values of transaction and their distribution, such as consumer surplus, benefits, price cost margin, and costs. Section 5 reports results of statistical test for whether the new transaction institution, such as contract farming or FPCs, contributes to increasing the income of farmers. Section 6 concludes.

2 Research Strategy

2.1 Estimation of Differentiated Market Structure

This study aims to identify whether upgrading of China's pork market has progressed, whether the upgrading generates higher economic value of transaction and whether this value is distributed to farmers too. In addressing these research problems, we need to quantify the utility of the pork produced and sold, as well as price and cost. Once the data are obtained on the product's utility, benefits or willingness to pay, the value of transaction, and distribution of the value along value chain can be quantified.

$$Value\ of\ transaction = B^{consumer}_{product} - P_{product} + P_{product} - C_{product} \tag{1}$$

Here, $B^{consumer}_{product} - P_{product}$ represents a fraction of value that distributed to the consumer, whereas $P_{product} - C_{product}$ belongs to the suppliers. This empirical study attempts to quantify the value of transaction in in China's Jilin and Henan provinces pork markets and then tests the impact of contract farming or FPCs on their value.

2.1.1 Model for demand estimation

To estimate $B^{consumer}_{product}$ in equation (1), we follow Berry(1994) and the Berry-Levinson-Pakes (BLP) literature of the estimation of a differentiated market. Details of the model are developed in Appendix B. Here, we provide a simple description of the basic estimation idea.

Assume a consumer has a choice to buy pork from firm A or firm B. The consumer will buy pork from firm A when his or her utility of firm A's products is higher than the product of firm B: otherwise, he or she would not buy it, denoted as "Not buy." The utility of pork from firm A can be described as follows:

$$u_A = -\alpha_i p_A + \beta X_A + error \geq u_B \geq u_{Notbuy}$$

If we further assume that the probability of buying pork from firm A follows logit forms. Then,

$$Prob_{BuyA} = \frac{exp(-\alpha_i p_A + \beta X_A + error)}{exp(U_A) + exp(U_B) + exp(U_{Notbuy})}$$

An point of assumption taken from Berry(1994) is that the probability of buying pork from firm A is equal to the market share of pork A, s_A , where the denominator includes the share of potential buyers, not only actual buyers.

Under these assumptions, market share s_A can be described as follows:

$$\begin{aligned} s_A &= \frac{Sales\ quantity\ of\ product\ A}{Sales\ quantity\ of\ product\ A + \ Sales\ quantity\ of\ product\ B\ +\ Potential\ demand} \\ &= \frac{exp(-\alpha_i p_A + \beta X_A + error)}{exp(U_A) + exp(U_B) + exp(U_{Notbuy})} \end{aligned} \tag{2}$$

Here, another wise treatment of the BLP procedure is to assume $U_{Notbuy} = 0$. If this holds, $exp(U_{Notbuy})$ becomes $exp(0) = 1$ and exploits its nature. Under this assumption, the market share of "Not buy" becomes

$$\begin{aligned} s_{Notbuy} &= \frac{exp(0)}{exp(U_A) + exp(U_B) + exp(U_{Notbuy})} \\ &= \frac{1}{exp(U_A) + exp(U_B) + exp(U_{Notbuy})}. \end{aligned} \tag{3}$$

Combining equations (2) and (3) yeilds the following relationship.

$$\frac{s_A}{s_{Notbuy}} = exp(-\alpha_i p_A + \beta X_A + error).$$

Taking the logarithm of this equation, this becomes;

$$ln(s_A) - ln(s_{Notbuy}) = -\alpha_i p_A + \beta X_A + error. \tag{4}$$

This is the estimation equation of the demand function in this study. The consumer surplus of pork from firm A can be derived from the right-hand side of equation (3)

$$CS_A = \frac{-\alpha_i p_A + \beta X_A}{\alpha_i}$$

The consumer surplus, benefits and price from firm pork A have the following relationship.

$$CS_A = B_A^{consumer} - P_A{}^1 \tag{5}$$

2.1.2 Empirical Procedure

The empirical procedure of this study is as follows. First, we define the markets so as to set the total market size. We set the boundary of a prefectural-level city as the unit of the market.[2]

In the second step, we assume "potential total demand"is population multiplied by 10 kg. Actual per capita consumption of pork of the whole nation in 2012 was 5 kg; however,

[1] For simplicity of description, we assume there is only one consumer in the market. In the real world, the consumer surplus of pork from firm A is the sum of the benefits of pork from firm A to those who actually choose it.

[2] The CAAS surveys have information about location of customers, according to the types of sales outlet. However, we do not fully utilize this information in this study. Extension and elaboration of this market definition will be a challenge for a future study.

European consumed 10kg per capita in the same year, and thus, we employ 10 kg as the potential consumption demand.

In the third step, we define independent variables in the estimation equation. A survey of CAAS whose data we use in this study, has information of each transaction with several types of sales outlets and procurement sources including price, quantity and characteristics of products. We use these transactions as the unit of observation. We obtain quantity (kg) and price (RMB/kg) and compute each product's market share. Then, we compute the share of "Not buy" by potential market consumption minus the total quantity of pork sold by the surveyed firms in respective markets.

The fourth step is the estimation. We estimated the demand parameters using generalized method of moment (GMM) procedures. Identification is an important topic, We provide details in the following Subsection 2.1.3.

The demand function takes a nested logit form, which is described in equation (15). As ρ is close to 1, it implies that the market is more closed to complete homogenization. Here, we can compute the consumer surplus and benefits of each transaction's products.

The fifth step is to compute price elasticities and price cost margin. Once the demand function parameters are obtained, particularly, the coefficient α_i on price in equation (3), we can derive the own price elasticity of product j and the cross price elasticity between products j and k from logit demand form as the following relationship:

$$\begin{aligned} \textit{own price elasticity} &= \alpha_i * price_j * (1 - share_j) \\ \textit{cross price elasticity} &= -\alpha_i * share_j * share_k \end{aligned}$$

The (marginal) cost is computed from the equation: $p_{jt} - mc_{jt} = -q_{jt} \cdot \frac{\partial p_{jt}}{\partial q_{jt}}$ where $\frac{\partial p_{jt}}{\partial q_{jt}} \frac{q_{jt}}{p_{jt}}$ is the estimated price elasticities.

The seventh step is to test the relationship between these market structure variables and contract farming, FPCs or other institutional setting.

2.1.3 Identification

In the demand estimation, the appropriate choice of instrument variables (IVs) is the key to obtain consistent parameter of α_i. As textbooks of econometrics often describes price variables is suffered from endgeneity problem because price is determined at an interaction between demand and supply. Here, we need to obtain demand parameters by eliminating supply or cost factors.

We employ the average price of other sales outlets of the same firm. The rationality and assumption behind this choice is that prices of the same firm at different sales outlets is correlated only with cost factors, not demand factors. As is observed easily, the pork market is very competitive, and firms can set the price as only cost plus individual market's demand factors. We assume that a firm cannot afford to set cross-pricing across different sales outlets as competition is very intensive. As described in the following section, this assumption holds and the IV works ideally. The variables pass the endogeneity test or over identification test. The partial R square is not low.

2.2 Data

The CAAS conducted a series of pork market surveys in 2008, 2010 and 2015 to document the rapid transformation of the industry. The surveys were implemented among hog slaughtering firms in Henan and Jilin provinces. Wang and Watanabe (2008) summarized the results of the 2008 survey. This study utilizes 2008, 2010 and 2015 surveys. Between 2008 and 2015, the pork industry in China experienced a big transformation from scattered pig-raising to concentration of big farms. This occurred alongside a hike in wage costs caused by labor shortage that developed from the mid 2000s, which also resulted in transformation of the production system. The survey provides a good base for tracing the transformation process.

2.2.1 Survey Implementation

The firm survey was conducted in two provinces of CAAS in each province from March to June 2008, November to December 2010, and November to December 2015. In each province, more than 100 firms were interviewed. The questionnaire was prepared by the authors of this report in consultation with local statistical officers as well as livestock experts in the CAAS. A total of 208 firms in 2008, 208 firms in 2010 and 196 firms in 2015 were surveyed in Jilin and Henan provinces. The accumulated actual number of firms surveyed is 516.

The firm questionnaire included detailed questions primarily on the characteristics, finance, investment plan, cash management, transactions with financial institutions, marketing, procurement, and transaction with contract farmers. The questionnaire was drafted by the authors, pre-tested by local enumerators, checked by the field supervisor and then revised in 2008. We finalized the questionnaire according to the results of the pilot surveys and the feedback from the enumerators.

The firm survey was conducted in Jilin and Henan provinces. These provinces were chosen because production of porks of these provinces in both ranked high in China. The interviewed firms were selected by stratified random sampling from the list of firms obtained from the local government statistical offices. Stratified by number of slaughtering, we interviewed small- medium, and large firms.

2.2.2 Survey Structure

The objective of the survey was to obtain information, such as price, quantity, and other related transaction issues, of hog slaughtering and processing firms. All pork marketed to consumers in China follows a very similar procedure set down by the government. Hogs are bred and produced by farmers, then become pork by slaughtering firms and are then marketed to the consumers. The slaughtering firms are located between farmers and consumers and are related to entire pork supply chains, thus information from this phase of the process is ideal for capturing an overview of the pork product chain. In addition, we are interested in industry transactions with financial institutions. Surveyed firms were asked to choose one concrete customers transaction partner among wholesalers, restaurants, supermarkets, and wet markets, and then from intermediary, contracted farmers, and independent farmers. After firms made their choices, they were asked to answer a number of questions related to pricing, quantity, and other transaction conditions with these partners. In addition, the surveyed firms were asked to provide answers regarding historical transaction records with financial institutions and basic information on firms' characteristics.

2.3 Market definition

We set out the prefecture-level city as the boundary of the market in this study. Table 1 lists the names of cities and their basic sizes. Table 2 summarize profiles of the markets sorted by type of sales channel. In this study, thie sales channel is regarded as a source of differentiation of products. Among four channels, agents and wet market account for the larger propotion of sales targets than the other two channels.

Table 1: **Size of Markets Defined (Mean, 2005 to 2010, 2013 to 2015)**

Prefecture-level city	**Pork quantity** kg, per transaction	**Population** 0000
Henan:		
Anyang	689,045	592
Hebi	1,794,511	164
Jiaozuo	14,730,941	367
Kaifeng	240,631	542
Luohe	638,535	274
Luoyang	1,410,536	697
Nanyang	581,529	1,177
Pingdingshan	126,144	542
Puyang	2,021,567	414
Sanmenxia	519,613	229
Shangqiu	2,232,040	930
Xinxiang	924,173	673
Xinyang	1,401,237	795
Xuchang	1,479,541	494
Zhengzhou (Provincial capital)	80,249	883
Zhoukou	664,211	1,199
Zhumadian	971,697	894
Jilin:		
Baicheng	445,397	201
Baishan	681,366	128
Changchun	3,918,654	756
Jilin	602,293	432
Liaoyuan	64,000	123
Siping	21,205,436	334
Songyuan	455,226	233
Tonghua	78,625	224

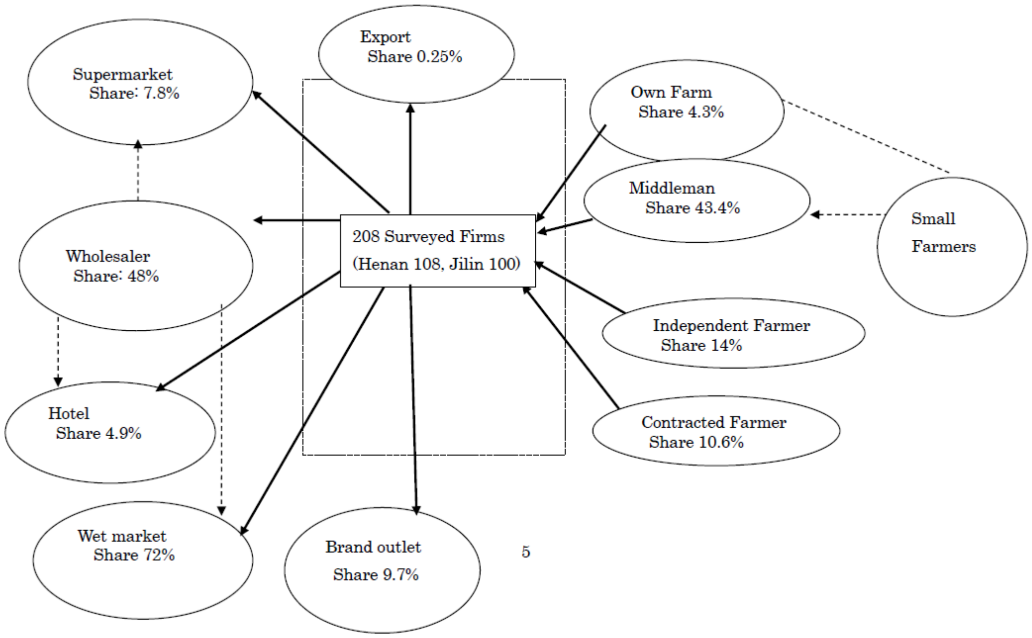
Source: CAAS survey for pork quantity. State Statistical Bureau for Population

Table 2: **Summary Statistics**

Channel	mean	sd	min	max	N
Agent					
Price (RMB/kg)	15.832	4.351	6	28	556
Volume of meat traded	3,476,974.172	26,254,210.934	79	420000000	556
Market share within Channel	0.247	0.328	0	1	556
Established year	1997.724	13.153	1952	2013	532
Henan	0.775	0.418	0	1	556
Jilin	0.225	0.418	0	1	556
Restaurant					
Price (RMB/kg)	17.109	4.466	8	32	146
Volume of meat traded	359,090.027	1,108,604.708	120	10,183,252	146
Market share within Channel	0.533	0.408	0	1	146
Established year	1995.750	15.847	1957	2013	136
Henan	0.911	0.286	0	1	146
Jilin	0.089	0.286	0	1	146
Supermarket					
Price (RMB/kg)	16.947	4.266	8	29	254
Volume of meat traded	2,080,348.091	22,111,776.525	83	350000000	254
Market share within Channel	0.434	0.401	0	1	254
Established year	1996.296	15.775	1957	2013	240
Henan	0.748	0.435	0	1	254
Jilin	0.252	0.435	0	1	254
Wetmarket					
Price (RMB/kg)	15.727	4.483	5	34	672
Volume of meat traded	1,096,606.988	5,809,420.004	84	82,140,000	672
Market share within Channel	0.202	0.315	0	1	672
Established year	1993.464	16.375	1952	2013	649
Henan	0.670	0.471	0.000	1.000	672
Jilin	0.330	0.471	0.000	1.000	672
Total					
Price (RMB/kg)	16.077	4.431	5	34	1,628
Volume of meat traded	1,996,899	18,069,590	79	420,000,000	1,628
Market share within channel	0.283	0.360	0	1	1,628
Established year	1995.556	15.305	1952	2013	1,557
Henan	0.740	0.439	0	1	1,628
Jilin	0.260	0.439	0	1	1,628

Source: CAAS survey

Figure 1: Transaction Structure of Surveyed Firms: 2010



Source: CAAS survey

Note: "Hotel" includes sales to "Hotel and Restaurants."

3 Estimation Results

3.1 Demand estimates

Estimated demand parameters are presented in Table 3. In these estimates, we regard different sales outlets (indirect sales via agent, and direct sales to restaurant, supermarket and wet market.). Identification by IV is successful, as the GMM c statistics does not reject the exogeniety assumption of IVs. Hansen's J statistics does not reject the result as an appropriate identification, and nor are any of the IVs is exogenous. The partial R square reached 0.6975, which is a satisfactory level.

As consistency of the parameters was not violated, we can interpret the parameters as a description of a real market structure. Here, we have three main findings: (1) differentiation of pork products of firms in Henan and Jilin are progressed. Size of consumer surplus of the buyer (i.e., benefit minus price) is in the following ascending order; direct sales to restaurant, supermarket, wet market and indirect sales via agent. (2) A certain level of homogeneity within the each differentiated cluster is observed. This is implied by nesting parameters ρ, which is 0.603. This is not low but it is not extremely high. (3) Coefficients of year dummies increased progressively. This implies that the consumer surplus of pork among the surveyed firms improved over time. Upgrading of pork processing industries is also observed from other information. We discuss this in the next subsection.

4 Findings on market structure

4.1 Market Upgrading

As mentioned already, market upgrading is defined in this study as increased value of transacation, that is consumer welfare plus firms' profit. Estimated demand parameters show the structural parameters of consumer surplus. Positive and increasing coefficients of year dummies indicate total improvement of consumer surplus took place during the estimation period[3]. In addition to positive and increasing coefficients of year dummies in the demand function, development of price elasticity of demand indicate technical progress and increasing evaluation by the consumer of the industry's products. Own price elasticity of demand indicates consumers will buy more if the price decreased as revenue of sellers will increase. This occurs when the price elasticity of demand is higher than 1: the larger the elasticity is, the more sensitive to price is the demand for products. As summarized in Table 4, the elasticity increased as time passes. It was only 1.1 initially, increased to 2.2 and stay around 1.5 or higher thereafter. During this period, price hike due to supply-side effect, such as pig cycles, is observed. However, price elasticity indicates a consumer preference against price increased. A consistent increase implies that an increase of consumers' evaluation of products supplied by the industry took place. These results indicate a steady market upgrading took place in the pork processing industry between 2005 and 2015.

In addition to the year dummies parameter, price elasticity, the estimated size of consumer surpluses, and benefits increased. These provide evidences of an upgrading of the industry.

[3] This interpretation is an analogy of total factor productivity. Technical progress, which is a factor other than an increase of input factors, is captured as residuals or year dummies. Market upgrading, an increase of total consumer surplus attributable to a factor other than price and characteristics of the products can be interpreted as captured by the year dummies.

Table 3: **Estimates of Demand Function: Jilin and Henan in 2005 to 2010, 2013 to 2015**

	$\ln(s_{product})$-$\ln(s_{notbuy})$
Price	-0.052**
	(0.020)
$\rho_{channel}$	0.603***
	(0.029)
Restaurant	-2.258***
(Reference=Agent)	(0.132)
Super market	-1.452***
	(0.101)
Wet market	-0.219***
	(0.081)
2006	0.270***
	(0.097)
2007	0.724***
	(0.202)
2008	0.845***
	(0.180)
2009	1.085***
	(0.161)
2010	0.607***
	(0.179)
2013	4.679***
	(0.503)
2014	4.903***
	(0.399)
2015	4.306***
	(0.423)
Constant	-5.684***
	(1.535)
City dummies	Yes
Firm dummies	Yes
N	1614
R^2	0.862
Partial R^2	0.6975
GMM C statistic	chi2(1) = -1.4e-13
	$p = 1$
Hansen's J statistics	chi2(1) = 4.3e-15
	$p = 1$

Standard errors are in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: **Market Upgrading**

Year	**Price Elasticity** mean	**Consumer Surplus** per transaction, mean	**Benefit** per transaction, mean	**Obs**
2005	1.194	7.878	18.72	251
2006	1.51	8.673	22.3	267
2007	2.291	10.98	31.5	297
2008	1.838	19.21	35.94	237
2009	1.73	19.64	35.87	219
2010	1.854	19.44	36.69	244
2013	1.529	10.37	28.51	81
2014	1.451	17.2	34.42	93
2015	1.708	14.03	33.07	91
Total	1.721	13.97	30.26	1,780

Source: Estimates by authors from CAAS survey

4.2 Value of Transaction by Sales Outlets, and Procurement Sources

Table 5 presents the estimated value of transaction, which was described in equation (1), estimated benefit (B), cost (C), price cost margin (PCM), consumer surplus (CS) and surveyed price (P). Notable findings here are as follows. (1) Jilin's median values of transaction value and benefit are higher in all types of sale outlets than their counterparts of Henan, although the actual average price is almost the same. (2) Restaurants and supermarkets generate higher values and benefits. The price cost margin and firm profit are not lower than those of other sales outlets. However, the cost of hog, that is the income of farmers, is observed as no higher than the income of other sales outlets. (3) On the procurement side: procurement from contractors generates higher value, and benefits in Jilin. Organizing own procurement team generates higher cost of hogs, that is income of farmers. (4) Transactions with FPCs definitely contributed to raising the value of transaction, benefits and profit of firms. The cost of hogs, that is, the income of farmers, is observed to be lower than that of non-cooperatives.

4.3 Geographical Distribution

Geographical distribution might have involved a systematic difference in utilizing contract farming or cooperatives. Therefore, we sort price, PCM and cost computed by source of procurements and by provinces in Table 5.

Indirect procurement via agent has a substantial share of overall procurement in both Jilin and Henan provinces. The price cost margins from these types of procurement are around 8.5 RMB for both provinces. There are no big outliers when sorting by cities. On the other hand, procurement from contract farmers generates higher price cost margins than the other procurement sources. Comparing Jilin and Henan, Jilin generates higher PCM from procurement from contract farmers.

Table 5 also shows the median price cost margin between firms who trade with FPCs and those who do not, and by provinces According to this table, average price cost margins for firms that utilize FPCs are higher than those who do not for both Jilin and Henan.

Table 6 shows the median price cost margin between firms who procure hogs from contractor by city. Here, we can observe that a large difference among cities in terms of price cost margin, that relies on transaction with contractors.

5 Test: Differentiated Market and Contract Farming/Cooperatives

This study is interested in whether market upgrading and institutional setting affect the profits of farmers. The observation of distribution of value in Section 4 implies that contract farming and cooperatives contribute positively to increase the value of transaction, but the cost of hog, that is, the income of farmers are maintained at the same level as other types of procurement source.

Tables 7 and 8 shows the results of the t-test on whether the mean of each groups is significantly different from each others. Firms that procured hogs from contractors and own farm generate higher benefits and consumer surplus than transaction with agent, own team and independent firms. Their transaction prices with customers are higher than independent farmers, but are no higher than that of their counterparts, own farm, own team and agent. It is noteworthy that the cost of hog, or the purchase price from contractor farmers is lower than when the farmer sells to the agent or the procurement team organized by firms. Although the contractor farmers appear to have improved economic value from trade, farmers do not actually enjoy increased income.

Table 8 shows a similar t test on the difference in the mean between firm that trades with FPCs and those that do not trade with. The results again show a less ideal results: the estimated cost and price cost margins of hog, the income of farmers who trade via FPCs, is no higher than for those who do not trade via FPCs, although FPC contributed to improving the benefit, consumer price and price.

6 Conclusion

This study quantified the value of transaction of hog and its distribution among their sales outlets and procurement partners. The main findings of this study are as follows. (1) The pork-processing industry in Henan and Jilin provinces are successful in upgrading the industry between 2005 and 2010 in terms of the size of welfares provided to society. (2) Firms that utilized contract farming or FPCs succeeded in upgrading benefits and consumer surpluses, and their own price cost margins. (3) However, farmers, who produced hogs for processing did not benefit from the upgrading of the industry as a whole.

Demand estimation enable us to quantify the distribution of value among firms, farmers and customers explicitly. This is the main contribution of this study.

We confirmed that contract farming and FPCs contributed to upgrading the economic value of the industry. In this positive sum environment, it would be feasible to increase profit distribution to farmers. However, the observations here show the opposite results. Further study is required to investigate the factors that hinder, such a win-win distribution relationship between farmers and firms.

A limitation of the current study is as follows. In order to confirm the validity of our findings, we need to test the robustness of the estimated cost and price cost margins based on different information. The CAAS survey contains information on actual prices between farmers and firms, and the attributes of transactions, such as type of meat processing, safety investigation points, species or size, and feeding days of hogs. Comparing the estimated procurement prices of hogs with the actual prices would confirm the distribution of the value between firms and farmers. The attributes of traded hogs between farmers and customers would yield richer information about which factors affect the distribution of value between firms, sales outlets and farmers.

Table 5: **Distribution of Value per Transaction: RMB, median**

Sales outlets	**Value**	**Benefit**	**CS**	**Price**	**PCM**	**Cost**	**Obs**
Henan							
Agent	17	23	7.9	16	8.2	6.1	432
Restaurant	20	25	7.9	17	12	3.7	135
Supermarket	19	26	8.2	17	9.8	4.8	189
Wet market	17	24	8.3	16	7.8	6.9	448
Total	18	24	8.2	16	8.2	6.1	1,204
Jilin							
Agent	22	30	12	16	8	6	125
Restaurant	62	63	42	16	9	5	13
Super market	28	36	19	16	9	6	64
Wet market	21	28	12	16	8	6	222
Total	22	30	13	16	8	6	424
Procurement source	**Value**	**Benefit**	**CS**	**Price**	**PCM**	**Cost**	**Obs**
Henan							
Agent	18	25	9	16	9	6	565
Contractor	16	21	4	15	9	5	147
Independentfarme	18	20	5	15	10	5	80
Ownfarm	23	29	10	19	12	4	33
Ownteam	18	26	9	16	8	6	364
Total	19	25	9	16	9	6	1,189
Jilin							
Agent	21	29	12	16	8	7	292
Contractor	94	103	86	16	9	6	36
Independentfarme	14	22	6	12	8	3	49
Ownfarm	21	40	29	13	8	3	11
Ownteam	63	104	86	16	8	8	36
Total	22	30	13	16	8	6	424
Cooperative	**Value**	**Benefit**	**CS**	**Price**	**PCM**	**Cost**	**Obs**
Henan							
No trade with FPC	18	26	8	16	8	7	503
Trade with FPC	25	28	9	18	16	4	108
Total	19	26	9	16	8	7	611
Jilin							
No trade with FPC	50	57	42	16	8	8	98
Trade with FPC	95	103	86	16	9	8	13
Total	50	58	42	16	8	8	111

Source: Estimates by authors from CAAS pork processing industry survey

Note (1) Value =benefit - cost. Consumer Surplus (CS) = benefit - price.
Price Cost Margin (PCM)= price -cost.

Note(2) Cost here is estimated based on the assumption that pork processing firms have sufficient bargaining power with their procurement source to maximize their revenue from the transaction. If the bargaining power of farmer, procurement sources were large, actual cost would become would move close to the transaction price. Thus, the actual cost of hogs, that. is, the income of farmers, is located somewhere between the estimated cost in this table and the price.

Table 6: **Price Cost Margin (PCM) of Firms that Procures Hogs from Contractor Most : Median by Cities**

City	Price	Estimated PCM	Estimated Cost
Hebi	19.3	19.6	0.4
Kaifeng	15.0	8.0	6.6
Luohe	14.8	21.2	-6.0
Luoyang	16.5	12.0	5.2
Nanyang	12.0	8.2	2.2
Pingdingshan	16.0	10.5	6.4
Puyang	11.0	12.5	-1.5
Shangqiu	16.1	7.7	8.4
Xuchang	13.0	9.3	2.7
Zhengzhou	18.0	7.8	10.0
Zhoukou	19.0	7.7	11.3
Provincial Total	15.0	8.8	5.4
Baishan	20.0	8.2	11.8
Changchun	13.9	14.1	-1.1
Liaoyuan	14.0	12.8	0.7
Siping	16.0	8.5	6.4
Songyuan	22.0	19.7	2.3
Provincial Total	15.9	9.4	5.7

Source: Estimated by authors

Table 7: **T test on Mean Differences of CS, Benefit and Price among Procurement Channels**

Benefit	Agent	Contractor	Independent F	Own farm	Own team
Agent	0				
Contractor	-6.419***	0			
Independent farmer	5.296***	11.715***	0		
Ownfarm	-13.387***	-6.968*	-18.683***	0	
Ownteam	-2.718**	3.701	-8.014***	10.669***	0
CS	Agent	Contractor	Independent F	Own farm	Own team
Agent	0				
Contractor	-7.135***	0			
Independent farmer	3.676***	10.811***	0		
Ownfarm	-12.369***	-5.234	-16.045***	0	
Ownteam	-2.262**	4.872**	-5.938***	10.107***	0
Price	Agent	Contractor	Independent F	Own farm	Own team
Agent	0				
Contractor	0.716**	0			
Independent faremer	1.620***	0.905**	0		
Ownfarm	-1.017	-1.733**	-2.638***	0	
Ownteam	-0.455	-1.171***	-2.076***	0.562	0
PCM	Agent	Contractor	Independent F	Own farm	Own team
Agent	0				
Contractor	-1.313**	0			
Independent farmer	-0.590	0.723	0		
Ownfarm	3.522	4.835	4.111	0	
Ownteam	-0.505	0.808	0.085	-4.027	0
Cost	Agent	Contractor	Independent F	Own farm	Own team
Agent	0				
Contractor	2.029***	0			
Independent farmer	2.210***	0.181	0		
Ownfarm	-4.539	-6.568	-6.749	0	
Ownteam	0.049	-1.979**	-2.160**	4.589	0

Standard errors are not displayed, Tested differences are defined as column-line

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: **T test on Mean Differences of CS, Benefit, Price and Cost between Cooperative/Non-cooperative**

	Non-nooperative
Benefit	
Cooperative	-6.323**
CS	
Cooperative	-5.342**
Price	
Cooperative	-0.981***
PCM	
Cooperative	-2.591
Cost	
Cooperative	1.610

Standard errors are not displayed. Tested differences are defined as column-line

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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A Profiles of CAAS Survey Results

Discussion: Henan versus Jilin/ 2008 versus 2010 and 2015 Here we focus on the quality control of products of pork processing firms in Henan and Jilin. We find a clear difference between Henan and Jilin in 2008 to 2010. Between 2008 and 2010, there was a serious pork shortage due to wage increases and epidemic problems. In this time, Henan increased reliance on agent-brokers for marketing, and firms conducted quality and safety inspections by themselves. Firms bore the cost of quality control, while marketing and procurement functions were outsourced. This might have been motivated in order to improve the quality of products and maintains costs low as much as possible. In 2015, there was a big structural change, and a decrease of firm numbers became apparent in the data. This is reported partly because of market saturation, and partly because of strict enforcement regarding environmental and food safety regulations.

The dataset has information about each transaction with price, quantity and quality information. By estimating a differentiated product demand model, we can observe what kind of strategy the surveyed firms took so as to tackle the increasing demand for safe and high quality meat at low prices. This statistical analysis is the next step of this research.

Entry and Exit between 2008, 2010 and 2015 The CAAS conducted repeatedly a similar survey in 2008, 2010 and 2015, The surveys enabled us to observe the entry and exit situation in the industry, In 2015, there was a massive exit of small processing firms from the industry because the government tightened market entry regulations so as to improve safety and environmental protection level. However, the data indicate that relatively old firms were still active: 18 per cent all firms appeared in all three surveys, as shown in Table A.1, On the other hand, there was vigorous entry of firm that entered the market between 2008 and 2009, which was a boom period after pork price hikes.The probability of exits of firms that entered in this period (7 per cent) was definitely higher than the probability of firms that entered prior to 2008 (1 per cent) as shown in Table A.3. Between 2010 and 2015, a relatively significant number of firms entered the market. It is necessary to confirm whether this vigorous entry and exit of firms improved the benefits and welfare that the industry offers to society, which is tested in the future study.

Table A.1: Appearances of firms: 2008, 2010, and 2015 surveys

Appearance	Number	Per cent
Three times: 2008, 2010 and 2015	105	18
Twice: 2008+2010	104	18
Twice: 2008+2015	12	2
Twice: 2010+2015	62	11
Once: 2008	112	19
Once: 2010	91	16
Once: 2015	93	16
Total	579	100

Source: CAAS prok processing industry survey

Table A.2: Appearance of the Survey and Established Period

Appearance	Prior to 2008	2008-2009	2010-2015	Unknown	Total
Survived through 2008 to 2015	104	1	0	0	105
Twice: 2008+2010	104	0	0	0	104
Twice: 2008+2015	12	0	0	0	12
Twice: 2010+2015	58	4	0	0	62
Once: 2008	110	2	0	0	112
Once: 2010	81	9	1	0	91
Once: 2015	61	9	22	1	93
Total	530	25	23	1	579

Source: CAAS pork processing industry survey

Table A.3: Entry Period of Surviving and Exit Firms in 2015

Year of entry	Survived in 2015	Exit in 2015 (Prob of exit)	Total
Prior to 2008	530	7 (1.3 %)	537
2008-2009	25	2 (7.4 %)	27
2010-2015	23	0	23
Unknown	1	22	23
Total	579	31	610

Source: CAAS pork processing industry survey

B Demand Estimation

B.1 Estimation Model of Demand

Here, we develop a model for demand estimation. Consumer demand is modeled using a discrete-choice formulation. This model describes a process by which a consumer chooses a product according to the size of his or her utility. On the supply side, we assume competition between several brands in different geographical markets at different timings.

B.1.1 Utility and Demand

First, we describe the utility of consumer i which consists of the benefit product j. Consumers chose a brand j in a given market (=city and year, here) to maximize their utility. We view a product as a particular brand sold in a city market $m = 1, 2, ...M$.(we delete m hereafter simply for convenience). The indirect utility U_{ijt} of consumer i from purchasing brand $j = 1, 2, ...J$ at time $t = 1, 2, ...T$ is,

$$u_{ijt} = -\alpha_i p_{jt} + \beta X_{jt} + \xi_{jt} + \epsilon_{ijt}. \tag{6}$$

p_{jt} denotes the price of brand j in market m in time t. Other factors affect product choice, such as the features of product x_{jt}. ξ_{jt} is a product-market specific unobservable. ϵ_{ijt} is the random unobservable error. To predict consumer surplus as appropriately as possible, we need to capture difference of elasticity of price for the same product by attributes of consumers. We need some random coefficient of the price. The random coefficients of price in this paper are defined as $\alpha_i = \alpha/Y_i$, whereas Y_{it} is the observed income[4].

The mean utility of product[5] j can be rewritten as,

$$\delta_{jt} = -\alpha_i p_{jt} + \beta X_{jt} + \xi_{jt}, \tag{7}$$

where ξ_{jt} represents unobservable and time specific characteristics. Each consumer i in market m will chooses product j to maximize his or her utility. Therefore, the aggregate market share for product j in market m is the probability that product j yields the highest

[4]We used average income of each city-year segments in this study because we do not have data of individual income. That means $Y_i = Y_{mt} = \sum Y_i/I_{mt}$ and $\alpha_i = \alpha_{mt} = \alpha/Y_{mt}$. I_{mt} is the population at market m and time t in this study. We do not presented it as demand estimates because we could not obtain a consistent parameters. Instead, we used non-random coefficient parameters in this study.

[5]Because this is the mean of utility, unobserved independent error ξ_{jt} in equation (6) can be regarded as zero.

utility across all products including outside goods 0. Therefore, the predicted market share of product $j = 1, ...J$, s_j is a function of mean utility δ_{jt} and parameter vector $\theta = (\alpha, \beta, \rho^6\ )$. If the unobserved error, ϵ_{ijt} in the equation (6) follows independently and identically distributed (i.i.d.) extreme value, this relationship can be rewritten as a logit choice probability as follows.

$$\begin{aligned} P_{jt} &= s_{jt}(\delta_{jt}, \theta) \\ &= \frac{e^{u_{jt}}}{\sum_k e^{u_{kt}}} \\ &= \frac{e^{-\alpha_i p_{jt} + \beta X_{jt} + \xi_{jt} + \epsilon_{ijt}\cdot}}{1 + \sum_k e^{-\alpha_i p_{kt} + \beta X_{kt} + \xi_{kt} + \epsilon_{ikt}}} \end{aligned} \tag{8}$$

Here, 1 in the denominator in equation (8) represents the value of outside option, because $exp(u_0) = exp(0) = 1$. The remaining variables in the denominator are the sum of exponential utilities of all of the choices in every market.

Under this logit assumption, consumer surplus CS_i for consumer i, previously indicated by $B - P$, takes the following closed format.

$$E(CS_i) = \frac{1}{\alpha_i} E[Max(u_{jt})] \tag{9}$$

The expectation is over all possible values of error ϵ_{ijt}. Here, expected consumer surplus for individual i or product j can be written as follows.

$$E(CS_i) = \frac{1}{\alpha_i} ln(\sum_{j=1}^{J} e^{u_{ijt}}) + C.^7 \tag{10}$$

$$E(CS_j) = \sum_{i=1}^{I} \frac{1}{\alpha_i} ln(e^{u_{ijt}}) + C \tag{11}$$

The absolute value of the consumer surplus is meaningless because of the unknown C. However, the difference between several states of consumer surplus as a figure generated from the structure. This study focuses on the difference between two different agents, for example, agent h or ownership type h compared to agent k or ownership type k, the difference of the sum of consumer surplus of products supplied by firm k and firm h. This

[6] ρ is the nesting parameter that explained later referring to equation (15)

can be written as follows:

$$\Delta CS_{hk} = [\sum_{j=1}^{J|h} \frac{1}{\alpha_i} ln(e^{u_{ijt}}) - \sum_{j=1}^{J|h} \frac{1}{\alpha_i} ln(e^{u_{ijt}})] \tag{12}$$

Once CS_j for product j is obtained from the above-mentioned estimates, we can compute the value of benefits of product j, B_{jt}.

$$Benefit_j = CS_j + Price_j \tag{13}$$

Here, we can observe the relative size of the benefits of the product in the same way as we do for the consumer surplus.

B.1.2 Nested Logit Model and Identification

The logit-based utility model provides an estimating equation of utility in the following form. Based on the model, we estimate the demand parameters following Berry (1994) and Nevo (2000) and other BLP literature.

Our estimation equation is,

$$ln(s_{jt}) - ln(s_{ot}) = -\alpha_i p_{jt} + \beta X_{jt} + \rho ln(s_j t|g) + \xi_{jt}. \tag{14}$$

Here, we set the outside option as the difference between population and total number of air conditioners for an individual market in a year, which represents number of potential buyer of the products. $s_{jt|g}$ is the share of product j withing group g.

The parameters of this demand can be identified as the previous empirical industrial organization literatures has claimed (see Ackerberg and Crawford (2009)). Identification of price parameters, which is critical for our benefit computing, relies on the fact that the unobserved determinants of demand are uncorrelated with input prices. To account for this potential endogeneity of prices, which may be caused by the presence of changes in unobserved attributes, we use the GMM estimator with either type of IVs discussed in Appendix B.2.

To account for the degree of preference correlation between products of the same group, We imposed a further assumption on the error term, ϵ_{ijt} of equation (6).

$$\epsilon_{ijt} = \rho\eta_{igt} + \bar{\epsilon_{ijt}} \tag{15}$$

ρ is a "nesting parameter" , $0 \leq \rho \leq 1$ which captures the correlation between preference and product characteristics. $\bar{\epsilon_{ijt}}$ is independently distributed error for consumer, products and timing.

When demand function parameters are estimated based on the nested logit model, consumer surplus will be computed as follows (see Ivaldi and Verboven, 2005:677 **?**).

$$E(CS_i) = \frac{1}{\alpha_i} ln(1 + \sum_{j=1}^{J} D_g^{1-\rho}) + C. \tag{16}$$

$$D_g = \sum_{k=1}^{G_g} exp(\delta_{jt}/(1-\rho)) \tag{17}$$

B.2 Instruments

The estimation of the models employed here is typically performed using IV or GMM using instruments for p_{jt} and nested variables. Instruments z_{jt} are correlated to p_{jt} but are independent of $\bar{\epsilon}_{ijt}$ or ϵ_{ijt} . In this case, candidates of instruments here mainly come from the following four sources: (1) cost shifters. (2) prices of the same products of the same brand in other cities.(here, we assume that price differences for the same products across cities reflects only demand factors, and the prices of the same products in other cities are correlated with price via cost factors only, as per. Berry, Levinson and Pakes, 1995; Hausman, 1996; Nevo, 2001). (3) price of the same type of products by competitor brands in the same city (Berry, Levinson and Pakes, 1995), and (4) characteristics of products (it is natural to assume that characteristics of products are designed and planned in advance, before the price is fixed.) Exploiting this natural assumption, we use the characteristics of products as instruments that predetermin the price. Any of four types of instruments were tried. (i) the first type of "quality" dummies are sum of index of characteristics within the own brand. (ii) The second type of this category's IV is sum of the characteristics of other products of rival firms, and (iii) the third one is sum of the characteristics of other products of own firms (see Grigolon and Verboven, 2011; Verboven,1996). (iv) The fourth type is the average index of the characteristics of a competitor.

The Hausman instrument approach (2) relies on the assumption that prices in two different markets be correlated via common cost shocks and not via common demand side shocks such as nationwide demand shock. If a situation occurs such as the market demand of two particular market's shrink owing to a common shock between the two particular markets, the instruments are invalid. However, in our estimation case, this IV works effectively.