Dancing with the *Dragon Heads*: Enforcement, Innovations and Efficiency of Contracts between Agricultural Processors and Farmers in China

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Abstract:

Contractual breaches are very common in developing countries such as China. In order to prevent breaches of contract, the contractual designs between farmers and agricultural processors (*Dragon Head Firms*) in China are innovating in two ways: organizational innovations and contractual innovations. Due to contractual innovations, simple price-quantity contracts are evolving into complex cooperation contracts. Using data for over 500 state key processors in 2003 from the Chinese Ministry of Agriculture, we construct econometric models to study contractual choices, contract intensity, and their impacts on sales and profits for agricultural processors in China.

The results indicate that capital and the number of contracted farmers are endogenous to contract choices. Processors are more likely to use cooperation contracts compared with price-quantity contracts as the number of contracted farmers increases, because the costs of coordinating, monitoring and enforcing price-quantity contracts may increase dramatically under these circumstances . On the other hand, contract types are not important for the number of contracted farmers, the intensity of contracts, or sales and profits for processors. The results also indicate that the elasticity of profits with respect to capital is 0.52, which implies that the returns to investing in the food processing industry are relatively high in China.

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Introduction

Agricultural processors are called *Dragon Head Firms* (*long tou qi ye*) in China because they are considered the key to leading small farmers on the road to prosperity. While this may be an oversimplification, it is certainly true that improved marketing channels can increase farm incomes by reducing transaction costs, connecting farmers to a larger customer base, and opening up markets for more profitable products than the staples traditionally grown on Chinese farms.

Starting with economic reforms in 1978, China has been transitioning from a planned economy to a market economy. The reform has fundamentally changed agricultural production and marketing organizations and systems. Under the planned economy, the state monopolized the purchase and marketing of agricultural products. Production and sales of agricultural products were based on state plans. After economic reforms, the government gradually overhauled regulations on agricultural production and marketing. Now farmers can and should make production and marketing decisions based on market information. Facing an emerging market full of uncertainties, how can Chinese farmers survive and be prosperous?

The government has realized the important role that processors play in a market economy, and has been helping improve marketing channels so as to increase farm incomes by promoting processors. The use of contracts for the production and marketing agricultural products is increasingly prevalent in China, similar to what is happening in other countries. According to the

U.S. Department of Agriculture, 39% of the total value of U.S. commodities in 2003 was produced or marketed under contracts (MacDonald and Korb 2006). And according to a survey in 2002 by Chinese Ministry of Agriculture, about 30% of the farmers used contracts to link themselves with processors and/or other marketing organizations, while that number in 1996 was less than 10% (Niu 2006).

The current literature on contractual choices mainly focuses on incentives and risk sharing. Case studies of contracts between farmers and processors include chicken broiler contracts (Knoeber 1989, Knoeber and Thurman 1994), tomato contracts (Hueth and Ligon 2002), fruit and vegetable contracts (Hueth et al. 1999), and sugar beet contracts (Hueth and Melkonya 2004), and hog contracts (Boger 2001).There is also a recent study by Jaenicke et al. (2007) that anlayzed contractual choices between farmers and processors for a range of different commodities.

However, a key issue for contracts in China that the theoretical and empirical literature generally does not consider is enforcement. Opportunistic behaviors by contracted parties are still the largest impediment to efficient market transactions in China (Tao and Zhu 2001; Zhou and Cao 2001, 2002). Current contract theory generally assumes that there is a well-functioning legal system under which any contract can be perfectly enforced by a court (Bolton and Dewatripont 2005).

There are many cases where public institutions do not function well in enforcing contracts, in particular in transition economies (Gow and Swinnen 1998,2001). Gow, Streeter and Swinnen (2000) attribute breaches of contracts between growers and processors in transition economies to the absence or ineffectiveness of public institution in enforcing contracts. The situation in China is not quite the same as in other transition economies because of social relationships that step in to fill some of the roles taken by courts in other countries. As Chow(1997) points out, the Chinese legal system might be called a “semi-legal system”, and a contract under this legal system usually is enforced partly by an informal social relationship known as *guanxi*. *Guanxi* plays an important role in ensuring that a contract is honored.

In contrast to the “shock therapy” of transition economies in Eastern Europe, China has been gradually transiting from a planned economy to a market economy. The reform of public enforcement institutions is not like what happened in other transition economies. Therefore, it may not be fully accurate to attribute breaches of contracts in China to the failure of public enforcement institutions as Gow, Streeter and Swinnen (2000) suggested in general for transition economies.

Even when enforcing a contract is possible it might be very costly. High costs may weaken enforcement of contracts. The parties to a contract might be very opportunistic when enforcement of contracts is very costly. This paper suggests that the absence of effective contract enforcement in China may result from the high costs of enforcing contracts, rather than a failure of public enforcement institutions.

China has a large number of very small farms. As a result, the monetary value of a contract between a farmer and a processor is often very small. If a farmer breaches a contract, the processor could only get a little from suing the farmer but the processor could incur significant court costs. If a processor breaches a contract, the farmer usually cannot pay the high court costs of suing the processor. Opportunistic behaviors by both farmers and processes have been quite prevalent since the start of economic reforms. This is very inefficient because it increases transaction costs and hurts long-term relationships between farmers and processors.

As noted above, contractual design in China is evolving from simple price-quantity contracts to complicated contracts to prevent opportunistic behaviors by the parties to the contract. The objective of this paper is to explore this process of contractual innovations. In this paper, we empirically analyze innovations in agricultural contracts in China and the impacts of these innovations on farmers and processors.

Opportunistic Behaviors and Innovations of Contracts

- **Opportunistic Behaviors**

China has a large number of very small farms. The land in general is equally divided among farmers. Property rights to agricultural land cannot be traded in the market by law. In 2005, China had 252 million farms, and the land area per farmer was only 2.08 mu (about 0.14 hectare)[1]. More than 80% of hogs are produced in backyard farms, and many backyard farms only raise 1 to 5 hogs in simple housing (Pan and Kinsey 2002).

After the emergence of a market economy full of uncertainties, particularly in the late 1980s, farmers and processors began to enter into price-quantity contracts in order to share risk between them, under which farmers supply a certain amount of agricultural outputs at specified prices to processors after harvest (Zhou and Cao 2001). They also can be viewed as forward contracts. Due to small farm sizes, the contracted amount in the typical contract was very small compared with the U.S. and other Western countries, and each processor usually had a large number of contracted farmers.

[Insert Figure 1]

[1] China Statistical Bureau, *China Statistical Yearbook 2006* (Tables 13-14).

Simple price-quantity contracts are very difficult to enforce because the opportunistic behaviors are very prevalent. As shown in Figure 1, suppose the contracted price for some commodity is P_C. After harvesting, if the market price P_M is different from P_C, opportunistic behaviors by either farmers or processors may occur. Suppose the court cost for each case is C_L.

If $P_M = P_H$ which is higher than P_C, farmers may breach their contracts and sell their outputs directly to the market for higher profits. The benefit to the farmer from such opportunistic behavior DE, as shown in Figure 1, which equals the loss to the processor. If $DE < C_L$, as one would expect given the small size of the typical contract, the processor has no incentive to sue.

On the other hand, if $P_M = P_L$ which is lower than P_C, processors may breach their contracts and buy commodities directly from the at lower prices. The benefit from breaching a contract to the processor is AB, which is equivalent to the loss to the farmer. If $AB < C_L$, as one would expect, the farmer has no incentive to sue.

Such opportunistic behaviors were very prevalent in the late 1980s and the early 1990s. They even can be seen in China in more recent years (Zhou and Cao 2001). From a long-run perspective, such opportunistic behaviors hurt both farmers and processors, because risks cannot be transferred via a contract and the trust between farmers and processors is damaged.

In order to make more reliable contracts, the simple price-quantity contracts between farmers and processors began to innovate in two directions: organizational innovations and contractual innovations.

[Insert Figure 2.a and 2.b]

- **Organizational Innovations**

Organizational innovations, as shown in Figure 2.a, involve establishing a mediating organization between farmers and processors. Such a mediating organization could be either a broker or a cooperative. Processors can make contracts with brokers or cooperatives, then brokers or cooperatives can make contracts with farmers. For two reasons, these organizational innovations can significantly reduce opportunistic behaviors relative to direct contracts between farmers and processors.

First, the contracted amount between a processor and a mediating organization is much larger than that between a processor and a farm. This increases the potential benefit from suing a breaching party in court.

Second, a contract between a farmer and a mediating organization also becomes more reliable, because the personal relationship (*guanxi*), as Chow (1997) suggested, usually works well and makes contracted parties honor the terms of a contract. If a farmer breaches the contract, the punishment may be outside of the contract itself, and sometimes would be very severe, because his reputation and credit would be damaged in the whole village or community.

- **Contractual Innovations**

Gow and Swinnen (2001) suggest that breaches of contracts can be prevented by designing “self-enforcing” contracts involving so-called “hold-ups” such that the private losses from breaching a contract outweigh potential benefits. The literature on contracts (e.g. Klein, Crawford, and Alchian 1978; Klein 1996) views hold-ups a as a very useful tool to prevent contract breaches. Gow and Swinnen (1998, 2001) found that foreign companies in transaction economies typically use hold-ups to prevent breaches of contracts. Gow and Swinnen (1998, 2001) suggested that processors can hold up farmers by providing seeds, new techniques and other inputs and services. If farmers breach contracts, the services will not be supplied in the following years. Contractual innovations in China are consistent with these findings, as shown in Figure 2.b.

Moreover, in the case of China, some contractual innovations stipulate that processors will return some profits to farmers as compensation, particularly when the contract price is lower than the market price. Such flexible institutional arrangements can share more risks between processors and farmers, and increase utility for both parties in the long-run if they are risk averse. In China, these types of contracts are known as cooperation contracts.

Some contracts require that farmers invest or deposit money with processors. This type of contract usually is called a joint-stock cooperation contract. In some sense the farmers become part owners of the processors, and they can affect the behaviors of managers in processing firms. Broadly speaking, this is a kind of vertical integration through which farmers integrate processors. Similar to cooperation contracts, processors return some profits to farmers as dividends. This measure also can effectively prevent both contracted parties from breaching.

- **Some Hypotheses**

From the analysis above, we can state four hypotheses:

(1) The number of contracted farmers for each processor is endogenous to the choice among contracts, because the contracts are designed simultaneously by farmers and processors.

(2) As the number of contracted farmers increases, processors are more likely to choose cooperation or joint-stock cooperation contracts. In the case of simple price-quantity contracts, as the number of contracted farmers increases, the cost of monitoring and enforcing contracts also increases, and the probability of breaching contracts also

increases. Processors are more likely to choose cooperation or joint-stock cooperation contracts to hold up farmers and share risks with them.

(3) The capital stock of processors and contract types are endogenous to the choice among contracts. Investments or deposits required in joint-stock cooperation contracts can be used as capital by processors.

(4) Controlling for the type of contracts and a processor's sales, the profits of a processor are negatively correlated with the number of contracted farmers. In the case of simple price-quantity contracts, as the number of contracted farmers increases, the costs of monitoring or enforcing contracts will increase, and more farmers may breach contracts. In the case of cooperation or joint-stock cooperation contracts, some profits will be returned to farmers by the contracts.

In the rest of this paper, we use micro data for over 500 state key processors in China, made available by the Chinese Ministry of Agriculture, in order to test these hypotheses. We analyze contractual choices by processors and their impacts on processors' sales and profits for the processors.

Data

The data used in this study include basic information about production and financial reports for 561 state key processors[2] in 2003. In total, there are 582 state key processors, of

[2] The criteria by which a processor is certified as a state key agricultural processor are listed in ***Provisional Rules on Certificating and Supervising The State Key Agricultural Processors*** (nong ye chan ye hua guo jia zhong dian long tou qi ye ren ding he yun xing jian ce guan li zan xing ban fa (nong jing fa [2001] No.4])), which was issued by The Ministry of Agriculture of China in 2001. This law has nine articles laying out the requirements for a processor to be a state key processor, such as firm scale, annual sales, operational details, the number of related farmers, credit scores and so on. For instance, the capital stock and the annual sales should not be less than 100 million and 150 million yuan, respectively; the number of related farmers should not be less than 3000 in eastern provinces; and the processor's credit score should not be less than "A".

which data for 21 are missing. In the following analysis, we also may drop some item-missing samples. Details on the variables used in this study are in the Appendix.

Though there are three types of contracts, each processor in practice typically uses only one type of contract. As shown in Table 1, leaving aside 35 processors whose contract types are unknown, only two processors used mixed types of contracts. Out of the 524 remaining processors, 474 used price-quantity contracts. This indicates that price-quantity contracts are still the dominant type of contract among key processors in China, even though they are more likely to be breached. Cooperation contracts were used by 43 processors, while 7 used joint-stock cooperation contracts. Given the small number of joint-stock cooperation contracts, they are grouped together with cooperation contracts under the heading “cooperation contracts” for analytical purposes.

The average numbers of contracted farmers for price-quantity contracts and cooperation contracts are 95,023 and 102,254, respectively. There are 88 processors for meats, 124 for grains, 44 for dairy goods, and 57 for vegetables. The average number of contracted farmers for dairy processors is 20,512, less than others; the numbers for meat processors, grain processors, and vegetable processors are 124,914, 96,585, and 116,179, respectively. A possible explanation for the relatively small number of contracted dairy farms is that dairy farms are not widespread in China, because the sector was in the past dominated by large state-owned dairy operations (Främling 2006). However, the number of contracted farms for dairy processors is expected to increase as the demand for milk in China increases.

Most processors (296 of the 561) are privately owned, and the average number of contracts is 71,476. There are only 28 foreign processors, and their average number of contracted farmers is 50,606, which lower than domestic processors. There are 58 processors which are publicly owned, and the average number of contracts for them is 195,926, much higher than other types of ownership.

In the next section, we construct econometric models to test the above-mentioned hypotheses.

Contract Choices

First, we study the contract choices for processors. A probit model is suggested as follows:

$$y_{1i}^* = Z_{1i} b_1 + A_{1i} g_1 + e_{1i} \tag{1}$$

$$\begin{cases} y_{1i} = 1 & if\ y_{1i}^* \geq 0 \\ y_{1i} = 0 & if\ y_{1i}^* < 0 \end{cases}$$

where y_{1i}^* is a random utility function for processor i .When $y_{1i}^* \geq 0$, the processor uses price-quantity contracts; otherwise, the processor uses cooperation contracts. Z_{1i} is a vector of exogenous variables; A_{1i} is a vector of endogenous variables; b_1 and g_1 are corresponding vectors of coefficients for Z_{1i} and A_{1i} . e_{1i} is an error term with a standard normal distribution $N(0,1)$.

We construct three models to test the hypotheses of exogeneity of capital and the number of contracted farmers. We use last year's profit as an instrumental variable for capital, because the change in the stock of the capital is correlated with profit in the previous year. We use last year's profit, fixed assets, and the credit score of the firm as instrumental variables for the number of contracted farmers, because we assume that farmers can observe these variables.

In general, there are two methods to estimate a probit model with endogenous variables: maximum likelihood estimation (MLE) and Amemiya' generalized-two-stage-least-squares estimation (G2SLS) (Amemiya 1978, Newey 1987). Newey (1987) points out that MLE is much more efficient than G2SLS. Rivers and Vuong (1988) suggest a Wald test to test the hypotheses of exogeneity of A_{1i} by regressing the error terms in the structural form with the error terms in the reduced form.

Table 2 reports the estimation results for the three models by MLE and G2SLS, and the results from an ordinary probit model are also reported for comparison. In model 1.A, capital is assumed endogenous; in model 1.B, the number of contracted farmers is endogenous; and in model 1.C, both capital and the number of contracted farmers are endogenous. Rivers and Vuong's test (1988) rejects the hypotheses of exogeneity in all three models. These results support the hypothesis that both capital and the number of contracted farmers are endogenous. The results indicate that contract types may be simultaneously determined by farmers and processors.

Model 1.C, in which both the capital and the number of contracted farmers are endogenous, is the best among the three models. There are no large differences between the estimation results of MLE and G2SLS. The results show that only the coefficients for the number of contracted farmers and public-ownership are statistically significant.

The negative sign of the coefficient for the number of contracted farmers implies that as the number of contracted farmers increases, processors are more likely to choose cooperation contracts. China has a large number of small farms, and the land, in general, is equally divided among farmers. In the case of simple price-quantity contracts, as the number of contracted farmers increases, the costs of coordinating, monitoring and enforcing contracts increase, and the probability of breaching contracts also increases. In this situation, processors are more likely to choose cooperation contracts to hold up farmers and share risks with farmers.

The type of ownership of a processor is important for contractual choices. In particular, publicly-owned processors are more likely to choose price-quantity contracts, because their risks can be born by the public due to the nature of public ownership of the firms.

The Number of Contracted Farmers

The model of contractual choices indicates that the number of contracted farmers and contract choices are endogenous. We suggest the following econometric model for studying the number of contracted farmers:

$$ln(Farmers) = Z_{2i}b_2 + A_{2i}g_2 + e_{2i} \qquad (2)$$

where $ln(Farmers)$ is the logarithm of the number of contracted farmers; Z_{2i} is a vector of exogenous variables for a processor i that can be observed by farmers (for example, we assume farmers can observe fixed assets, but cannot observe the processor's capital stock); and A_{2i} is a vector of endogenous variables. b_2 and g_2 are corresponding vectors of coefficients for Z_{2i} and A_{2i}. e_{2i} is an error term with a normal distribution $N(0, s_2^2)$.

Since the model of contractual choices rejected the exogeneity hypothesis of the number of farmers, contract types and the number of contracted farmers may be simultaneously determined. The contract type might be an endogenous variable in the equation for the number of contracted farmers. Instrumental variable regressions are suggested. Though the contract type is a discrete variable, the ordinary instrumental-variables method is consistent in this case (Wooldridge 2002).

We report the instrumental-variable estimation results in Table 3. The estimation results by OLS are also reported for comparison.

The estimation results indicate that locality, operational details, ownership and fixed assets are important for the number of contracted farmers. If processors are located in major cities and far away from farmers, the number of contracted farmers is less than those located in small towns or villages. A possible explanation is that an increase in the distance between farmers and processors increases transaction costs due to asymmetric information and higher transportation costs, which may hinder the development of contracts between farmers and processors.

Consistent with the descriptive statistics, dairy processors have fewer contracts than other types of processors. In contrast to traditional commodities such as grains, meats and vegetables, dairy is still a relatively new industry in rural China, and dairy farmers are not widely spread (Främling 2006). It is also reasonable that foreign processors have fewer contracts than other types of ownerships, because they are newcomers to the market and it will take them more time to build relationships with farmers.

The estimation results also show that the value of fixed assets for processors is positively related to the number of contracted farmers. Fixed assets have two effects: (1) more fixed assets implies the scale of a processor is larger and the processor needs to contract with more farmers for inputs; (2) the fixed assets can be viewed as collateral for contracts and can attract more farmers.

Intensity of Contract Purchase

Though contracts are widely used by processors for buying inputs, some processors may purchase inputs directly from the market when the contracted supply is not sufficient for production. Jaenicke et al. (2007) analyze the intensity of contract purchase for agricultural processors in Pennsylvania. Their method is used here for analyzing the intensity of contract purchase for agricultural processors in China. The econometric model is given as follows:

$$S_i = Z_{3i} b_3 + A_{3i} g_3 + e_{3i} \qquad 0 \le S_i \le 100 \qquad (3)$$

where S_i is the percent of contracted purchases to total purchases, and $0 \le S_i \le 100$. That is, S_i is left censored at 0 and right censored at 100. Z_{3i} is a vector of exogenous variables for a processor i which can be observed by farmers; for instance, we assume farmers can observe fixed assets, but cannot observe capital; and A_{3i} is a vector of endogenous variables. b_3 and g_3 are corresponding vectors of coefficients for Z_{3i} and A_{3i}. e_{3i} is an error term with a normal distribution $N(0, s_3^2)$.

Similar to Jaenicke et al. (2007), tobit models can be used here to estimate equation (3). In contrast to Jaenicke et al. (2007), we include some potentially endogenous variables and then test for endogeneity. The potential endogenous variables are contract types and the number of contracted farmers. We also can use maximum likelihood estimation (MLE) and Amemiya's generalized-two-stage-least-squares estimation (G2SLS) (Amemiya 1979, Smith and Blundell 1986, Newey 1987) to estimate the tobit model with endogenous variables. Smith and Blundell (1986) also suggested a Wald test to test the endogeneity in a tobit model.

Table 4 reports the estimation results. Wald tests of models 3.E and 3.F cannot reject the exogeneity of contract types or the logarithm of the number of the contracted farmers. Hence, we can estimate the model with a standard tobit model.

The results for model 3.D show that only the coefficients of the dairy dummy variable, the logarithm of capital and the R&D dummy variable are statistically significant; all have positive signs. The positive sign on the coefficient for dairy processors implies that dairy processors are more likely to use contracts to purchase their inputs, perhaps because they usually need a stable supply of milk from dairy farmers.

The capital variable serves as a proxy for the scale of a processor. The positive sign on the capital variable implies that larger processors are more likely to use contracts to stabilize the supply of inputs.

The positive sign of the R&D dummy variable indicates that processors who have R&D departments tend to have a higher contract intensity. A possible explanation might be that R&D departments for processors can hold up farmers, and farmers are more likely to sign long-term contracts with processors.

Sales and Profits of Processors

In this section we analyze whether contract types and the number contracted farmers impact sales and profits of processors. Equations for sales and profits of processors are:

$$\begin{cases} Ln(sale_i) = Z_{4i}b_4 + e_{4i} & (4) \\ Ln(profit_i) = Z_{5i}b_5 + g_5 Ln(sale_i) + e_{5i} & (5) \end{cases}$$

where Z_{4i} and Z_{5i} are vectors of independent variables, and b_4 and b_5 are the corresponding vectors of coefficients. e_{4i} and e_{5i} are error terms, respectively, with normal distributions $N(0, s_4^2)$ and $N(0, s_5^2)$.

If $Z_{4i} = Z_{5i}$, equations (4) and (5) become a triangular system of equations. Without imposing some restrictions on e_{4i} and e_{5i}, equation (5) is not identified. Here, we assume e_{4i} and e_{5i} are uncorrelated. We can use OLS to consistently estimate the two equations respectively. The estimation results are reported in Table 5, respectively, for models 4.A and 4.B. For comparison, we also report the estimation results for a profit function without controlling for sale values. That all R^2 values are over 0.4 implies that the models fit reasonably well. The main findings for the sale and profit functions are as follows.

First, we find that the coefficient on contract type is not statistically significant either for sales or for profits, while the coefficient on the number of contracted farmers is statistically significant in for both equations. Interestingly, the signs of the coefficients for the logarithm of the number of contracted farmers are different. A positive sign for sales implies that sales of processors increase as the number of contracted farmers increases. On the other hand, a negative sign for profits implies that profits decrease as the number of contracted farmers increase. A possible reason might be that an increase in the number of contracted farmers increases the transaction costs of coordinating, monitoring and enforcing contracts, which may lower profits for processors.

Second, the coefficient on the dummy variable for city location is negative in both the sales function and the profit function, and only the coefficient in the profit function is statistically significant (at the 10% level). This implies that processors located in major cities and far away from farmers are less profitable than those located in small towns or rural areas. A possible explanation is that the distance between farmers and processors increases transaction costs due to asymmetric information and higher transportation costs.

Third, operational details also affect sales and profits for processors. Only the coefficients for the meat dummy variable and the grains dummy variable are statistically significant, and are estimated at 0.18 and 0.24 in the sales function, respectively. These results imply that sales for grain processors are larger than those for meat and other processors. Only the coefficients for the dairy dummy variable and the meat dummy variable are statistically significant in the profit function, and are -0.37 and -0.21, respectively. This implies that profits for dairy and meat processors are in general lower than for other types of processors.

Fourth, ownership is important for both sales and profits. Our results show that the coefficients for the dummy variables of publicly-owned, foreign and privately-owned processors are all statistically significant, and they are 0.56, 0.50 and 0.29, respectively. This implies that publicly-owned processors have higher sales than other ownership structures in China, perhaps resulting from a higher loyalty on the part of farmers built up over a long history. Only the coefficient for the dummy variable for publicly-owned processors is statistically significant and is -0.72. This implies that publicly-owned processors have a lower profitability than processors with other types of ownership structure. This might be explained by the fact that the workers and managers in publicly-owned processors may be less motivated due to ambiguity of ownership rights and soft budgets, as one generally observes in publicly-owned firms. This is one important reason why China is moving from a planned economy to a market economy.

Fifth, the dummy variable for export licenses is only statistically significant in the profit function and not in the sales function. In particular, export licenses are negatively correlated with profits. One possible explanation for this finding is that agricultural products face highly competitive world markets, particularly after China's accession to the WTO in 2001. Exporting agricultural products entails higher costs than selling on the domestic market, and under these circumstances would be used to dispose of products that could not be sold on the domestic market. An alternative explanation is that exporters are holding export prices down now in order to build up markets over time in other countries.

Sixth, capital plays an important role in both sale and profit functions. Specifically, the elasticities of sales and profits with respect to capital are 0.60 and 0.52, respectively, and both are statistically significant at the 1% level. The latter value implies that the returns to investing in the food processing industry are relatively high in China.

Finally, the coefficients for the dummy variable for R&D are also statistically significant in both the sales and profit functions. A negative sign for the coefficient in the sales function and a positive sign in the profit function imply that processors with R&D departments lower sales but higher profits. Hence, the results indicate that investments in R&D improve profits for processors in China, even though they are associated with lower sales.

Conclusions

Contracts are widely used by agricultural processors for purchasing inputs not only in developed countries but also in developing countries such as China. In order to prevent opportunistic behaviors which may cause breaches of contracts and threaten the efficiency of contracts, the contractual design of simple price-quantity contracts in China have been evolving in two directions: organizational innovations and contractual innovations. Organizational innovations involve intermediate organizations, such as cooperatives or brokers, placed in between farmers and processors. Contractual innovations involve the evolution of price-quantity contracts into complex cooperation contracts to hold up the parties to a contract. Currently, price-quantity contracts are still very prevalent in China.

Using data for over 500 state key processors in 2003 from the Chinese Ministry of Agriculture, we construct econometric models to study contract choices, contract intensity, and the impacts on sales and profits of processors.

The results indicate that capital and the number of contracted farmers are endogenous to contract choices. This suggests that contract types may be simultaneously determined by farmers and processors. In particular, processors are more likely to choose cooperation contracts compared with price-quantity contracts as the number of contracted farmers increases, because the costs of coordinating, monitoring and enforcing price-quantity contracts may increase dramatically under these circumstances.

On the other hand, contract types are not important for the number of contracted farmers, the intensity of contracts, or sales and profits for processors.

Ownership structure is very important for contract choices, sales and profits of processors. In particular, publicly-owned processors are more likely to use price-quantity contracts, and have larger sales but lower profitability. This might be explained by the fact that the risks of publicly-owned processors can be born by the public, and the workers and managers in publicly-owned processors may be less motivated due to ambiguity of ownership rights and soft budgets, as one generally observes in publicly-owned firms. This is one important reason for China moving from a planned economy to a market economy.

Finally, it is worth noting that the elasticity of profits with respect to capital is 0.52, which implies that the returns to investing in the food processing industry are relatively high in China.

Appendix

Variable explanations:

Contract Type: 1—a price-quantity contract; 0—a cooperation contract or a joint-stock cooperation contract;
Capital: capital in the current year (billion yuan);
Farmers: contracted farmers (1000 farmers);
City Location: 1—Located in major cities; 0—Located in small towns or villages;
Dairy: 1—a dairy processor, 0—others;
Meat: 1 —a meat processor, 0— others;
Grain: 1 –a grain processor, 0— others;
Vegetables: 1 –a vegetable processor, 0— others;
Publicly-Owned: 1–a publicly—owned processor, 0— others;
Foreign: 1–a foreign processor, 0— others;
Privately-Owned: 1–a privately-owned processor, 0— others;
Export: 1—a processor with an export license; 0—others;
Green Food: 1— a processor producing green food; 0—others;
R&D: 1— a processor with a department of research and development.
Fixed Assets: value of fixed assets in current year (million yuan);
Credit Score: 3—AAA, 2—AA, 1—A, 0—others;
Sale: value of sales in previous year (10 thousand yuan);
Last Year's Profit: profits in previous year (10 thousand yuan);
Profit: profits in the current year (10 thousand yuan);
Contract intensity: percent of total processed quantity accounted for by contracts.

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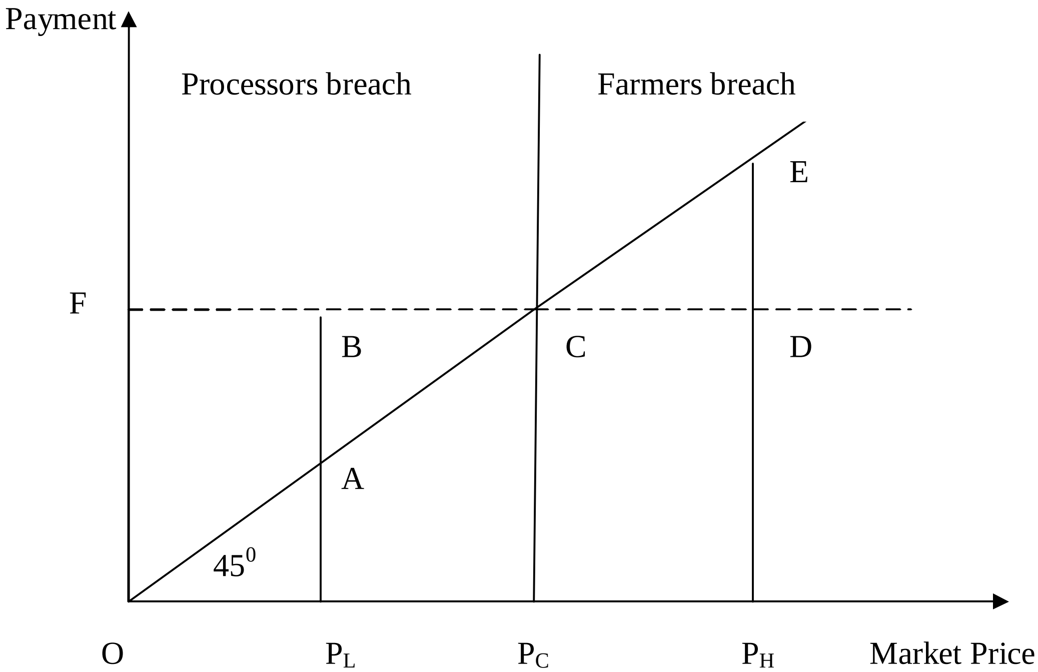

Figure 1. Price-Quantity Contracts

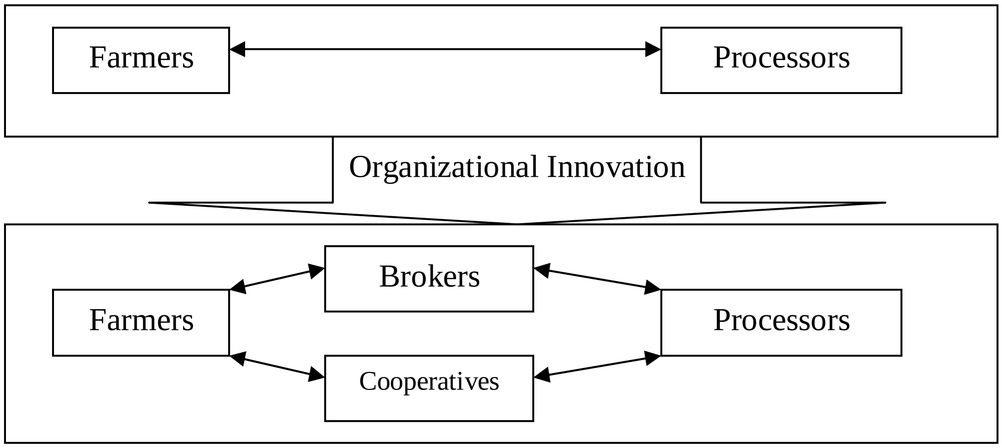

Figure 2.a. Organizational Innovation

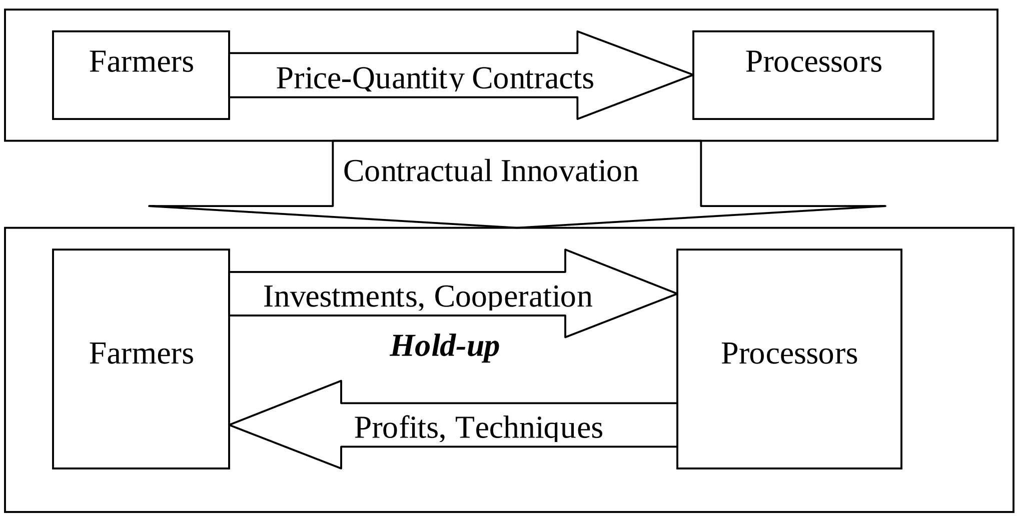

Figure 2.b. Contractual Innovations

Table 1. Descriptive Statistics for 561 State Key Processors

	No. of Processors	Average No. of Contracted Farmers for Each Processor
Contract Types		
Price-Quantity Contracts	474	95,023
Cooperation Contracts	43	113,349
Joint-Stock Cooperation Contracts	7	34,096
Price-Quantity Contracts and Cooperation Contracts	1	15,000
Price-Quantity Contracts and Joint-Stock Cooperation Contracts	1	22,100
Unknown	35	86,150
Operational Details		
Meat	88	124,914
Grains	124	96,585
Dairy	44	20,512
Vegetables	57	116,179
Others	248	91,091
Ownership		
Public	58	195,926
Foreign	28	50,606
Private	296	71,476
Others	179	106,502
Total	561	94,579

Table 2. Estimation Results for Contract Choices for Processors

Contract Type	Model 1.A						Model 1.B						Model 1.C					
	Probit		IV-MLE		IV-G2SLS		Probit		IV-MLE		IV-G2SLS		Probit		IV-MLE		IV-G2SLS	
	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio
Capital	-0.0254	-0.88	-0.1537	-3.15***	-0.1669	-2.77***							-0.0260	-0.91	0.0052	0.20	0.0101	0.19
Farmers							0.0003	0.57	-0.0030	-5.45***	-0.0058	-2.18**	0.0004	0.60	-0.0031	-5.51***	-0.0061	-2.05**
City Location	-0.0838	-0.48	-0.0405	-0.23	-0.0439	-0.23	-0.0856	-0.49	-0.1594	-1.26	-0.3067	-1.18	-0.0816	-0.46	-0.1609	-1.28	-0.3215	-1.18
Dairy	0.2298	0.62	0.2090	0.59	0.2270	0.59	0.2360	0.64	-0.0201	-0.07	-0.0364	-0.07	0.2450	0.66	-0.0282	-0.10	-0.0546	-0.10
Meat	0.1563	0.66	0.1081	0.47	0.1174	0.47	0.1517	0.64	0.1844	1.07	0.3549	1.03	0.1494	0.63	0.1839	1.07	0.3677	1.03
Grain	0.3564	1.51	0.2743	1.20	0.2978	1.21	0.3611	1.54	0.2031	1.18	0.3927	1.23	0.3499	1.48	0.1984	1.17	0.3982	1.22
Vegetables	0.4207	1.20	0.5233	1.30	0.5682	1.30	0.4225	1.21	0.2534	0.90	0.4915	0.95	0.4266	1.22	0.2440	0.87	0.4910	0.93
Publicly-Owned	0.3290	0.97	0.7095	1.95*	0.7703	1.92*	0.2622	0.79	0.6105	2.46**	1.1745	2.09**	0.3211	0.94	0.5947	2.37**	1.1898	2.05**
Foreign	0.4812	1.01	1.3705	1.12	1.4881	1.10	0.4829	1.02	0.7075	0.95	1.3611	0.91	0.4991	1.05	0.7265	0.90	1.4519	0.87
Privately-Owned	0.1278	0.68	0.1146	0.63	0.1244	0.63	0.1294	0.68	-0.0039	-0.03	-0.0060	-0.02	0.1351	0.71	-0.0087	-0.06	-0.0162	-0.06
Export	0.1440	0.60	0.2015	0.87	0.2188	0.87	0.1264	0.53	0.1222	0.70	0.2356	0.69	0.1353	0.56	0.1182	0.69	0.2368	0.68
Green Food	0.2073	1.19	0.2651	1.55	0.2879	1.55	0.1973	1.14	0.0578	0.43	0.1129	0.45	0.2040	1.17	0.0497	0.37	0.1010	0.39
R&D	-0.1644	-0.44	-0.1291	-0.36	-0.1402	-0.36	-0.1462	-0.39	-0.0980	-0.38	-0.1889	-0.38	-0.1444	-0.39	-0.0987	-0.39	-0.1977	-0.39
Intercept	1.0459	2.30**	0.9288	2.13**	1.0085	2.13**	1.0094	2.20**	0.8451	2.50**	1.6295	2.38**	1.0038	2.18**	0.8359	2.48**	1.6740	2.33**
Wald Test for Exogeneity			$\chi^2(1)=$ 8.76***		$\chi^2(1)=$ 8.10***				$\chi^2(1)=12.89$***		$\chi^2(1)=9.56$***				$\chi^2(2)=67.03$***		$\chi^2(2)=7.88$**	
Sample Size	456		454		455		455		449		449		453		449		449	

Note: (1) ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

(2) Profits last year as an instrument for capital.

(3) Fixed assets, last year's profit, and credit score as instruments for the number of contracted farmers.

Table 3. Estimation Results for the Number of Contracted Farmers

Ln(Farmers)	2.A OLS		2.B OLS		2.C IV Regression	
	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio
Contract Type			-0.0444	-0.20	-1.1833	-0.35
City Location	-0.3191	-2.29**	-0.3205	-2.30**	-0.3469	-1.93*
Dairy	-0.8424	-4.12***	-0.8407	-4.10***	-0.8910	-3.98***
Meat	-0.1193	-0.62	-0.1188	-0.62	-0.1161	-0.56
Grain	0.3566	1.94*	0.3582	1.95*	0.3724	1.41
Vegetables	0.2888	1.11	0.2907	1.12	0.2649	0.89
Publicly-Owned	0.3764	1.41	0.3800	1.42	0.3345	0.95
Foreign	-0.6770	-2.67***	-0.6732	-2.64***	-0.6465	-1.92*
Privately-Owned	-0.0528	-0.34	-0.0515	-0.33	-0.0528	-0.34
Ln (Fixed Assets)	0.4069	4.24***	0.4068	4.24***	0.4330	4.49***
Ln(Last Year Profit)	0.0072	0.09	0.0063	0.07	-0.0804	-0.75
Credit Score	0.0417	0.42	0.0413	0.42	-0.0008	-0.01
R&D	-0.1151	-0.41	-0.1157	-0.42	-0.1579	-0.52
Intercept	6.3818	8.00***	6.4294	7.63***	7.9987	1.99**
R^2	0.1355		0.1356		0.0815	
Sample Size	491		491		443	

Note: (1) ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.
(2) The export license and green food dummy variablesare used as instruments for contract type.

Table 4. Estimation Results for the Intensity of Contracts for Processors

Share	Tobit		Tobit		Tobit		Tobit		3.E [Endog. Contract]				3.F [Endog. Ln(Contracted Farm)]			
	3.A		3.B		3.C		3.D		IVTobit-G2SLS		IVTobit-MLE		IVTobit-G2SLS		IVTobit-MLE	
	Coef.	t-ratio	Coef.	T	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio
Ln (Farmers)			0.1549	0.19			0.1488	0.18	0.3937	0.33	0.2421	0.18	-2.1846	-0.35	0.9637	0.15
Contract Type					4.1227	1.02	4.2554	1.05	77.6848	1.03	110.4793	1.25	4.7814	1.16	1.0516	0.30
City Location	-0.9230	-0.38	-0.6814	-0.28	-0.7879	-0.33	-0.5406	-0.22	1.8717	0.49	1.4789	0.34	-1.8580	-0.49	-1.2250	-0.34
Dairy	9.4003	2.04**	9.6512	2.08**	9.2798	2.01**	9.5219	2.06**	9.4352	1.38	8.0273	1.02	8.5054	1.40	10.0350	1.78*
Meat	3.6176	1.08	4.1051	1.22	3.5614	1.07	4.0581	1.21	3.6106	0.72	-1.3762	-0.24	4.2681	1.25	0.9491	0.31
Grain	-2.5915	-0.87	-2.4138	-0.80	-2.7023	-0.90	-2.5227	-0.83	-5.1573	-0.95	-2.1713	-0.35	-0.8829	-0.19	1.2458	0.29
Vegetables	1.0974	0.25	1.3104	0.30	0.9030	0.20	1.1123	0.25	-2.6386	-0.38	-10.0752	-1.23	1.5720	0.30	-3.9887	-0.84
Publicly-Owned	-2.5646	-0.61	-2.8670	-0.68	-2.9426	-0.70	-3.2619	-0.77	-9.1666	-1.11	-9.3098	-0.97	-2.4855	-0.51	-1.5684	-0.37
Foreign	5.4987	0.99	5.2913	0.95	5.1539	0.93	4.9256	0.89	0.1063	0.01	-6.5071	-0.61	4.2826	0.67	1.5659	0.26
Privately-Owned	0.9546	0.36	0.7389	0.28	0.8218	0.31	0.5975	0.22	0.1759	0.05	2.5088	0.58	1.3509	0.49	3.7514	1.55
Ln (Capital)	2.9098	2.50**	3.0584	2.55***	3.0023	2.58***	3.1570	2.63***	6.1422	2.04**	6.9752	1.99**	3.6843	1.63	2.7204	1.24
R & D	8.0476	1.57	9.6483	1.86*	8.2392	1.61	9.8462	1.90*	12.9297	1.64*	17.4266	1.91*	11.7064	2.15**	13.3469	2.86***
Constant	50.0294	3.73***	45.2698	3.09***	45.2681	3.19***	40.3860	2.63***	-62.4948	-0.64	-114.1443	-0.99	55.9176	1.21	23.8105	0.52
Wald Test for Exogeneity									$\chi^2(1)$ =1.68		$\chi^2(1)$ =1.55		$\chi^2(1)$ =0.11		$\chi^2(1)$ =0.00	
Sample Size	475		472		475		472		428				462			

Note: (1) ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

(2) The export license and green food dummy variables are used as instruments for contract type.

(3) The logarithm of fixed assets, the logarithm of last year's profit, and credit score are used as instruments for the logarithm of the number of contracted farmers.

Table 5. Estimation Results for the Sale and Profit Functions for Processors

	4.A Ln(Sales)		4.B Ln(Profit)		4.C Ln(Profit)	
	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio
Ln(Sales)			0.4042	7.83***		
Ln (Farmers)	0.1203	4.82***	-0.0502	-1.83*	-0.0029	-0.10
Contract Type	-0.1231	-0.97	0.1567	1.14	0.1291	0.88
City Location	-0.1035	-1.37	-0.1558	-1.92*	-0.1942	-2.24**
Dairy	-0.1536	-0.97	-0.3682	-2.16**	-0.4317	-2.38***
Meat	0.1821	1.77*	-0.2134	-1.93*	-0.1373	-1.17
Grain	0.2443	2.57***	-0.1408	-1.36	-0.0405	-0.37
Vegetables	0.2096	1.63	-0.1114	-0.80	-0.0254	-0.17
Publicly-Owned	0.5608	4.22***	-0.7222	-4.89***	-0.5104	-3.30***
Foreign	0.5029	3.04***	-0.1611	-0.90	0.0407	0.21
Privately-Owned	0.2871	3.40***	-0.0760	-0.83	0.0401	0.41
Export	-0.1717	-1.60	-0.3322	-2.88***	-0.4035	-3.29***
Green Food	-0.0968	-1.27	0.0367	0.45	-0.0079	-0.09
Ln(Capital)	0.5982	16.20***	0.5162	10.16***	0.7625	17.91***
R & D	-0.4515	-3.06***	0.4243	2.60***	0.2305	1.34
Intercept	3.3853	7.33***	-1.6812	-3.20***	-0.3533	-0.67
R^2	0.4907		0.5211		0.4535	
Sample Size	453		450		450	

Note: ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.