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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 prevalent in developing countries, such as in China. In order to prevent breaches of contracts, the contractual designs between farmers and agricultural processors (*Dragon-Heads Firms*) in China, innovate in two ways: organizational innovations and contractual innovations. In particular, contractual innovations are that initial simple price-quantity contracts involve into complex cooperation contracts. Using the data for over 500 State Key Processors in 2003 from Chinese Ministry of Agriculture, we construct econometric models to study contract choices, contract intensity, and the impacts on sales and profits for agricultural processors in China.

The results indicate that capital and the number of contracted farmers are endogenous in contract choices. Processors are more likely to use cooperation contracts compared with price-quantity contracts as the number of contracted farmers increases, because then the costs of coordinating, monitoring and enforcing price-quantity contracts may increase dramatically in the case of price-quantity contracts. On the other hand, contract types are not important for the number of contracted farmers, the intensity of contracts, sales and profits for processors, because the purposes of different contract types are related with prevention of breaching contracts. By the way, the results 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.

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

Introduction

Agricultural processors are called *Dragon-Heads 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.

From the Economic Reform after 1978, China has been transiting from a planned economy to a market economy. The reform has fundamentally changed agricultural producing and marketing organizations and systems. Under the planned economy, the state monopolized the purchase and marketing for agricultural products. Production and sales of agricultural products were based on the state plans. After the Economic Reform, the government gradually overhauled the regulation on agricultural production and marketing. Now farmers could and should make decisions of producing and marketing based on market information. Facing an emerging market full of uncertainties, how could Chinese farmers survive and be prosperous?

As mentioned above, the government has realized the important roles of processors in a market economy, and has been helping improve the marketing channels to increase farm incomes through promoting processors. The use of contracts for producing and marketing agricultural products are increasingly prevalent in China, similar to what is happening in US and some 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).

Current literature for contract studies mainly focuses on incentives and risk shares. Case studies of the contracts between farmers and processors include chicken broilers 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) in U.S. and hog contracts in Poland (Boger 200). Besides, Jaenicke et al. (2007) studied the contract choices between farmers and processors for different commodities in Pennsylvania State of USA.

However, the key issue for the contracts in China is the enforcement, and the opportunitistic behaviors for contracted parties are still the biggest threat to efficient market transactions, even though the contracts in China is evolving from simple price-quantity contracts to very complicate contracts to prevent contracted parties from breaching in the past two decades (Tao and Zhu 2001; Zhou and Cao 2001, 2002).

Current literature for contract economics does not pay much attention to enforcement of contracts. The benchmark of current contract theory is that it assumes there is a well-functioning legal system under which any contract will be enforced perfectly by a court (Bolton and Dewatripont 2005 pp.3).

However, there are many cases that public institutions do not function well in enforcing contracts, in particular for these transition economies (Gow and Swinnen , 1998 2001). Gow, Streeter and Swinnen (2000) attribute breaches of contracts between growers and processors in transition economies to absence or ineffectiveness of public institution in enforcing contracts. Though China, as an economy in transition, might not be an exception of absence of effective contract enforcement of public institutions in some sense, it might be a different story. As Chow(1997) pointed out, 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 insuring that a contract is honored. Such a "semi-legal system" may help enforcement of contracts rather than weaken it.

On the other hand, different from the "Shock Therapy" of transition economies in Eastern European, 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 reasonable to attribute breaches of contracts in China to the failure of public enforcement institutions as Gow, Streeter and Swinnen (2000) suggested in general transition economies.

Also, as we know, enforcing a contract might be possible but very costly. High costs may weaken enforcement of contracts. It means that the parties in a contract might be very opportunitistic when enforcement of contracts is very costly even the public enforcement institutions function well. Therefore, this paper suggests that the absence of effective contract enforcement in China may result from the high costs of enforcing contracts, rather than failure of public enforcement institutions.

China has a large amount of very small and fractional farmers. Under such an economic background, the deal for each 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 farmers but the processor should pay a very high court cost. On the other hand, if a processor breaches a contract, the farmer usually can not pay a high court cost for suing the processor. Stemmed from the resource endowment, at the early stage of the Economic Reform, opportunitistic behaviors for both parties of contracts have been very prevalent. It is very inefficient since it increases transaction costs and hurts the long-run relationship between farmers and processors. However, the contractual design in China has evolved from simple price-quantity contracts to complicate contracts to prevent opportunitistic behaviors in enforcing contracts. It would be very interesting and meaningful to explore such a process of contractual innovations. In the next part, we will concretely analyze the innovations of agricultural contracts in China. Then, we use the data for over 500 State Key Agricultural Processors in 2003 from Chinese Ministry of Agriculture to verify such a fact, and to analyze the contract choices and the impacts on the profits of the processors as well.

Opportunitistic Behaviors and Innovations of Contracts

- Opportunitistic behaviors

Different from USA and other western countries, China has a large amount of very small and fractional farmers. The land in general is equally divided among farmers. The property rights of agricultural land can not be traded in the market by the law. In 2005, China has 252 million farms, and the land area per farmer is only 2.08 mu (about 0.14 hectare)[1]. And 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, in particularly at the end of 1980s, in order to transfer risks, farmers and processors began to make some price-quantity contracts, under which farmers supply a certain amount of agricultural outputs with some prices to processors after harvest (Zhou and Cao 2001). They also can be looked as forward contracts. Resulting from the resource endowment, the contracted amount for each contract in China was very small, compared with U.S. and other western countries, and each processor usually had a large amount of contracted farmers, as we show in the following part.

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

[Insert Figure 1]

Simple price-quantity contracts are very difficult to be enforced because the oppotunitistic behaviors were very prevalent. As shown in Figure 1, suppose contracted price for some commodity is P_C. After harvesting, if the market price P_M might be different from P_C, the opportunitistic behaviors either for farmers or for processors may happen. Then, suppose the court cost for each case is C_L.

If $P_M = P_H$ which is higher than P_C, the farmers may breach the contracts, and sell their outputs directly to the market for higher profits. The benefit for the opportunitistic behavior for a farmer is DE, as shown in Figure 1, which equals the loss for a processor . As mentioned above, the contracted amount with each farm is usually very small. As the number of contracted farmers increases, the processors can not sue each farmer for a small amount of benefit but with a high court cost.

On the other hand, if $P_M = P_L$ which is lower than P_C, the processors may breach the contracts, and would buy the commodities directly from the market with a lower price. The benefit from breaching a contract for a processor is AB, and also equivalent to the loss of a farmer. Given the situation of no organizations for farmers, each small farmer can not sue a big processor for a small amount of benefit but facing a high court cost.

Such opportunitistic behaviors were very prevalent at the end of 1980s and in the early 1990s. They even can be often watched in current China (Zhou and Cao, 2001). From a long-run perspective, such opportunitistic behaviors hurt both farmers and processors, because the risks can not be transferred and the trustable relationship between farmers and processors were also damaged.

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

[Insert Figure 2.a and 2.b]

- **Organizational Innovations**

Organizational innovation is that, as shown in Figure 2.a, a mediate organization has been constructed between farmers and processors. Such a mediate organization could be either brokers or cooperatives. Processors can make contracts with brokers or cooperatives, then brokers or cooperatives can make contracts with farmers. The organizational innovations can significantly reduce opportunitistic behaviors than the contracts directly between farmers and processors.

First, the contracted amount between a processor and a mediate organization is much larger than that between a processor and a farm. It would increase the potential benefit from suing a breaching party in the court. Such a possible outcome can effectively deter the opportinitistic behaviors for both parties of the contract.

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

- **Contractual Innovations**

Gow and Swinnen (2001) suggest that breaches of contracts could be prevented by designing some "self-enforcing" contracts such that these private losses from contract breach outweigh potential benefits. Initiated by Klein, Crawford, and Alchian (1978) and Klein

(1996), hold-ups are looked as a very useful way to prevent contract breaches. Gow and Swinnen (1998, 2001) found that foreign companies in transaction economies usually use hold-ups to prevent breaches of contracts. Also, the innovations of contracts in China are consistent with these findings, as shown in Figure 2.b.

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 won't be supplied in the following years. It eventually increases the potential costs of beaching contracts. Similar things can be observed in the contractual practice in China.

Moreover, in the case of China, some innovated contracts regulate that the processors will return some profits to farmers as the compensation, particularly when the contract price is lower than the market price. Such a flexible institutional arrangement can share more risks between processors and farmers, so that it can increase the utilities for both parties in the long-run if they are risk-aversion. In China, we call this type of contracts "Cooperation Contracts". Such an arrangement can tie up farmers and processors.

Some contracts require that farmers invest or deposit some money in the processors. This type of contracts usually is called "Joint-Stock Cooperation Contracts". It implies that the farmers hold some stocks of the processors. In some sense the farmers become the owners of the processors, and they can affect the behaviors of managers of the processors. Broadly speaking, it is a kind of vertical integration through which farmers integrate processors. Similar with "Cooperation Contracts", the processors would return some profits to farmers as dividends. This measure also can effectively prevent both contracted parties from breaching.

- **Some Hypotheses**

From the above-mentioned analysis, we can give some hypotheses:

(1) The number of contracted farmers for each processor and the contract types may be endogenous, because the contracts may be designed simultaneously by farmers and processors.

(2) From the perspective of processors, as the number of contracted farmers increases, the processors would be 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 for farmers would increase, and the risks can not be transferred. Then, processors are more likely to choose "Cooperation or Joint-Stock Cooperation Contracts" to hold up farmers and share risks with farmers.

(3) The capital of processors and contract types are also endogenous. Because the investment or deposits required in Joint-Stock Cooperation Contracts, can be used as capitals.

(4) Controlling the types of contracts and sale value, the profits of processors may 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 will use micro data for over 500 State Key Processors in China, made available from the Chinese Ministry of Agriculture, for analyzing the behavior of the agricultural processors, such as contract choices and the impacts on sales and profits for the processors, and for testing the above-mentioned hypotheses as well.

Data

The data used in this study including the basic information of production and financial reports for 561 State Key Processors in 2003. Totally, there are 582 State Key Processors, in which 21 are missing. In the following analysis, we also may drop some item-missing samples. The explanation to the variables used in this study can be seen in the Appendix.

Though there are three types of contracts; in practice, each processor typically uses only one type of the contacts. As shown in Table 1, except for 35 whose contract types are unknown, only two processors use mixed types of contracts, and 474 processors use price-quantity contracts. It implies that price-quantity contracts are still prevalent in the Key Processors in China, though they are more likely to be breached. Only 43 and 7 processors use cooperation contracts and joint-stock cooperation contracts, respectively. For the convenience of analysis, in the rest part of this paper, joint-stock cooperation contracts are also called cooperation contracts. The average numbers of contracted farmers for price-quantity contracts and cooperation contracts are 95023 and 102254, respectively, and the number for cooperation contracts is slightly higher than that for price-quantity contracts.

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 20512, less than others, and the numbers for meat processors, grains processors, and vegetables processor are, respectively, 124914, 96585, and 116179. The possible explanation would be that dairy farmers are not widely spread in China, because it was dominated by state-owned dairy operations (Främling 2006). However, the number of contracted farmers for dairy industries is expected to increase in the next few years as the demand for milk in China increases.

Most processors, 296 of the 561 processors, are privately owned, and the average number of contracts is 71476. There are only 28 foreign processors, and the average number of contracted farmers is 50606, which is the lowest. There are 58 processors which are publicly owned, and the average contract number is 195,926, much higher than other types of ownerships. The main type of the contracts in the rest 179 processors is the joint-stock ownership. It implies that scales of publicly-owned are larger than others.

In the next part, we construct some econometric model to test the above-mentioned hypotheses.

Contract Choices

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

$$y_{1i}^{*} = Z_{1i}\beta_1 + A_{1i}\gamma_1 + \varepsilon_{1i} \qquad (1)$$

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

where y_{1i}^{*} is a random utility function for processor i .When $y_{1i}^{*} \geq 0$, the processor would use price-quantity contracts; otherwise, the processor would use cooperation contracts. Z_{1i} is a vector of exogenous variables; A_{1i} is a vector of endogenous variables; β_1 and γ_1 are corresponding vectors of coefficients for Z_{1i} and A_{1i}. ε_{1i} is an error term with a standard norm distribution $N(0,1)$.

We constructed three models to test the hypotheses of exogeneities of capital and the number of contracted farmers. We use the profit of the last year as an instrument for the capital, because the change of the capital is correlated with the profit in the last year. We use the profit of the last year, fixed assets, and credit score as instruments for the number of contracted farmers, because we can assume farmers can observe these variables, but these variables are not important for current behaviors of the processors.

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 Maximum Likelihood Estimation 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 by the ordinary Probit 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 tests (1988) reject the hypotheses of exogeneity in all three models. The result supports the above-mentioned hypotheses that both capital and the number of contracted farmers are endogenous. The results indicate that the contract types may be simultaneously determined by farmers and processors.

The 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 big 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 with an increase in the number of contracted farmers, processors are more likely to choose cooperation contracts from the perspective of processors. China has a large amount of small (fractional) farmers, 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 cost of coordinating, monitoring and enforcing contracts also increases, and the probability of breaching contracts for farmers would increase, so that the risks can not be transferred. Then, processors are more likely to choose cooperation contracts to hold up farmers and share risks with farmers.

The type of ownership for processors is important for contract 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 the public ownership of the firms.

The Number of Contracted Farmers

The last model of contract choices shows that number of contracted farmers and contract choices are endogenous, then we can suggest an econometric model for studying the number of contracted farmers:

$$Ln(Farmers) = Z_{2i}\beta_2 + A_{2i}\gamma_2 + \varepsilon_{2i} \qquad (2)$$

Where $Ln(Farmers)$ is the logarithm of the number of contracted farmers; Z_{2i} is a vector of exogenous variables for a processor i which can be observed by farmers; for instance, we assume farmers can observe the fixed assets, but can not observe the capital; A_{2i} is a vector of endogenous variables. β_2 and γ_2 are corresponding vectors of coefficients for Z_{2i} and A_{2i}. ε_{2i} is an error term with a norm distribution $N(0, \sigma_2^2)$.

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

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

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

Consistent with the descriptive statistic, dairy processors has fewer contracts than others. Different from the traditional commodities, such as grains, meats and vegetables, dairy is still a 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 new comers to the market and it will take more time to construct a reliable relation with farmers.

The estimation results also show that the value of fixed assets for processors is positively related with 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 more farmers for more inputs; (2) the fixed assets can be looked as the 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 some inputs directly from the market when the contracted supply is not enough for production. For instance, Jaenicke et al.(2007) analyze the intensity of contract purchase for agricultural processor in Pennsylvania. The same method is also used here for analyzing the intensity of contract purchase for agricultural processors in China. The econometric model is given as follows:

$$S_i = Z_{3i}\beta_3 + A_{3i}\gamma_3 + \varepsilon_{3i} \qquad 0 \le S_i \le 100 \qquad (3)$$

where S_i is the percent of contracted purchase to total purchase, 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 the fixed assets, but can not observe the capital; A_{3i} is a vector of endogenous variables. β_3 and γ_3 are corresponding vectors of coefficients for Z_{3i} and A_{3i}. ε_{3i} is an error term with a norm distribution $N(0, \sigma_3^2)$.

Similar with Jaenicke et al.(2007), Tobit models can be used here. Different from Jaenicke et al.(2007), we will include some possible endogenous variables and then test the endogeneity. The possible endogenous variables are contract types and the number of contracted farmers. We also can use Maximum Likelihood Estimation (MLE) and Amemiya' 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 for Tobit models.

Table 4 reported the estimation results. Wald tests in Model 3.E and Model 3.F, can not reject the exogeneities of contract types and the logarithm of the number of the contracted farmers, respectively. Hence, we can estimate the model with usual Tobit Models.

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

The capital can represent the scale of a processor. A positive sign of the coefficient of the logarithm of the capital implies that larger processors are more likely to use contracts to stabilize the supply of input.

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

Sales and profits of Processors

In the last step, we will analyze whether the contract types and the number contracted farmers can impact sales and profits of processors. We can give the functions of sale value and profits for processors as follows,

$$\begin{cases} Ln(sale_i) = Z_{4i}\beta_4 + \varepsilon_{4i} & (4) \\ Ln(profit_i) = Z_{5i}\beta_5 + \gamma_5 Ln(sale_i) + \varepsilon_{5i} & (5) \end{cases}$$

Where Z_{4i} and Z_{5i} are two vectors of independent variables, and β_4 and β_5 are corresponding vectors of coefficients. ε_{4i} and ε_{5i} are error terms, respectively, with norm distributions $N(0,\sigma_4^2)$ and $N(0,\sigma_5^2)$.

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

First, we find that the coefficient of the contract types is not statistically significant either for sales or for profits, while the coefficients in the number of contracted farmers are 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 contrary, a negative sign for profits implies that the profits decrease as the number of contracted farmers increases, and the possible reason might be that increase in the number of contracted farmers may sharply increase transaction costs due to coordinating, monitoring and enforcing contracts, which may lower profits for processors.

Second, the coefficients in the dummy variable of city location are negative both in the sale function and the profit function, and only the coefficient in the profit function is statistically significant of 10%. It implies that processors located in major cities and far away from farmers may have lower profitability than those located in small towns or rural areas. The possible explanation is that the distance between farmers and processors will increases transaction costs due to asymmetric information and higher transportation costs, which may decrease the profitability of processors.

Third, operational details also affect the sales and profits for processors. Only the coefficients for the meat dummy variable and the grains dummy variable are statistically significant, and, respectively, are 0.18 and 0.24 in the sale function. It implies that the sale values for grain processors are larger than meat and other processors. While only the coefficients for dairy dummy variable and meat dummy variable are statistically significant in the profit function, and, respectively, are -0.37 and -0.21. It implies that the profits for dairy and meat processors are in general lower than others.

Fourth, ownerships are also 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, respectively, are 0.56, 0.50 and 0.29. It implies that publicly-owned processors have a higher sale than other ownership structures in

China, perhaps resulting from a higher loyalty on the part of farmers built up over a long history. While only the coefficient for the dummy variable of public-owned processors is statistically significant and is -0.72. It implies that publicly-owned processors have 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 for China moving from a planned economy to a market economy.

Fifth, the coefficient for the dummy variable of export licenses is only statistically significant for the profit function, and not for the sale function. In particular, export licenses are negatively correlated with the profits. Agricultural products are highly competitive commodities in the world market, in particularly after China's accession to WTO in 2001. Exporting agricultural products usually face higher costs and it might have lower profitability than selling in the domestic market.

Sixth, capital plays important roles in both sale and profit functions. Specifically, the elasticities of sales and profits with respect to capital, respectively, are 0.60 and 0.52, and both are statistically significant of 1%. 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 of research and development (R&D) are also statistically significant both for sale and profit functions. A negative sign for the coefficient in the sale function and a positive sign in the profit function imply that processors with R&D departments have lower sales but higher profits. Hence, it indicates investments in R&D can improve the profits for processors in China, though they have lower sales.

Conclusions

Contracts are widely used by agricultural processors for purchasing inputs not only in developed countries but also in developing countries, as happens in China. In order to prevent opportunitistic behaviors, which may cause breaches of contracts and may also threaten the efficiency of contracts, the contractual designs of simple price-quantity after the 1978 Economic Reform in China innovate in two directions: organizational innovations and contractual innovations. Organizational innovations are that some mediate organizations, such as cooperatives or brokers, are constructed between farmers and processors. Contractual innovations are that price-quantity contracts begin to involve into complex cooperation contracts to hold up the parties of contracts, though, currently, price-quantity contracts are still prevalent in China.

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

The results indicate that capital and the number of contracted farmers are endogenous in contract choices. It suggests that the 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 then the costs of coordinating, monitoring and enforcing price-quantity contracts may increase dramatically.

On the other hand, contract types are not important for the number of contracted farmers, the intensity of contracts, sales and profits for processors, because different contract types in China involve from prevention of breaching contracts.

Ownership structures are 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 worthy 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: values of fixed assets this year (million yuan);
Credit Score: 3—AAA, 2—AA, 1—A, 0—others;
Sale: sale value in last year (10 thousand yuan);
Last Year Profit: profits in last year (10 thousand yuan);
Profit: profits in the current year (10 thousand yuan);
Contract intensity: percent of purchased quantity by contracts in total processed quantity.

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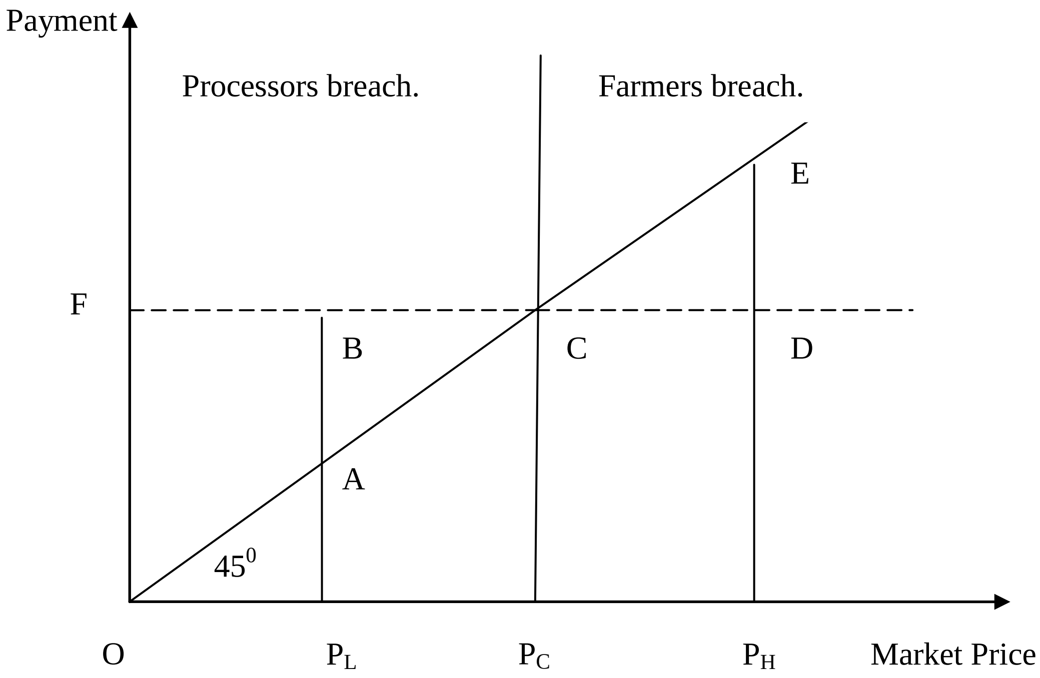

Figure 1   Price-Quantity contracts

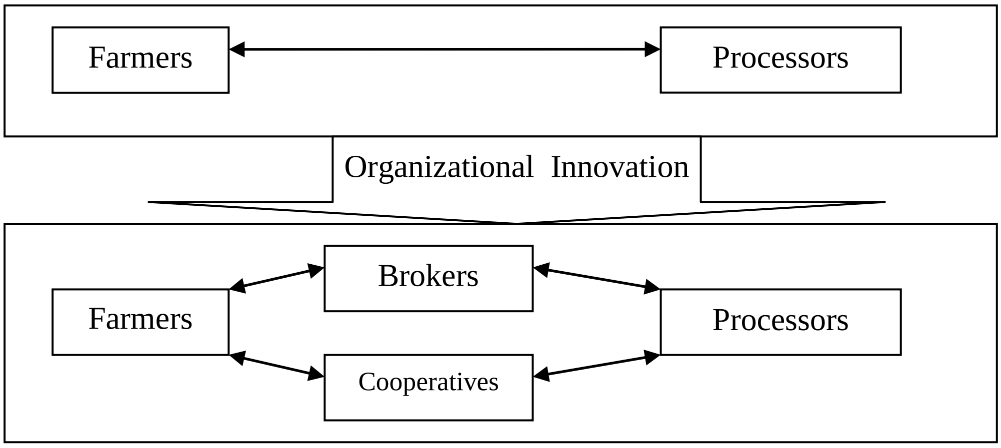

Figure 2.a Organizational Innovation

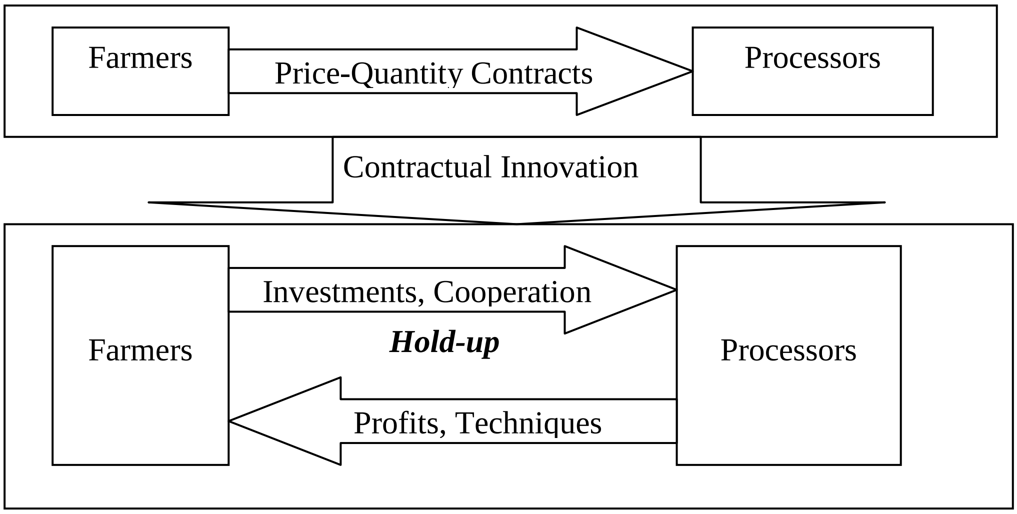

Figure 2.b Contractual Innovations

Table 1, Some 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 the Function of 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(1)= 8.76***		Chi(1)= 8.10***				Chi(1)= 12.89***		Chi(1)= 9.56***				Chi(2)= 67.03***		Chi(2)= 7.88**	
Samples	456		454		455		455		449		449		453		449		449	

Note: (1) ***, **, and * are significant of 1%, 5% and 10%, respectively.

(2) Profits last year as an instrument for Capital;

(3) Fixed Assets, Last Year Profit, and Credit Score as instruments for the Number of Contracted Farmers.

Table 3 Estimation Result for the Function of 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 Types			-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**
R2	0.1355		0.1356		0.0815	
Samples	491		491		443	

Note: (1) ***, **, and * are significant of 1%, 5% and 10%, respectively.
(2) The Dummy Variable of Export License, and the Dummy Variable of Green Food are used as instruments for Contract Types.

Table 4 Estimation Result for the Function of Intensity of Contracts for Processors

Share	Tobit		Tobit		Tobit		Tobit		3.E [Endo. Contract]				3.F [Endo. Log(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									Chi2(1) =1.68		Chi2(1) =1.55		Chi2(1) =0.11		Chi2(1) =0.00	
Samples	475		472		475		472		428				462			

Note: (1) ***, **, and * are significant of 1%, 5% and 10%, respectively.

(2) The Dummy Variable of Export License, and the Dummy Variable of Green Food are used as instruments for Contract Types.

(3) Logarithm of Fixed Assets, Logarithm of Last Year Profit, and Credit Score as instruments for the Logarithm of the Number of Contracted Farmers.

Table 5 Estimation Results of Sale and Profit Functions for Processors

	4.A Log(Sale-Value)		4.B Log(Profit)		4.C Log(Profit)	
	Coef.	t-ratio	Coef.	t-ratio	Coef.	t-ratio
Log(Sale-Value)			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
R2	0.4907		0.5211		0.4535	
Samples	453		450		450	

Note: ***, **, and * are significant of 1%, 5% and 10%, respectively.