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Three essays on contract farming in China

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Three essays on contract farming in China

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ABSTRACT

Contract farming in China has grown rapidly over the past 10 years. The first part of this dissertation examines the evolution of contract farming, and explores the incentives to engage in contract farming, preferred contract provisions, and contract performance from the perspective of both Chinese farmers and contracting firms. Firm and household perceptions of contracting are assessed using data obtained from village and firm level surveys. Farmers identify price stability and market access as the key advantages to contracts, while firms consider improved product quality as the primary incentive to use contracts.

In Part II, the survey data are used to empirically analyze the farm level income effect of a contract farming program in China. Two methods, propensity score matching and the econometric sample selection model, are used to estimate the treatment effect of a contract farming program. Four samples are obtained from the survey by restricting the analysis to farmer groups of varying levels of homogeneity. Results using the four samples of farmers and the two estimation methods vary in important ways. When the sample is the most homogeneous, both estimation methods indicate that the contract farming program does not substantially increase per laborer's gross income.

The third paper develops an applied contract model taking into account hidden information and other factors to show the pricing mechanism could result in the exclusion of small-scale farmers from the contract production program. The empirical results show that small-scale farmers are likely to be excluded out of the contract farming program in China. Further a linear pricing method employed by contracting firms is one of the primary factors contributing to the exclusion of small farms. The resulting policy implication is that the government should encourage contracting firms to employ a differentiating pricing strategy offering contracts with price and quantity provisions. Possible policy instruments include contract pricing regulations and the redesign of the government's grant distribution mechanisms.

CHAPTER 1. GENERAL INTRODUCTION

Contract farming has been supported by the central government of China in order to make agricultural production more profitable and competitive. Contract farming offers a means to effectively connect small-scale farmers and large-scale food processing firms. Direct benefits from contracting accrue to smallholders from improved access to markets, improved technology, better management of risk and opportunities for employment of family members. Indirect benefits occur from empowerment of women and increased commercial acumen on the part of smallholders. While contract farming promises significant benefits for growers in many cases, recent studies (Carney and Watts, 1990; Little 1994; Singh 2000) have highlighted circumstances in which members of the rural population have realized only limited gains, or have been directly or indirectly harmed by contract farming programs. In China either outcome is possible. This dissertation provides a systematic analysis of two issues critical to the performance of China's contract farming program: the ability of the program to increase incomes of participating households and the extent to which the program reaches the target beneficiary.

1. Introduction

The agricultural sector in China has been fundamentally reshaped during the last 25 years. Agricultural output and farm household income have grown continuously, due, to a large extent, to the agrarian reforms put into effect by the central government. As with a number of government programs currently taking effect, the contract farming program, which appeared as a result of the government's agricultural industrialization program, is a fairly new venture for the Chinese agricultural sector. Contract farming, at its best, offers a means to effectively connect small-scale farmers and large-scale food processing firms. Therefore, contract farming has potential advantages over independent farmer production in restructuring the agriculture supply chain and providing farmers with better access to production resources and commodity markets.

The first part of the dissertation performs a general analysis of China's contract farming program from the perspective of both farm households and agribusiness firms. Following this preliminary study, two issues critical to the performance of contract farming program in China, have been addressed in this dissertation.

First, the increasing use of contracts in rural China is not necessarily associated with the improved income received by the farmer. The use of contracts could potentially lower on-farm income, if they reduce incentives for growers to work hard or to invest fully in specific productive assets. The fundamental goal of this part of the study is to assess whether contract farming plays a positive role in raising farmers' incomes. We use recent survey data from China to analyze the causal effect associated with contract farming programs. We use two methods to evaluate whether or not the use of contract farming improves farmer income. One method is propensity score matching that involves pairing treatment and control units that are similar in terms of their observable characteristics. The second method is the sample selection treatment effect model that reduces the selection bias by accounting for the correlation between a selection equation and a regression equation. The two methods use different techniques to try to correct for selection bias. Both methods are used in an attempt to obtain better estimates of the income effect of contract farming after removing the selection bias.

The second concern about contract farming is the program's ability to reach smallholders in order to transfer technology and increase their incomes. In many countries contract-farming programs appear to bypass small households. This concern is critical to China's development because agriculture production is fragmented and a large proportion of farmers are very small-scale. The government's policy objective in creating the contract production program was to benefit smallholders and increase their household incomes. However, if the contract farming program tends to attract only large-scale farmers, then the policy objectives will not be achieved. Consequently understanding if and why smallholders are excluded from the contract farming program is critical to its success.

2. Thesis Organization

The dissertation is composed of three interrelated studies, which contribute to an evaluation of the performance of China's contract farming program. Part I examines the evolution of contract farming, and explores the incentives to engage in contract farming, preferred contract provisions, and contract performance from the perspective of both Chinese farmers and contracting firms. The survey data are described in Section 2. Farm household and agribusiness firms' assessments of contract farming are presented in Sections 3, 4 and 5. Finally, conclusions and policy implications are presented in Section 6.

Part II of the dissertation evaluates the income effect of the contract farming program in Chinese farm households. The paper is organized as follows. We discuss the method and estimation approaches in the next section. In Section 3, a descriptive review of the survey data is presented. Section 4 illustrates the results and implications from the two methods. The last section concludes the paper.

Part III develops a contract model to study the potential used for exclusion of small-scale farmers out of contract farming. Section 2 reviews the literature with regard to contract exclusion and contract provisions that could be used to exclude smallholders. Section 3 discusses the pricing strategy that could result in the contract exclusion. Section 4 develops two hypotheses and tests them using the survey data from China. Section 5 provides concluding remarks.

CHAPTER 2. CONTRACT FARMING IN CHINA: PERSPECTIVES OF FARM HOUSEHOLDS AND AGRIBUSINESS FIRMS

Modified from a paper to be published in
Comparative Economic Studies

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Abstract

Contract farming in China has grown rapidly over the past 10 years. This paper examines the evolution of contract farming, and explores the incentives to engage in contract farming, preferred contract forms, and contract performance from the perspective of both Chinese farmers and contracting firms. Firm and household perceptions of contracting are assessed using data obtained from village and firm level surveys. Farmers identify price stability and market access as the key advantages to contracts, while firms consider improved product quality as the primary incentive to use contracts.

1. Introduction

Over the past 25 years, the Chinese agricultural sector has been fundamentally restructured. Agricultural production and farm household income has grown rapidly, due largely to agrarian reforms undertaken by the government. Beginning in 1978, a series of institutional reforms significantly transformed a collectivized planned agricultural sector into something resembling a capitalist structure. The crucial milestones have been the abolition of the communal property base, the introduction of the household contract responsibility system, price and market liberalization, the revision to the Land Administration Law in 1998, and, most recently, China's admission to the World Trade Organization (WTO) (Kedliker, 1992; Oi, 1999; Unger, 2002; Whiting, 2001; Zweig, 1997). The farm household has become an active agent in the marketplace in contrast to a passive production unit in the planned economy. After meeting some minimum production requirements from local government, farm households at the village level have certain rights to decide what they will produce and how to market their products. However, Chinese farmers face a number of challenges – low agricultural prices due to large stocks of products, lagging incomes and excess labor in the agricultural sector, among others. Externally, Chinese agriculture faces increasing competition from foreign products due to China's recent entry into the WTO and the continuing globalization of agriculture. Domestically, Chinese agriculture has moved into a new development stage characterized by significant increases in the level of production, along with shifts in food demand as a consequence of urbanization and rising incomes. Under these circumstances millions of small-scale farm households in China are unable to compete effectively and respond to changes in domestic demand and withstand pressure from international markets. For many small holders, market access has become increasingly difficult and their incomes continue to lag behind the rest of the economy.

Agricultural officials in China are faced with the problem of how to overcome the limits imposed by a fragmented production system, improve the quality and competitiveness of agricultural products, and raise the income of rural households. In 2004 a system of subsidies, along with infrastructure investments and reform in rural credit institutions, was introduced to improve the welfare of farm households. (Gale, Lohmar, Tuan, 2005; Gale and Collender, 2006). However, institutional innovations to create new ways of doing business also play an important role in China's attempts to modernize its agricultural system and improve rural incomes. One of these innovations is contract farming. Contract farming is a fairly new venture for the Chinese agricultural sector – one that emerged as a result of the government's agricultural industrialization programs.

Contract farming has a checkered history throughout the world. At its best, contract farming provides a means to manage complex production processes with greater precision than is possible through arm's length market transactions. This can result in higher quality, safer food with lower production and marketing costs. In some cases, particularly in developing or transition economies, contracting can overcome imperfections in input and output markets or institutional deficiencies by providing credit, seeds, machinery services, human capital and market access to farmers. However, without adequate competition among contracting firms, informed farmers and rule of law, contract farming may lead to economic serfdom for peasant farmers or a food system that meets the economic objectives of power elites. (See, for example, Allen and Lueck, 2003; Eaton and Shephard, 2001; Little and Watts, 1994; MacDonald, et al, 2004; Runsten and Key, 1996.)

The agricultural industrialization program, of which contact farming is a part, has been supported and motivated by the Chinese government with the purpose of making agricultural production more profitable and competitive. Contract farming offers a means to effectively connect small-scale farmers and large-scale food processing firms. Local governments also recognized the potential of contract farming for transforming the structure of agriculture and raising farm income. Many have implemented a number of programs and incentives, such as credit support and tax reduction for agribusinesses involved in contract farming.

Contract farming in China has made considerable progress since its emergence 20 years ago. Four characteristics can be safely generalized from its growth so far. First of all, the number of agricultural commodities produced under contract has increased steadily. Agricultural products produced or marketed under contract have grown from small-quantity locally specialized products, such as food oil and vegetables, to bulk commodities such as corn, beans, rice and wheat. For example, in Jiling Province, the number of contracted commodities has grown from 30 in 1999 to 70 in 2000. Second, the geographic distribution of contract farming has also expanded greatly. Initially, contract farming was developed in the economically advanced coastal provinces. Now contract farming is spreading rapidly into the underdeveloped areas of Central and Western China. Many firms sign contracts not only with local farmers, but also with farmers in other provinces. Third, the scale of products produced under contract (planted areas, volume of cash receipts and number of farmers) has also increased. According to the Chinese Ministry of Agriculture, the planted area involved in all types of contracts reached 18.6 million hectares in 2001, approximately 40 percent higher than in 2000. (Niu, 2002). Finally, the number and complexity of contracts have also increased. Beyond rather standard production and marketing contracts, some new contracts cover food transactions between main production regions and high demand regions and seed provision between farmers and research institutions.

According to the most recent survey from the Chinese Ministry of Agriculture, there were 4.6 times the number of organizations involved in agricultural industrialization across 31 provinces in 2000 than in 1996. The number of farmers who signed contracts with firms increased twofold over the same period. The proportion of farmers involved in contract farming went up correspondingly, from 10 to 25 percent. (Niu, 2002).

Table 1 shows the level and composition of firms or organizations involved in agricultural industrialization between 1996 and 2000, the most recent data available. The dominant type of firm is the so-called "dragon-head-driven" company. Dragon-head companies are agribusiness firms designated by national, provincial, municipal or county authorities with regard to their economic strength, operation scale, level of technology, management, and their potential to improve farm incomes. For example, a national dragon-head firm must meet the scale and management criteria drafted by the National Agricultural Industrialization Development Joint Committee. Other rankings are specified by committees at corresponding levels. County level dragon-head firms are the lowest level with the smallest size and impact within this ranking system. These firms agree to develop production or marketing systems that include market access, technology, technical assistance, credit and other inputs for local farmers. Most of the dragon-head firm systems involve the use of contracts. In exchange for their role in rural development, the dragon-head firms receive support from all levels of government and, since 2002, receive financing from the Agricultural Development Bank of China. In some cases, the dragon-head firms that are engaged in contracting are also encouraged to develop "bargaining associations" for farmers in an attempt to create some degree of countervailing power.

The types of organizational relationships between farmers and agribusinesses over the 1996 to 2000 period are reported in Table 2. Contracts are the dominant form of farmer-to-firm relationships. Note, however, that the proportion of contract relationships dropped steadily from 70.8 percent in 1996 to 49 percent in 2000. This would suggest that although the volume of production under contract appears to be increasing in China, the proportion of firms involved in contracting is declining, presumably because other forms of business organization, such as cooperatives or farmer-owned businesses, are becoming more prominent or are proving to be more effective. Consolidation of firms may also offer explanations, however these trends may be offset by the Government of China's efforts to encourage new firm development. Note, too that cooperatives and farmer-owned businesses may also rely on contracts.

This paper presents information on contract farming from two independent surveys of peasant households and designated dragon-head firms. The survey data sketches out some of the characteristics of the participants in contract farming, the types of contractual relationships being developed as well as the perceived benefits and limitations of contracting. A brief profile of a contracting firm and a participating farm household is given in Appendix A.

2. Survey Data Description

2.1 Farm-level data

Farm-level data were obtained through a survey conducted by more than 60 undergraduate rural-area students from Zhejiang University when they returned to their home villages during their winter break in February 2004. The survey contained questions on the farm household, farm production status and involvement in contract farming. Student survey enumerators were carefully trained before they returned home. Each student randomly selected 30 households in their home village to survey. The students returned 1820 surveys of which 1036 were complete and usable. Because many of the student volunteers came from Zhejiang, Jiangxi and Shangdong provinces, more data were collected in these three provinces. In total, the farmers included in the survey represent over 13 provinces and 47 counties, as shown in Table 3.

Table 1. Types of Organizations

Organizational Forms	1996	1998	2000
1. Dragon-head firms	5381	15088	27000
% of total	45.51	49.93	41
2. Middlemen	3384	8024	22000
% of total	28.62	26.44	33
3. Government authorities	1450	4848	7600
% of total	12.26	15.98	12
4. Other types	1600	2384	9600
% of total	13.61	7.85	14

Source: Data derived from the survey of the Ministry of Agriculture, Peoples Republic of China in 1996, 1998, 2000 reported in Niu, 2002

Table 2. Economic Relationships between Firms and Farmers

Relationship Structure in Different Years	Firm Numbers	Percent
1996	11824	100.0
1. Contract relationship	8377	70.8
2. Cooperative	1255	13.3
3. Farmer-owned business	2222	18.8
1998	30344	100.0
1. Contract relationship	16948	55.7
2. Cooperative	2791	9.2
3. Farmer-owned business	3396	11.2
4. Others	7209	23.8
2000	66000	100.0
1. Contract relationship	32340	49.0
2. Cooperative	9240	14.0
3. Farmer-owned business	8580	13.0
4. Others	15840	24.0

Source: Data derived from the survey of the Ministry of Agriculture, Peoples Republic of China in 1996, 1998, 2000 reported in Niu, 2002

2.2 Firm-level data

Firm-level surveys were conducted by mail and through direct interviews. The survey was restricted to designated dragon-head firms. A preliminary survey, conducted in June 2004, was sent to a small sample of dragon-head firms across China. Return rates were so low that a national survey was abandoned. The low return rates were likely due to the unwillingness of the firms to share information with University faculty with whom they had no established relationships. Instead, to assure a high rate of return through mail surveys, the survey population was limited to dragon-head firms within Zhejiang province. Zhejiang University has a close relationship with many of these firms and we believed this would improve the return rate. The survey was mailed to 111 agribusiness firms in Zhejiang province with the assistance of the provincial government. A total of 80 usable completed surveys were returned. During the same period we interviewed an additional 36 firms using the same instruments as the mail survey. The distribution of the various organizational types of dragon-head firms and their geographical locations are presented in the Table 4.

Table 3. Regional Distribution of Farmers in Survey

Regions	Households (units)	Proportion (%)
East Area	586	56.6
Fujian	60	5.8
Guangdong	50	4.8
Jiling	61	5.9
Jiangsu	23	2.2
Shandong	128	12.4
Zhejiang	264	25.5
Central Area	304	29.3
Hubei	11	1.1
Hunan	57	5.5
Jiangxi	236	22.7
West Area	146	14.1
Sichuan	58	5.6
Yunnan	29	2.8
Chongqing	30	2.9
Guangxi	29	2.8
Total	1036	100

Source: Primary survey 2004

Table 4. Distribution of Different Types of Firms

Types of Firms	Number	Percentage
Privately owned	78	67.2
Collectively-owned	5	4.3
State-owned	8	6.9
Joint-venture	11	12.1
Other	14	12.4

Source: Primary survey 2004

3. Farmer Households

3.1 Incentives to engage in contract farming

Out of 1036 farmer households included in the survey, as shown in Figure 1, only 220 households, or 21.2 percent, of the total have participated in contract farming. However, when farmers without contracts are asked whether they would be willing to engage in contract farming, 76.0 percent farmers answer positively. Only the remaining 2.0 percent indicate that they would not consider a contract if offered. The results suggest that most farmers view contract production favorably and would like to be involved in contract farming if offered the opportunity. The primary reason farmers do not participate in contract farming is the lack of opportunity – no firms in their area were offering contracts (Table 5). Other reasons include a lack of perceived benefits, by the households or a lack of interest from contractors operating in their area.

Table 6 illustrates several incentives identified by current contract producers that make them willing to engage in contract farming. Farmers strongly identify price stability and market access as the key advantages to contracts. Farmers' concerns about price risk reflects the sweeping price liberalization in China's agricultural commodity markets and the absence of market based risk management instruments. However, credit availability and technology support provided by contracting firms were also identified by some households.

3.2 Types of organizations that contract with farmers

Table 7 presents information on existing and preferred business relationships for the farmers. Agribusinesses, cooperatives and middlemen contract with farmers. Some village governments and Departments of Technology at the county government level, (responsible for the extension of agricultural technology), also contract with farmers. Nearly 70 percent of all existing farm contracts are with middlemen and firms. However, farmers would prefer to increase contract relations with cooperatives and technology departments and reduce their relationship with middlemen and village governments. In many cases, middlemen are the only contracting alternatives available to farmers, since cooperatives are not well developed in China. The apparent preference of Chinese farmers for cooperatives deserves further investigation.

3.3 Types of contracts

Production and marketing contracts are the two dominant contract types (Table 8). Marketing contracts involve the collecting and selling of a variety of goods, without the contractor's active involvement in production. Production contracts often involve the provision of seed, fertilizer, technology and other inputs by the contractor. (A sample contract is given in Appendix B.)

3.4 Forms of contracts

Approximately 51 percent of all contracts are written and the remaining are oral contracts between agents (Table 9). But the choice of contract form is highly correlated with contractor type. Oral contracts are used primarily by middlemen and written contracts are used by firms. The reputation and local knowledge of the middlemen, who are from the same villages as the contracting farmers can substitute for a written contract. Outside firms prefer written contracts that clearly specify rights and responsibilities for both parties.

3.5 Contract specifications

Farmers with contracts were asked to provide information on contract duration. Long-term contracts (more than one year) account for only 17.7 percent; the remaining 82.3 percent of contracts were short-term contracts of less than one year.

Several price strategies often used in contracts are identified in this context. The flexible price strategy specifies the goods transaction price to be equal to the market price at delivery. The price floor strategy defines the delivery price to be the maximum of the market price and the floor price set in the beginning period. The fixed price strategy means that the delivery price would be fixed in advance of signing contracts. Approximately 44 percent of actual contracts reported in Table 10 specified a flexible delivery price that fluctuated with the local market. The second most common provision is the price floor, at 27.3 percent. Fixed price contracts accounted for 23 percent of the total. When farmers without contracts were asked about preferred pricing mechanisms, 68.6 percent selected a price floor and only 20.9 percent of farmers would shift to a flexible delivery price. Downside risk protection appears to be an important attribute lacking in current contract designs.

The delivery payment method, as reported in Table 11, is another critical contract specification that directly affects farmers. Three payment methods are used in most cases.

These methods are cash payment at delivery, the prepaid deposit method that requires partial payment to farmers as a deposit in advance, and the pay-after-delivery method that allows firms to pay the delivery price within a certain period after delivery. Cash payment at delivery is used in half of all transactions and payment after delivery accounts for another 22.3 percent. Most farmers would prefer immediate cash payments.

3.6 Enforcement and violation of contracts

Information presented in Table 12 indicates 60 percent of farmers with contracts did not have a conflict with the other party. About 35.9 percent of farmers reported infrequent conflict and 4.1 percent of farmers often had a problem with their contractor. As shown in Table 13, most conflicts were about price and quality terms. Quality standard vary widely, some set by the firms, others by the Chinese government or international bodies. The specific standards used generally reflect those required with specific product market. In addition, farmers reported that most of the conflicts were resolved by negotiation between farmers and buyers and only 2.3 percent of conflicts were resolved in court.

3.7 Farmers' perceived benefits

Farmers with contracts were asked to rank, using a Likert scale, a number of the potential benefits of contracting (Table 14). The primary benefits were improving quality of products, stabilizing the sale price and lowering marketing costs. However, farmers did not perceive significant benefits in reducing production costs and increasing selling prices.

3.8 Econometric analysis

According to studies from Lajili et al. (1997), Rehber (2000), Sartwelle et al. (2000) and Key (2003), a farmer's choice to enter into contract farming is influenced by household characteristics, operation features, product categories, market attributes and underlying environmental conditions. A discrete choice model is constructed in this paper to test the hypothesis that a farmer's decision to engage in contract farming is affected significantly by the above factors.

In the discrete choice model, the choice by farmer households to participate in contract farming is influenced by the following five explanatory variables: (1) farmer household characteristics (P) that are reflected by education level and risk attitude; (2) the extent of production specialization and commercialization (R); (3) agricultural product categories (C);

(4) market attributes (T) represented by degree of price fluctuation and distance to the target market; and (5) underlying environmental conditions (E) measured by the presence of a government support policy and transportation conditions to the primary market. The general model takes the form:

$$A_i = F(P_i, R_i, C_i, T_i, E_i; \beta) + \varepsilon_i$$

The above specification can be estimated as a logistic model where A_i is the binary choice in which 1 denotes participation in contract farming. A maximum likelihood method is adopted to obtain the estimation results. The variables included in the estimating equation are listed in Table 15, along with their mean values. Risk aversion was assessed using farmer responses to a standard lottery with economically significant gains and losses and an expected value of zero. Price fluctuation was determined from a subjective estimate by the respondent.

We used SPSS 11.5 software to run the logistic regression on the 1036 observations in the farmer data set. Regression results are presented in Table 16. We briefly highlighted some of the key findings. We would have expected a positive relationship between a farmer's education level and his participation in contract farming, but the regression results indicate that a farmer's education level and attitude toward risk have no significant impact on his choice probabilities. The reason for this might be that there is only a slight difference in the farmers' education levels, with most at a very low level. The same logic accounts for attitudes toward risk, as most farmers rejected the reference lottery. Commercialization in production is positively and significantly related to a farmer's acceptance of a contract. Note that this may reflect the impact of the contract on the farm's output mix. Distance to the target market has a significant positive impact on contract choice. If farmers are far from their target market, they would consider participating in contract farming. Most exporters contract for products with local farmers in order to ensure high quality, lock in adequate supplies and ensure timeliness for processed goods going to foreign consumers. Price fluctuations in target markets are not significant. Government support is another important factor that drives farmers to contract. Its coefficient is significant at the 1 percent confidence level in both models. Finally, there is a significant relationship between enterprise type and the existence of a contractual relationship. This may reflect the fact that farms with specific enterprises were selected for contracts, or that a contractual relationship cause the farm to adjust its output mix.

4. Agribusiness Firms

Of the 116 dragon-head firms included in the survey, 100 reported being involved in contract farming (Table 17). As shown in Table 18, the primary incentives for firms to contract are the stabilization of the supply of raw materials and improvement of product quality. Reducing transaction costs and obtaining government support were identified by 16 and 20 percent of the firms, respectively.

4.1 Types of contract organizational chains

Agribusiness firms utilize a number of organizational or supply chains to contract with farms. In Table 19, different supply chains are identified with a plus sign to show the type of transaction link between corresponding agents. For example, "Firm + Farm" tells us that farmers interact directly with firms, while "Firm + Cooperative + Farm" means that agribusiness firms deal directly with cooperatives that collect the goods from farmers, with no transactions directly between firms and farmers.

The most common chain is the "Firm + Farm," used by half of the surveyed firms. "Firm + Cooperative + Farm," in which cooperatives link farms and firms like a bridge, is the second most common type of chain, used by 21 percent of firms. Some firms utilize local government authorities, and middlemen to establish contractual relationships with farms. We also find that the organizational chains selected by firms are related to farm size. More firms choose the "Firm + Farm" chain with larger farms. Firms tend to use an intermediary in the supply chain to deal with small farms.

4.2 Types of contracts

Among the 100 agribusiness firms included in the survey, 63 firms signed marketing contracts with farms (Table 20). The type of contract depends largely on the categories of delivered goods. Marketing contracts are used more frequently in the fruit, vegetable and tea processing industries, whereas production contracts are more common in the meat and dairy processing industries.

Table 5. Reasons Farmers Do not Contract

	No Contracting Opportunities	No Obvious Benefits	Process Too Complicated	Buyers Show No Interest	Total
Number	426	169	21	200	816
Percentage	52.2	20.7	2.6	24.5	100

Source: Primary survey 2004

Table 6. Contract Farming Incentives

Incentives	Market Access	Price Protection	Credit Support	Technology Support	Total
Number	124	73	17	6	220
Percentage	56.4	33.2	7.7	2.7	100

Source: Primary survey 2004

Table 7. Organizational Types Dealing with Farmers

Type of Organization	Middle-Man	Firm	Village Government	Dept. of Technology	Cooperative	Other	Total
Actual Percentage	34.1	34.1	12.7	5.9	0.5	12.7	100
Perferred Percentage	18	32.7	8.8	14.4	18.7	7.5	100

Source: Primary survey 2004

Table 8. Types of Contracts

Type of Contracts	Marketing	Production	Others	Total
Households	149	61	10	220
Percentage	67.7	27.7	4.6	100

Source: Primary survey 2004

Table 9. Forms of Contracts (by percent)

Organizations	Forms of Contracts		Total
	Oral	Written	
Middlemen	64.0	36.0	100
Agribusiness firms	14.7	85.3	100
Village government	75.0	25.0	100
Local authorities	61.5	38.5	100

Source: Primary survey 2004

Table 10. Actual and Preferred Pricing Mechanisms (percent)

	Flexible Price	Price Floor	Fixed Price	Others	Total
Actual situation	44.1	27.3	22.7	5.9	100
Preferred	20.9	68.6	9.1	1.4	100

Source: Primary survey 2004

Table 11. Payment Methods and Percent of Contracts

Payment Method	Cash Payment	Prepaid Deposit	Pay-after-Delivery	Total
Actual	50.0	27.7	22.3	100
Preferred	66.4	27.3	6.4	100

Source: Primary survey 2004

Table 12. Frequency of Contract Conflicts

	Never	Seldom	Often	Total
Frequency	132.0	79.0	9.0	220
Percentage	60.0	35.9	4.1	100

Source: Primary survey 2004

Table 13. Reasons for Contract Conflicts

Issues	Price Terms	Quality Terms	Quantity Terms	Delivery Time
Percent who have experienced	86.4	72.7	6.8	18.2

Source: Primary survey 2004

Table 14. Perceived Farmer Benefits from Contract Farming

Benefit	None	Somewhat	Significant	Total
Reducing production cost	31.8	54.1	14.1	100
Improving quality	7.3	58.7	34.0	100
Increasing selling price	22.3	65.4	12.3	100
Stabilizing sale price	10.5	45.9	43.6	100
Reducing marketing cost	21.3	44.1	34.6	100

Source: Primary survey 2004

Table 15. Interpretation and Summary of Explanatory Variables

Variable Names	Definition	Mean
Household Characteristics (P)		
Education level	1=below elementary school; 2=elementary school; 3=middle school; 4=above middle school	2.46
Risk attitudes	1=risk averse; 2=risk neutral; 3=risk favorable	1.06
Operation features (R)		
Specialization	Income from main agricultural product/total income (%)	0.45
Commercialization	Quantity of marketed products/total production (%)	0.65
Product categories (C)		
Grain	Dummy variable 1: yes 0: no	0.43
Vegetable	Dummy variable 1: yes 0: no	0.13
Fruit	Dummy variable 1: yes 0: no	0.06
Tea	Dummy variable 1: yes 0: no	0.01
Edible mushroom	Dummy variable 1: yes 0: no	0.04
Floral crops	Dummy variable 1: yes 0: no	0.02
Poultry	Dummy variable 1: yes 0: no	0.05
Meat	Dummy variable 1: yes 0: no	0.08
Market attributes (T)		
Price fluctuation	1=0-10%; 2=10-20%; 3=20%-50%; 4= >50%	2.20
Target market	1=local market; 2=regional; 3=foreign market	1.20
Environmental Condition (E)		
Traffic condition	0=bad; 1=good	0.91
Government support	0=no support; 1=support available	0.50

Table 16. Farm-Level Logistic Regression Results

Explanatory Variables	Coefficient (B)	Wald	Exp (B)
Intercept	-3.530***	41.759	.029
Farmer characteristics (P)			
Education	-.058	.459	.944
Risk aversion	.285	1.342	1.329
Operation features (R)			
Specialization	.489	2.343	1.631
Commercialization	.574*	3.288	1.775
Product categories (C)			
Grain	.401*	2.665	1.493
Vegetable	.128	.154	1.137
Fruit	.784**	5.248	2.191
Tea	1.603***	7.887	4.969
Edible mushroom	.118	.063	1.125
Floral crops	1.179**	4.419	3.252
Poultry	1.058***	7.944	2.880
Meat	1.194***	13.750	3.302
Market attributes (T)			
Price fluctuation	-.110	1.762	.896
Target market	.540***	10.161	1.716
Environment (E)			
Traffic condition	.148	.262	1.159
Government support	.662***	13.158	1.940
-2 loglikelihood	969.38		
Chi-square value	93.23***		
Nagelkerke R^2	0.135		

Note: "*", "**" and "***" represent significance at 10%, 5% and 1% levels, respectively.

4.3 Forms of contracts

Most agribusiness firms use written contracts (Table 21). The rank or hierarchy of dragon-head firms also influences the types of contracts selected. Lower ranking firms, particularly county level firms, choose oral contracts more often, in part because they maintain close relationships with local farms and have confidence in each other.

4.4 Contract specification

The price floor is the most common delivery price specification approach used by firms (Table 22). The price floor is established by the contracting firm and is set near the cost of production. The objective of the contracting firm is to limit fluctuations in supply. This result is in contrast to the farmer survey that indicated flexible price contracts were the most common. Flexible price and fixed delivery price mechanisms are also used in some cases. When the rank of dragon-head firms is considered, the price floor strategy is preferred by firms of higher rank, whereas flexible pricing works better for lower-ranked firms. Due to their strong financial status and the favorable public policy afforded them by government, highly ranked firms tend to make better use of the riskier price floor method.

The amount of price fluctuation in the local market is highly correlated with the type of price mechanism (Table 23). When the price is fairly stable, firms tend to accept fixed price and flexible price methods. Most firms select flexible prices as price fluctuation increases.

Table 24 reports the lengths of contracts used by various types of processing firms. Longer term contracts tend to be preferred in industries with longer replacement cycles – tea or livestock for example.

The length of the contract is also affected by the price fluctuations of the processed goods (Table 25). As would be expected, the wider the price fluctuation due to uncertainty about future prices, the shorter the contract period.

The type of processed good is strongly associated with the use of contracts by firms. All firms in the dairy, the aquaculture and honey industries in our survey make use of contracts, although the number of these firms included in the survey is small (Table 26).

Firms were asked to rank the importance of input quality using a four point Likert scale (Table 27). Generally, the higher the quality requirement for the raw material, the higher the percentage of firms engaged in contract farming. If the target market is in foreign countries, firms tend to use contracts more often (Table 28). If price fluctuation in the local market is relatively high, firms are less likely to use contracts (Table 29).

4.5 Econometric Analysis

As described in the preceding subsection, we categorize factors into three classes: type of firms (E) represented by their rank, characteristics of processed goods (P) denoted by the requirement on the quality of raw materials, and corresponding industry and market attributes (M). The study only examines four typical goods: vegetables, meat, food oil and tea. Explanatory variables along with their mean values are listed in detail in Table 30. The general model takes the form:

$$T_i = F(E_i, P_i, M_i, \beta) + \varepsilon_i$$

The dependent variable T_i is binary, where 1 denotes participation in contract farming. A maximum likelihood estimation method is used to obtain the estimation results. Excluded classes are municipal firm type and all other product categories. The regression results are presented in Table 31.

We are able to draw the following results from the sample data. First, the rank of firms has a significant and positive effect on the use of contracts. This may reflect the fact that scale and reputation are viewed as favorable signals by farmers and makes them more willing to cooperate with highly ranked firms.

Second, characteristics of processed goods have a certain positive effect on the dependent variable, consistent with expectations. The firms in the fresh vegetable processing industry are more likely to use contracts, since firms need a stable and timely supply of raw goods that are quite perishable.

Third, price fluctuation in the target market has a significantly negative effect on the use of contracts. Firms tend to use contracts in a market with relatively less price variation.

Table 17. Firm Types and Contract Farming

Type of Firm		Without Contract	With Contract	Total
National	Quantity	1	9	10
	(%)	(10.0)	(90.0)	(100)
Provincial	Quantity	4	66	70
	(%)	(5.7)	(94.3)	(100)
Municipal	Quantity	7	16	23
	(%)	(69.6)	(30.4)	(100)
County	Quantity	4	9	13
	(%)	(30.8)	(69.2)	(100)
Total		16	100	116

Source: Primary survey 2004

Table 18. Main Incentives to Sign Contracts

	Stable Supply of Raw Material	High Quality of Delivery Goods	Reduced Transaction Cost	Stabilized Delivery Price	Government Support Obtained	Total
Number of Firms	78	77	16	44	20	100

Source: Primary survey 2004

Table 19. Farm Size and Organizational Chains

	Types of Chains (by percent)				
Farm Size	Firm +Farm	Firm+ Village +Farm	Firm+ Cooperative +Farm	Firm+ Middlemen +Farm	Firm+Local Authority +Farm
Number of	50	8	21	14	4
firms	8.0	62.5	28.6	21.4	25.0
Small					
Relatively small	10.0	35.0	71.4	78.6	50.0
Large	66.0	2.5	0.0	0.0	25.0
Very large	16.0	0.0	0.0	0.0	0.0
Total	100	100	100	100	100

Source: Primary survey 2004

Table 20. Categories of Goods and Contract Type

Categories of Goods	Number of Firms Using Contract Type (Percent)		Total
	Marketing Contract	Production Contract	
Vegetable processing	21	8	29
(%)	(65.5)	(34.5)	(100.0)
Meat processing	4	6	10
(%)	(40.0)	(60.0)	(100.0)
Food oil processing	10	4	14
(%)	(71.4)	(28.6)	(100.0)
Fruit processing	3	0	3
(%)	(100.0)	(0.0)	(100.0)
Aquaculture	6	8	14
(%)	(48.3)	(51.7)	(100.0)
Dairy	0	3	3
(%)	(0.0)	(100.0)	(100.0)
Tea	8	1	9
(%)	(100.0)	(0.0)	(100.0)
Silk	0	2	2
(%)	(0.0)	(100.0)	(100)
Edible mushroom	2	2	4
(%)	(50.0)	(50.0)	(100.0)
Bee honey	1	1	2
%	(100)	(0.0)	(100.0)
Other goods	6	4	10
%	(40.0)	(60.0)	(100.0)
Total	37	63	100

Source: Primary survey 2004

Table 21. Contract Forms and Rank of Firms

Rank of Dragon-Head Firms	Contract Form		
	Percentage of Oral Contracts	Percentage of Written Contracts	Total
National	11.1	88.9	100
Provincial	14.2	84.8	100
Municipal	12.5	87.5	100
County	66.7	33.3	100

Source: Primary survey 2004

Table 22. Rank of Firms and Price Specification

Ranks of Dragon-Head Firms	Price Specification				
	Flexible Price	Price Floor	Fixed Price	Others	Total
National	22.2	66.7	11.1	0.0	100
Provincial	28.8	57.6	4.5	9.1	100
Municipal	37.5	50.0	6.3	6.3	100
County	33.3	55.6	11.1	7.0	100

Source: Primary survey 2004

Table 23. Width of Price Fluctuation and Price Specification

Width of Price Fluctuation	Price Specification Methods				
	Flexible Price	Price Floor	Fixed Price	Others	Total
Very narrow	25.0	0.0	50.0	0.0	100
Narrow	32.8	57.8	6.3	3.1	100
Wider	30.8	61.5	0.0	7.7	100
Very wide	56.7	10.0	0.0	33.3	100

Source: Primary survey 2004

Table 24. Categories of Goods Processed and Contract Period

Types of Goods Processed	Contract Period				Total
	Less than 1 year	1-2 years	2-3 years	Over 3 years	
Vegetable	44.8	27.6	6.9	20.7	100
Meat	30.0	60.0	0.0	10.0	100
Edible Oil	50.0	35.7	7.1	7.1	100
Fruit	33.3	33.3	0.0	33.3	100
Aquaculture	21.4	50.0	14.3	14.3	100
Diary	33.3	33.3	14.3	33.3	100
Tea	22.2	11.1	22.2	44.4	100
Silk	0.0	50.0	0.0	50.0	100
Edible mushroom	25.0	50.0	25.0	0.0	100
Bee honey	0.0	100.0	0.0	0.0	100
Others	30.0	40.0	20.0	10.0	100

Source: Primary survey 2004

Table 25. Width of Price Fluctuation and Contract Period

Width of Price Fluctuation	Contracting Period (percentage of firms)				Total
	Less than 1 year	1-2 years	2-3 years	Over 3 years	
Very narrow	50.0	25.0	15.0	10.0	100.0
Narrower	29.7	42.2	17.5	10.6	100.0
Wider	52.4	34.6	9.2	3.8	100.0
Very wide	53.3	38.7	8.0	0.0	100.0

Source: Primary survey 2004

Table 26. Processed Products and Contract Farming

	Without Contract	With Contract	Total
Vegetables	2	29	31
	6.5	93.5	100
Meat	2	12	14
	16.7	83.3	100
Edible oil	5	14	19
	26.3	73.7	100
Fruit	2	3	5
	40.0	60.0	100
Aquaculture	0	14	14
	0.0	100.0	100
Dairy	0	3	3
	0.0	100.0	100
Tea	1	9	10
	10.0	90.0	100
Silk	0	2	2
	0.0	100.0	100
Edible mushrooms	0	4	4
	0.0	100.0	100
Bee honey	0	2	2
	0.0	100.0	100
Other	4	11	15
	26.7	63.3	100

Source: Primary survey 2004

Table 27. Input Quality Requirement and Contract Farming

Quality Level	Without Contract	With Contract	Total
Low	1	2	3
(%)	33.3	66.7	100
Relatively high	4	32	36
(%)	11.1	89.9	100
High	10	36	46
(%)	21.7	78.3	100
Very high	1	30	31
(%)	3.2	96.8	100

Source: Primary survey 2004

Table 28. Target Market and Contract Farming

Target Market	Without Contract	With Contract	Total
Domestic market	13	67	80
(%)	16.3	83.7	100
Foreign market	3	33	36
(%)	8.3	91.7	100

Source: Primary survey 2004

Table 29. Price Fluctuation and Contract Farming

Price Fluctuation	Without Contract	With Contract	Total
Very narrow	1	6	7
	14.3	85.7	100.0
Narrow	9	71	80
	11.2	88.8	100.0
Wider	4	22	26
	15.4	84.6	100.0
Very wide	2	1	3
	66.7	33.3	100.0

Source: Primary survey 2004

Table 30. Interpretation and Summary of Explanatory Variables

Variable Names	Definition	Mean
Types of firm (E)		
National	Dummy variable: 1=yes, 0=no	0.09
Provincial	Dummy variable: 1=yes, 0=no	0.60
Product characteristics (P)		
Categories		
Vegetable	Dummy variable: 1=yes, 0=no	0.27
Meat	Dummy variable: 1=yes, 0=no	0.09
Edible Oil	Dummy variable: 1=yes, 0=no	0.14
Tea	Dummy variable: 1=yes, 0=no	0.08
Quality requirement	1=low; 2=relative high; 3=high; 4=very high	2.91
Market attributes (T)		
Foreign market	Dummy variable: 1=yes, 0=no	0.31
Price fluctuation	1=never; 2=narrower; 3=wider; 4=very wide	2.22

Table 31. Results on Factors that Influence Firms in Engaging in Contract Farming

Explanatory Variables	Coefficient	Wald	Exp (B)
Types of firm (E)			
National	2.57*	3.81	13.10
Provincial	3.18***	13.40	23.92
Product characteristics (P)			
Categories			
Vegetable	2.97**	7.85	19.40
Meat	0.13	0.01	1.14
Food oil	1.45	1.83	4.26
Tea	1.39	1.00	4.00
Quality requirement	0.23	0.30	1.26
Market attributes (T)			
Foreign market	0.03	0.01	1.03
Price fluctuation	-1.14**	4.14	0.32
Intercept	1.18	0.47	3.26
Overall Tests			
Prediction accuracy		91.4%	
-2loglikelihood		67.05	
Chi-Square value		26.03**	
Nagelkerke' R^2		0.364	

Note: "*", "**", "***" represent significance at 10%, 5% and 1% levels, respectively, based on t values.

5. Contract Performance

The firm level survey allows us to analyze the potential factors that influence a contract's performance and the likelihood of violation. We define acceptable contract performance if the ratio of acceptable contracts to the total number of contracts, is 75 percent or greater. Our data indicate that 72 percent of firms with contracts have a performance ratio higher than the 75 percent benchmark. About 10 percent have less than 50 percent acceptable performance. Reasons for contract failure include unacceptable delivery quality and contractees selling products to other parties for a higher bid price. Resolution of contract disputes is difficult. As many as 53 percent of firms report that there is no way to resolve conflicts. Legal action occurs in seven percent of contracting firms. Another 7 percent rely on local government to resolve disputes. Generally speaking, the legal mechanism used to guarantee high contract performance is less important than other types of informal mechanisms. Contract violation is strongly associated with farm size. We find that 79 percent of firms report contract violations with small farms, 14 percent with middle sized farms, and only 7 percent with large farms. Smaller farms may fail to perform well because they are not specialized and incentives for growers are weak.

The firm level survey reveals that contract performance is influenced by the type of contract organizational chain (Table 32). Contract performance under the "Firm + Cooperative + Farm" chain is highest, with "Firm + Middlemen + Farm" next. The "Firm + Local or Village Government + Farm" supply chains have the worst performance.

Table 33 summarizes a number of contract provisions and performance. Marketing contracts perform somewhat better than do production contracts. Oral contracts appear to perform somewhat better than written contracts. The result seems contrary to expectations, but it indicates the importance of reputation and social networks in the Chinese rural economy.

The performance ratio is highest with a price floor and lowest for a flexible price mechanism. For payment method, the pre-paid deposit method has a better performance ratio than cash payment at delivery time or after delivery time. Comparing the length of contract period and performance rate suggests that contracts written for less than one year or longer than three years perform better, using the 75 percent benchmark.

The use of performance standards where a contractor specifies a minimum quality standard for example, significantly influences the performance rate. We also find that the use of direct incentives, such as bonuses to farms that successfully implement contracts, encourage a higher performance rate. Finally, the existence of an indemnification clause that requires compensation if the contract terms are violated also improves performance.

6. Conclusions and Policy Implications

This study examines the extent and performance of contract farming from the perspectives of Chinese farm households and contracting agricultural firms. The farm-level survey indicates that the actual proportion of farms engaged in contract farming is relatively low and significantly less than the proportion of farm households willing to produce under contract. A lack of contract opportunities is the most frequently cited reason, particularly for smaller farms. Farmers identify price stability and market access as the key advantages to contracts, while firms consider improved product quality as the critical incentive for contract use. The organizational chain “Firm + Cooperative + Farm” appears to be viewed as the most desirable way to maintain contracts, although the use of middlemen and direct “Firm + Farm” contracting are the most common types at present. Marketing contracts are more common than production contracts, both for firms and growers. Oral contracts are most commonly used by middlemen and county-level dragon-head firms because of strong social capital and social networks in rural areas. The price floor provision is favored by most farmers because it limits downside risk exposure and still allows them to take advantage of price increases. Cash payment at delivery time is the preferred payment method. The short-term contract is the main type used with growers, but both the type of commodity and the commodity’s price fluctuation affect contract length to a certain degree.

Logistic regression suggests that for farmers, acceptance of contracts is influenced by enterprise type, marketplace attributes, public policy and the farm’s production characteristics. Econometric analysis also shows that quality requirements for delivered raw material, price volatility and public support policies encourage firms to utilize contracts.

Table 32. Organizational Chain and Contract Performance

Organizational Chain	Performance Ratio				Total
	< 25%	25% -50%	50%-75%	> 75%	
Firm+Farm	4.0	16.0	24.0	56.0	100
Firm+Village Government+Farm	0.0	25.0	25.0	50.0	100
Firm+Cooperative+Farm	0.0	9.5	14.3	76.2	100
Firm+Middlemen+Farm	0.0	14.3	21.4	64.3	100
Firm+Local Government+Farm	0.0	25.0	25.0	50.0	100

Source: Primary survey 2004

Table 33. Contract Provisions and Performance

	Contract Performance Ratio				Total
	less 25%	25% -50%	50%-75%	above 75%	
Contract Type					
Marketing contract	3.2	15.9	25.4	55.6	100
Production contract	0.0	13.5	18.9	67.6	100
Contract Form					
Oral	0.0	16.4	10.0	73.8	100
Paper	1.2	9.5	21.4	67.9	100
Delivery Price					
Flexible price	2.9	11.8	35.3	50.0	100
Price floor	0.0	9.6	1.9	88.5	100
Payment Method					
Cash payment	1.8	10.5	17.5	70.2	100
Pre-paid deposit	0.0	16.7	8.3	75.0	100
Payment-after-delivery	0.0	4.3	26.1	69.6	100
Contract Length					
Less 1 year	2.9	11.8	8.8	76.5	100
1-2 years	0.0	7.9	23.7	68.4	100
2-3 years	0.0	20.0	20.0	60.0	100
More than 3 years	0.0	0.0	22.2	77.8	100
Quality Requirement					
With	0.0	0.0	9.4	90.6	100
Without	4.3	31.9	38.3	25.5	100
Incentives					
With	0.0	5.7	20	74.3	100
Without	3.3	23.3	26.7	46.7	100

The study shows that the overall successful implementation rate of contracts is still low. Key reasons for contract violation include the failure of delivered goods to meet the contract quality requirements and the sale of contract goods to other parties if prices are higher. Contract violation is common with smaller farms.

Our results also show that the degree of commercialization is associated with a higher likelihood of contract farming. Public policies that encourage the adjustment of the agricultural structure so as to improve farmers' options for specialization and commercialization should be made right now. The development of farmer cooperatives is another critical public policy consideration. Firms have to incur increased contracting and monitoring costs when confronted with a fragmented farm structure. Bargaining associations or other types of cooperatives might reduce transaction costs and generate better performance. Further, a more stable external environment would increase the use of contracts and improve contract performance. In addition better risk management instruments for both contractors and farmers should improve supply chain management. In the absence of well developed futures markets wider use of floor price provisions might offer a reasonable start. Public policy can encourage contract farming from the perspective of both firms and farms. Government has a responsibility to monitor the performance of contacts by protecting the rights of both parties. In addition, credit support, tax benefits and access to improved technology can encourage more dragon-head firms and farms to consider contract production.

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CHAPTER 3. PROPENSITY SCORE AND SELECTION MODEL EVALUATION OF THE INCOME EFECT OF A CONTRACT FARMING PROGRAM IN CHINA

Abstract

This paper uses recent survey data to empirically analyze the welfare achievement of a contract-farming program carried out in China. Two methodologies are discussed and used for estimation. First the method of propensity score matching is outlined to investigate the treatment effect of offering contract farming. A couple of matching algorithms are tried and results are compared. Second, in contrast, the income effect of the contracting program is examined by the use of the sample selection treatment effect model from econometrics. Four samples, upon which these methods are applied, are obtained from the survey. We find evidence in the full sample that contract production tends to bring significantly higher income to growers than independent production. But this welfare improvement becomes smaller and less significant as homogeneous farmers are concerned. The average contract contribution to income is weakly negative in each sample using the treatment effect model in that a certain selection bias was removed. The sample classification helps to obtain the consistent results, namely our two classes of estimation methods both indicate that contract-farming program does not substantially raise income for the homogeneous farmers.

1. Introduction

Since the 1980s, the food and agricultural sector in China have experienced the dramatic change, in the structure and the development of the Chinese economy into a market driven and globally integrated economy. During this period the agricultural production and farm household income in China have grown rapidly. Rural industries have absorbed a large part of farm labor, and poverty has fallen dramatically. Most of these improvements are largely driven by a series of agricultural reforms that have been instigated by the government. In line with the improving economic situation, government priorities have shifted from increasing production, especially of food grains, to rural income support and, more recently, to environmental concerns. As with a number of government programs currently taking effect, contract farming, which emerged as a result of the government's agricultural industrialization program, is a fairly new venture for the Chinese agricultural sector. The central government has attempted to encourage contract farming by implementing a series of incentive measures, such as the financial support and tax credits Contract production in China has made considerable progress since its emergence 20 years ago. Both the number of varieties of agricultural commodities and the total productions under contract has increased steadily.

Contract farming offers a means to effectively connect small-scale farmers and large-scale food processing firms. It is generally recognized that contract farming has potential advantages over independent farming in reshaping the agriculture supply chain and providing farmers better access to production resources and commodity markets. However, a growing literature discussing the dangers of contract farming for small holders, particularly in developing countries in Africa and Latin America, has received considerable attention recently (Carney and Watts, 1990). Little (1994) argues that contract farming is exploitative when it involves a highly unequal power relationship so that contract farmers are relegated to the status of hired hands. Under these situations a contract program fails to achieve its initial goal and becomes detrimental to farmers. Consequently, the government's expenditures on the program would be wasted and even produce an unexpected inverse effect.

The increasing number of contracts used in rural China is not necessarily associated with improved income. A number of conceivable benefits from contract production accrue to small holders coming from improved access to markets, better management of price risks, and widespread credit and technology support. However, the use of contracts could potentially lower on-farm income if they reduce incentives for growers to work hard or to invest fully in specific productive assets. In addition, because the contractors generally have greater bargaining power when there are a lot smaller growers, they do not fully reward grower effort, effectively exploiting the contract arrangement as occurs in other developing countries.

Our concerns here are with the micro-level impact of contract farming in China on individual farmers rather than on the macro-level impact on the economy. Contract farming has its downsides, but it may be beneficial overall in some cases. The goal of this paper is to assess whether contract farming plays a positive role in raising farmers' incomes. We use recent survey data from China to analyze the causal effect associated with contract farming programs. We use two seemingly related methods to carefully evaluate whether the use of contract farming improves farmer income. One method is the method of propensity score matching (Rosenbaum and Rubin 1983, 1985) that involves pairing treatment and control units that are similar in terms of their observable characteristics. The propensity score is the probability that an agent takes treatment, in this case a contract, conditional on the available covariates. It is well recognized that the sample selection bias can be corrected to a large extent by the use of the propensity score matching method. Selection bias, or participation bias, can arise in this application, because farmers must choose to participate in contracts; it is not a randomized study. A number of matching algorithms, such as nearest neighbor matching, caliper matching and kernel matching, have been introduced in the related literature. The second primary method is the sample selection treatment effect model from econometrics (Greene, 2001) that reduces the selection bias by accounting for the correlation between a selection equation and a regression equation. The two methods use different techniques to try to correct for the selection bias. Both methods are used in an attempt to obtain better estimates of the income effect of contract farming after removing the selection bias.

In studies that analyze treatment effects, data often do not come from experimental designs but from non-experimental observations. Under non-randomized studies, the direct comparison of a treatment group with a control group tends to generate a biased estimate of the causal effect of treatment on an outcome due to problems such as self-selection or some systematic judgment by the researcher in selecting units to be assigned to the treatment (Dehejia and Wahba, 2002). Rosenbaum and Rubin (1983) first suggested propensity score matching (PSM) as a method to reduce the dimensionality of the observable characteristics so as to obtain a more manageable summary of covariates and still produce a less biased estimate of a treatment effect. This method has become increasingly prevalent in the evaluation of social programs since its introduction. Papers using PSM methods in this area have focused on two approaches. First, papers including Heckman, Ichimura and Todd (1998) discuss the decisions that must be made to implement the matching algorithms and how to produce better performance. Second, other papers focus on applications of the PSM method to real situations. Benjamin (2003) studied the impact of 401(k) eligibility on savings to identify whether or not 401(k)'s have encouraged additional savings. The PSM method in this case was carefully carried out by creating propensity score subclasses and then aggregating results across subclasses. The paper concluded that, on average, about one-- half of 401(k) balances represent new private savings. As another example, Levine and Painter (2003) focused on the impact of teenage pregnancy on drop-out rates and college attendance using PSM. These authors used propensity score caliper matching with matching within schools to control for school and regional effects.

The limited dependent variable model, such as a Logit model, allows us to estimate a farmer's probability to engage in contract farming given that contract farming is available. To evaluate the impact of contracting on farm income we must control for differences between farmers who choose to contract and those that do not. Except for the scale of production, contract farmers may be more risk averse, farther from the target market and more limited in developed regions. However, a number of elements, such as personal contracts, trust of the government and knowledge about markets, are correlated with both contracting and income, but are not within the range of our survey observation. When this is the case, a simple regression of farm income on a contracting dummy indicator will provide a biased estimate of the impact of contracting on farm level income. The problem is one type of self-selection: farmers who choose to contract would have had relatively high income whatever the decision they make regarding whether to have contracts or not. To control for the potential endogeneity of access to the contract markets, we use the sample selection model to account for the limited information on unobservable elements affecting both contract access and farm level income. In the procedure of Heckman, two equations are estimated at the same time. One is the Logistic equation that estimates the probabilities to contract or not to contract. The other one is the main income regression equation that identifies the effect of contracting adjusted for other explanatory factors. The sample selection bias can be remedied to a certain extent by the use of the joint distribution of the two disturbances in the models.

The paper is organized as follows. We discuss the method and estimation approaches in the next section. In the Section 3, a descriptive review of the survey data is presented. Section 4 illustrates the results and implications from the two methods. Section 5 concludes the paper.

2. Methodology and Estimation

2.1 The matching model and the sample selection regression model

To illustrate the matching method explicitly, we will describe a prototype model of economic choice outlined by Heckman and Lozano (2004). Two potential outcomes (Y_{i0}, Y_{i1}) for each individual unit are considered. Let $D_i = 1$ when Y_{i1} is selected, and $D_i = 0$ if Y_{i0} is selected. The choice of treatment assignment is based on utility maximization described by the standard random utility model (RUM). Let latent variable V_i denote the utility for unit i and define $Y_i = D_i Y_{i1} + (1 - D_i) Y_{i0}$, where

$$V_i = \mu_V(X_i, U_{iV}) \text{ and, } D_i = 1(V_i > 0) \qquad (1)$$

where X_i are observed factors, U_{iV} are unobserved factors determining choices, and $1(\cdot)$ is an indicator function. Potential outcomes are written in terms of the same observed variables X_i and unobserved outcome-specific variables U_{ij}, $j = 0,1$. So

$$Y_{i1} = \mu_1(X_i, U_{i1}) \text{ and } Y_{i0} = \mu_0(X_i, U_{i0}) \qquad (2)$$

The corresponding individual level treatment effect is $\tau_i = (Y_{i1} - Y_{i0})$. The average treatment effect is $\tau = E(Y_{i1} - Y_{i0})$. The fundamental problem in identifying a causal effect is that each individual is only observed in one state of the world, but never in both, and thus the counterfactual is unavailable. Nevertheless, it does not induce any trouble in estimating treatment effects in a randomized experimental setting because the randomization mechanism makes potential outcomes and treatment assignment independent by design. Consequently, $\tau = E(Y_i \mid T_i = 1) - E(Y_i \mid T_i = 0)$ is estimated without bias by he difference in observed means within treatment assignment groups.

To examine more closely how the matching method works and to note distinctions between it and the sample selection model specified later, the additively separable specifications and an assumption on the error terms are made to the above utility functions to obtain the following more familiar equation forms:

$$V_i = \mu_V(X_i) + U_{iV}\ , \qquad E(U_{iV}) = 0 \tag{3}$$

$$Y_{i1} = \mu_1(X_i) + U_{i1}\ , \qquad E(U_{i1}) = 0 \tag{4}$$

$$Y_{i0} = \mu_0(X_i) + U_{i0}, \qquad E(U_{i0}) = 0 \tag{5}$$

where U_{i1}, U_{i0} and U_{iv} are *i.i.d* with zero means conditional on X_i. Furthermore, U_{i1} and U_{i0} may be correlated, but both are independent of U_{iv}. The sample selection model addressed in next subsection relaxes this independence assumption by allowing for correlation between the error terms.

Three types of estimands derived from this model are typically of interest, namely average treatment effect (ATE), average treatment effect for the treated population (ATT) and marginal treatment effect (MTE), all conditional on observed covariate values (Heckman and Lozano, 2004). In many cases, the primary treatment effect of interest in a non-experimental context (observational study) is the treatment effect on the treated population. Throughout the paper we will focus on ATT. The ATT is defined as

$$\begin{aligned}\tau\,|_{D=1} &= E(Y_{i1} - Y_{i0} \mid X_i, D_i = 1) \\ &= E(Y_{i1} \mid X_i, D_i = 1) - E(Y_{i0} \mid X_i, D_i = 1)\end{aligned} \tag{6}$$

The missing data problem here arises because of the fact that we cannot observe Y_{i0} for treated units and Y_{i1} for the non-treated units. So the estimand described by the whole expression cannot be estimated directly. From the samples we are able to obtain unbiased estimates of $E(Y_{i1} \mid X_i, D_i = 1)$ and $E(Y_{i0} \mid X_i, D_i = 0)$. The resulting ATT bias from comparing $(D_i = 1)$ and $(D_i = 0)$ means is the difference between the average Y_{i0} for participants and non-participants, and is given below.

$$\begin{aligned}\text{Bias}\ \ ATT &= [E(Y_{i1} \mid X_i, D_i = 1) - E(Y_{i0} \mid X_i, D_i = 0)] - [E(Y_{i1} - Y_{i0} \mid X_i, D_i = 1)] \\ &= [E(Y_{i0} \mid X_i, D_i = 1) - E(Y_{i0} \mid X_i, D_i = 0)]\end{aligned} \tag{7}$$

To remove the selection bias due to observable variables, matching methods are often implemented. The fundamental assumption behind these methods, named by Rosenbaum and Rubin (1983), is called ignorability of treatment assignment or ignorability due to selection on observables. To further reduce the dimensionality problem rising in covariate matching, matching on propensity score is an alternative that focuses on scalar matching instead of multiple-dimensional matching, but provides the coarsest balancing score. The following two assumptions are required for the treatment assignment to be ignorable:

$$(Y_0, Y_1) \perp D \mid X \qquad \text{Unconfounded assumption} \qquad \text{(M1)}$$

and

$$0 < p(X) = \Pr(D = 1 \mid X) < 1 \qquad \text{Common-support assumption} \qquad \text{(M2)}$$

where $\perp$ represents statistical independence given the conditioning covariates. The unconfoundedness assumption suggests that, even though (Y_0, Y_1) and D might be correlated, once we control for X they are independent. The common-support asssumption implies that, for each X, in very large samples there are observations for which we observe a Y_0 and other observations for which we observe a Y_1. Rosenbaum and Rubin (1983, Theorem 3) show that under conditions (M1) and (M2) the assignment to treatment is also unconfounded given the propensity score $p(x)$:

$$(Y_0, Y_1) \perp D \mid p(X) \qquad \text{(P-1)}$$

$$0 < \Pr(D = 1 \mid p(X)) < 1 \qquad \text{(P-2)}$$

Under these conditions, conditioning on the propensity score eliminates the ATT bias since we can now directly estimate the counterfactual of interest without producing bias. The following formulas express the equivalence of estimands under the assumption P1 and P2.

$$E(Y_0 \mid D = 1, p(X)) = E(Y_0 \mid D = 0, p(X)) = E(Y_0 \mid p(X)) \qquad (8)$$

In fact, we only need the weaker assumption that $Y_0 \perp D \mid p(X)$ to remove the bias because $E(Y_0 \mid D = 0, p(X))$ is estimable from the sample and only $E(Y_0 \mid D = 1, p(X))$ is unknown. As a result, given a population of units indexed by i, if the propensity score $p(X_i)$ is known, the ATT can be estimated as follows:

$$\tau \mid_{D=1} = E\{E(Y_{i1} \mid X_i, D_i = 1) - E(Y_{i0} \mid X_i, D_i = 0) \mid D_i = 1\}$$

$$= E\{E(Y_{i1} \mid p(X_i), D_i = 1) - E(Y_{i0} \mid p(X_i), D_i = 0) \mid D_i = 1\} \qquad (9)$$

where the outer expectation is over the distribution of $(X_i \mid D_i = 1)$ for the first expression and $(p(X_i) \mid D_i = 1)$ for the second expression.

Matching on propensity scores provides a way to overcome the curse of the dimensionality, but for it to work well samples have to be adequately large. If treatment and control units are matched based on nearest propensity score, it is possible that matches occur between individuals with quite different treatment outcomes even though they have the same propensity scores (Zhao, 2004). To rule out the possibility of mismatching problems, the balancing property and sufficiently large sample sizes are required to generate high quality PSM estimates.

In contrast, the sample selection treatment effect model (Goldberger, 1972;Greene, 1993) is an alternative parametric method to identify the income effect through conditional regression. The model assumes the joint normal distribution between the underlying disturbances of the Logistic equation regarding the decision to accept or to reject a contract and the treatment equation in which the income impact is specified. As discussed in the introduction, this approach accounts for the fact that unobservable variables may be correlated with both the operators' decision to contract and farm income. Accounting for this fact allows for an unbiased estimate of the impact of contracting on income. The treatment effects approach is used here rather than an instrumental variables approach because there are too few variables available with which to construct an instrument to use with the contracting dummy variable.

Let the latent variable Z_i^* reflect the net benefits to a small landholder from participating in contracts compared to independent production and marketing:

$$Z_i^* = \gamma' w_i + u_i \qquad (10)$$

Let $Z_i = 1$ if $Z_i^* > 0$ and $Z_i = 0$ otherwise. The vector w_i denotes the vector of explanatory covariates consisting of farmer $i's$ characteristics. If the latent variable is positive the dummy variable indicating contracting Z_i equals one and zero otherwise. The interest in terms of inference is on the second regression equation that measures the impact of a production contract on a farmer's income y_i:

$$y_i = \beta' x_i + \tau \cdot Z_i + \varepsilon_i \tag{11}$$

where the vector x_i plays the analogous role as w_i and they may be identical. A linear relationship between contract participation and income is assumed and the coefficient τ measures the magnitude of contract impact. In contrast with matching methods this assumption is not necessary to produce the ATT estimates.

We cannot simply run estimation on equation (11) because the decision to contract may be affected by unobservable variables that may also influence income level. If this is the case, the disturbance terms in equation (10) and (11) will be correlated, resulting in biased estimates of τ. To correct the bias, we make the assumption that the error terms have a joint normal distribution with the following form:

$$\begin{bmatrix} u \\ \varepsilon \end{bmatrix} \sim N\left[\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & \sigma^2 \end{bmatrix}\right]$$

By combining both equations we are able to derive the expected income in the treatment group that contracts as follows:

$$E[y_i \mid Z_i = 1] = \beta' x_i + \tau + E[\varepsilon_i \mid Z_i = 1]$$

$$= \beta' x_i + \tau + \rho\sigma\left[\frac{\phi(\gamma' w_i)}{\Phi(\gamma' w_i)}\right] \tag{12}$$

For non-participants in the control group, the counterpart to (12) is:

$$E[y_i \mid Z_i = 0] = \beta' x_i + E[\varepsilon_i \mid Z_i = 0]$$

$$= \beta' x_i + \rho\sigma\left[\frac{-\phi(\gamma' w_i)}{1 - \Phi(\gamma' w_i)}\right] \tag{13}$$

Equation (12) suggests that ignoring the last term $\left[\frac{\phi(\gamma' w_i)}{\Phi(\gamma' w_i)}\right]$ in an ordinary least squares regression would lead to an omitted variable bias in estimates of β and τ. To produce the unbiased parameter estimates the Heckman's two-step procedure turns out to be a variable strategy. The net result will be a different estimate of τ that will account for the self-selected nature of contract participation. The difference in expected earnings between participants and non-participants is then,

$$E[y_i \mid Z_i = 1] - E[y_i \mid Z_i = 0] = \tau + \rho\sigma\left[\frac{\phi_i}{\Phi_i(1-\Phi_i)}\right] \tag{14}$$

If the selectivity correction term is omitted from the least squares regression, then this difference is what is estimated by the least squares coefficient on the treatment dummy variable. If the correlation coefficient ρ is positive, we will see that least squares overestimate the treatment effect.

2.2 Matching algorithms and Heckman's two-step procedure

Estimation of ATT using matching is accomplished in two steps. First, we need to estimate the propensity score for each unit in the treated and control groups. The logistic probability model is adopted, but other standard models will yield similar results. The critical issue in the first step is that the balancing property must be achieved when determining what pretreatment covariates to include in the logit model. After estimating the propensity score, for any given specification, sample observations are divided into strata based on the estimated propensity score. Then whether pretreatment covariates are balanced within each stratum is examined. We use tests for the statistical significance of differences in the distribution of covariates, focusing on first and second moments as in Rosenbaum and Rubin (1984).

In the second step, a class of matching algorithms suggested in Rosenbaum and Rubin's article can be used to pair treated units and control units. Because the probability of observing two units with exactly the same value of the propen1sity score is in principle zero given $p(x)$ is a continuous variable, matching on the propensity score is essentially a weighting strategy in that we need determine what weights are placed on comparison units at each level of p when computing the estimated treatment effect. The estimator takes the general form:

$$\tau\,|_{T=1} = \frac{1}{n_1} \sum_{i \in I_1 \cap S_P} \left[Y_{1i} - \sum_{j \in I_{0i}} \hat{W}(i,j) Y_{0j} \right] \tag{15}$$

where I_1 is the set of treatment observations, n_1 the number of units in the treatment group, I_{0i} is the set of comparison observations matched to treatment unit i, S_P denotes the region of common support, and $\hat{W}(i,j)$ are weights that depend upon the distance between the propensity scores for i and j.

To reduce the estimation variance and improve the matching quality, we match here with replacement. In cases with very large sample sizes, one may consider matching without replacement without as much concern for variance and matching quality. Among the large stock of matching algorithms, nearest neighbor matching and caliper matching are two methods most commonly applied, partly from considerations of convenience. Brief illustrations on these two alternatives are presented next.

Nearest neighbor matching is frequently used due to ease of implementation, in which a unique alternative individual with the closest propensity score serves as counterfactual for the treated unit unless there are multiple nearest neighbors. Since we lose control of the distance between treated unit and its paired individual, a low quality estimate is likely to be generated when a large gap of propensity score is observed. Instead of finding one nearest neighbor, matching on the nearest k neighbors is sometimes used with the same weight put on each paired unit. It is essentially the tradeoff between reduced variance and increased bias. Nearest neighbor matching sets are defined as follows:

$$\hat{W}(i,j)=\begin{cases}1 & j=\arg\min_{k\in I_0}\left\|\hat{P}_i-\hat{P}_k\right\| \\ 0 & otherwise\end{cases} \tag{16}$$

In caliper matching, all the control units with estimated propensity scores falling within a radius c from $\hat{P}_i$ are matched to the treated unit i. Those treated individuals, for whom no matches can be found, are discarded from the analysis. Caliper matching set are defined as follows:

$$\hat{W}(i,j)=\begin{cases}\dfrac{1}{n_i} & \left\|\hat{P}_i-\hat{P}_j\right\|<c \\ 0 & otherwise\end{cases} \tag{17}$$

where n_i denotes number of caliper matches for i.

To estimate the sample selection treatment effect model, Heckman's two-step procedure turns out to be a good approach to follow. The first step in Heckman's procedure estimates a Probit model based on the discrete variable:

$$Z_i = \begin{cases} 1 & u_i \geq -\gamma' w_i \\ 0 & u_i < -\gamma' w_i \end{cases} \tag{18}$$

Maximum likelihood estimates from the first stage provide consistent estimates for γ in a normalized term. These can in turn be used to construct consistent estimators for the additional term in the second stage OLS estimation. For each observation in the selected sample, we compute $\hat{\lambda}_i = \dfrac{\phi(\hat{\gamma}' w_i)}{\Phi(\hat{\gamma}' w_i)}$ and $\hat{\delta}_i = \hat{\lambda}_i(\hat{\lambda}_i + \hat{\gamma} w_i)$, where $\Phi(\;)$ is the cumulative normal distribution function and $\phi(\;)$ is the density function.

In the second stage, we can just use the treated group observations and follow the regression equation (12) to obtain the estimates for τ, β and $\beta_\lambda = \rho\sigma$ by the OLS method. Since we have observations for both treated group and control group, the alternative approach we can adopt is to run OLS regression on both equation (12) and (13) with all available observations. We can then obtain a consistent estimator for σ^2 using

$$\hat{\sigma}^2 = \frac{1}{n} e' e + \hat{\bar{\delta}} \beta_\lambda^2 \tag{19}$$

where e is a vector of estimated residuals and $\hat{\bar{\delta}} = \dfrac{1}{n} \sum_{i=1}^{n} \hat{\delta}_i$. Finally, an estimate of ρ^2 is computed as $\hat{\rho}^2 = \dfrac{\beta_\lambda^2}{\hat{\sigma}^2}$ which provides a complete set of estimates of the model's parameters. This two-stage procedure generates consistent estimates, albeit not efficient. Efficient parameter estimates using maximum likelihood estimation can be jointly obtained by maximizing the corresponding log-likelihood function after reparameterizing:

$$\log L = \sum_{Z=0} \log \Phi(-q_i) + \sum_{Z=1} \log \theta - \frac{1}{2} \log 2\pi - \frac{1}{2} (\theta Y_i - \nu' x_i)^2$$
$$+ \log \Phi\left[\omega(\theta Y_i - \nu' x_i) + q_i \sqrt{1 + \omega^2}\right] \tag{20}$$

where $q_i = \gamma' w_i$, $\theta = 1/\sigma$, $\nu = [\beta, \tau]/\sigma$ and $\omega = \rho/\sqrt{1-\rho^2}$.

3. Data

Farm-level data were collected through a survey conducted by more than 60 undergraduate rural-area students from Zhejiang University in China when they returned to their home villages during the winter break in February 2004. As we did not receive responses from a large enough number of volunteers, the distribution of regions that the farmers come from across the China cannot be considered to be approximately random. As a result more data were collected in Zhejiang, Jiangxi and Shangdong provinces since many of the student volunteers came from these three provinces. In total, the farmers included in the survey represent over 13 provinces and 47 counties. The survey contained questions on the farm household, farm production status and involvement in contract farming. Student survey enumerators were carefully trained before the time they returned home. All of them had the ability to explain each item on the survey form to local growers. Each student randomly selected 30 households in their home village to interview. Even though contract farming is becoming prevalent in production processes for some goods, contracts are still rarely adopted in some regions for a specified commodity.

The students returned 1820 surveys of which 1036 were complete and usable. Further, one observation with extremely large land size, 60 hectares compared to 0.48 hectares on average operated by farmers in the sample, was thrown away because it might not be a typical farm; farms of that size are not of interest to our study. In the whole sample we obtained 1035 usable observations. Two filtering criteria are applied further for our purpose. First, farmers whose proportion of agricultural income is less than 10 percent of total income are considered as non-farmer oriented businesses and are excluded from the sample. Second, we eliminated 30 observations reporting incomes per laborer greater than 20,000 Yuan. This income level is 7 times the average responded income of 3,000 Yuan. Several reasons justify our decision to remove the observations from the sample. First, the observations are so much greater than average we cannot rule out a data recording issue. If we divide income by farm size for these observations, we will get something much closer to other farmers' income per laborer. Second, the initial goal of China's contract farming program is to raise small farm income. So we are more concerned with the economic impact on small farms of contract farming. In addition, these unusually large farms have a variety of income sources other than contracting income, and their production characteristics are significantly different from small farms. The last, all of these observations are found to be contract participants. In the propensity score matching method, these observations would potentially reduce the matching quality, because their counterparts cannot be found in the control group. After these two steps, the overall sample has 905 valid observations; we label this sample as Sample 1.

Farmers involved in the survey can be classified into three groups: farmers who have contracts, farmers who decide not to contract given contract opportunities and farmers who do not have the opportunity to access contracts. For the third group of farmers, they are excluded from having contracts and do not need to make a decision to contract or not to contract based on their anticipated gain in net profit. A variety of underlying reasons might account for the exclusion, such as regional development status and product category not consistent with contract arrangement. For the sample selection model, we rule this group of growers out and only concentrate on the first two groups of growers. The first two groups from sample 1 account for 522 valid households. This sub-sample is treated as sample 2 in our context. However, when implementing the propensity score matching methods we had better treat the third group of farmers as non-contractees and thereby obtain more comparison units in the control group for the purpose of improving matching quality. In order to do that, the additional assumption has to be made that this type of farmers would reject the contacting offer if such an offer were available. Finally, we note that the contracts studied in the context are within a very wide range and include contracts for vegetable, fishery, dairy and hog production, and are not limited just in one type of product. So the farmers are quite heterogeneous far with respect to production and income characteristics. To make income per labor more comparable among different farmers, one option is to focus on food and vegetable production only, the sectors that dominate the agriculture industry in China. As a result, we have 665 and 376 farmers, who are more homogeneous producers than in Sample 1 and Sample 2, left in Sample 3 and Sample 4. The Sample 4 only involves growers who decide to accept or reject contracts under the same production type, whereas the remaining growers without access to contracts are stilled contained in Sample 3. To further refine our data, we remove those farmers who report land size as zero and those whose majority income comes from sources other than agricultural production.

One limitation of our survey data is the missing information regarding the cost and investment in the production. Since it is hard for Chinese farmers to identify the labor cost and some other operating costs, only gross income for the household was collected in the survey. As a result, we have to use the gross income as the proxy for the net farm income to assess the income effect. Therefore, the income effect tends to be overestimated to some degree. Nonetheless, our data, in the pilot study stage to assess the welfare effects of contract farming program in China, will still work in the comparison of income effects using different methods to remove selection bias. Marketing contracts and production contracts are two forms of contracts widely adopted by the growers.

Table 1 presents descriptive characteristics of the three samples. Tests for equality of means and proportions between contract and non-contract farming in the three samples are reported. The average means of covariates for the treatment and control group and the test results tend to have the same magnitude and significance in the three samples. The table highlights a couple of striking differences between the two groups. Contracting growers are slightly younger and more educated than independent growers, but the disparities are not significant in our sample. The average size of contract farmers is almost twice than that of independent farmers in Sample 2, 3 and 4 and 1.5 times in Sample 1; these differences are statistically based on their t statistics. Farmers under contract treatment have income on average 2,000 Chinese Yuan (one dollar is approximately 8.2 Yuan) higher than those who decide not to contract in the three samples, and this simple mean difference seems to be fairly important and statistically significant. The result also strongly indicates that the regions where contracts are used are more likely to be supported by some government policies. Among the three geographical regions in which the sample comes from, contracting is significantly more commonly used in the Eastern and Western regions than independent production. Contracts are seldom found in the central region’s production process. Generally speaking, the Eastern and Central regions are traditionally more developed agriculturally than is the Western. But the Western area is now receiving numerous beneficial policies, such as tax reduction, fundamental construction appropriation and investment encouragement, under a priority program driven by the central government. The contract-farming program is supported by the local government as well. The simple comparison of means provides us the evidence that the use of contract farming is dependent on regional agricultural development status. The distribution of other covariates, such as price fluctuation and market distance, for the contract and independent groups are not significantly differentiated.

4. Results

4.1 Contract participation and propensity scores

Both the matching method and the sample selection model involve estimation of two equations. Of course, the two methods use the results of a choice model for different purposes. The first estimation result allows the matching method to create propensity scores, whereas it is used in the selection model to construct the additional adjustment covariates used to remove the bias. Table 2 illustrates the results of three commonly used models, namely the linear, Probit and Logit models, applied to three samples to predict the contract decision. The linear probability model is often criticized because of its poor prediction power, but it is used in our context for the purpose of comparison.

Maximum likelihood estimates are obtained for the three models. The coefficient signs are strictly consistent among three models within each sample. All three samples indicate that both the production size and its squared term are the most important covariates in explaining the farmer’s contract decision. The large-scale farmers are more likely to join contract production rather than independent production along with a decreasing trend after a certain amount of size. The younger farmers are associated with significantly higher participation possibility in Sample 1 and 2. Well-educated farmers would independently take advantage of their own production resources and local markets to sell their products. We expected farmers facing wider fluctuations of marker prices and a greater distance to target markets to be more likely to exercise contracts in order to reduce the price risk and marketing risk. However, all four samples present estimates other things being equal of the inverse effects of these two market characteristics, but at non-significant statistical levels.

Having a higher education level and the availability of government support seems to have an inconclusive impact on the likelihood of whether to contract. A negative effect of education and positive effect of government support are found in Samples 1, 3 and 4, whereas opposite results occur in Sample 2.

Compared with farmers in Western region, other things being equal, an operation being located in the Central region significantly reduces the likelihood of contracting in Sample 1, 2 and 4. The insignificant impact occurs for Sample 3. But an Eastern farmer shows an insignificantly higher propensity to have contracts except in Sample 1. Because farmers in Central regions are historically focusing predominantly on rice and grain production, it is relatively difficult for them to convert to producing other commodities even in the presence of contracts. To achieve the national food security the China central government currently still controls the supply system of major grains, such as rice and wheat, even though the demand side has been completely market oriented. Most growers in the Central region have to fulfill a certain amount of specified products required by the local government. Otherwise, they must pay an amount of indemnification due to violating the government regulation. If the violation fee is large enough, farmers will reject the contracts and follow the government's production plan. Production regulation in the well-developed Eastern region is often less restricted so that growers in the Eastern region have more of a chance to use contracts to organize production.

We often use the Logistic estimation results to calibrate propensity scores for the matching model. In the meanwhile, the Probit estimation results are used to construct the bias term in Heckman's second step. The region of common support is the interval of propensity scores that are represented in both the control and treatment units. The common support region for Sample 1 is $[0.04,0.73]$ and excludes only two control units. Similarly, only one control observation is found outside of the common support region $[0.05,0.91]$ in Sample 2 and $[0.033,0.800]$ in Sample 3, and only two control observations are outside the Sample 4 region of $[0.04,0.95]$. After dropping these outlier observations, the histograms of the estimated propensity scores for Sample 1 and 2 are illustrated in Figure 1 and 2. A quick inspection on three figures reveals the common feature of the contract and noncontract groups: most comparison units have propensity scores concentrated within the first half range of $[0.1,0.5]$. When comparing the histogram bins for the large propensity score values, particularly greater than 0.5, we find that the number of comparison units in upper bins is less than the number of treated units in lower bins for Sample 2. In Samples 1 and 3, however, this is only the case for the last two bins, those with score values greater than 0.7. In other words, very few of the comparison units are able to be comparable to the treated units having larger propensity scores in three samples. Matching results in the Sample 2 might be worse than those in the Sample 1 and 3 due to Sample 2's largest interval covering the mismatching. As a consequence, the matching quality is expected to be reduced when pairing the treatment observations that are more likely to be involved in the contract-farming program. This mismatching problem could be exacerbated if matching without replacement were implemented.

4.2 Sample selection model treatment effect results

In spite of its expected poor performance due to bias, the simple linear regression without any bias correction may provide us a benchmark in order to see how the other two methods change and improve the basic results. The simple linear regression estimates and the sample selection treatment effect results using Heckman's two-step procedure and maximum likelihood estimation in four samples are reported in the Table 3. The biased estimates in the linear regression suggest that the significant positive effects of farming size, market distance and central region on the improvement of household's per labor income. They are consistent with our initial expectation. The market price has a non-significant, but negative impact on farm income in all four samples from the biggest impact in Sample 3 to the smallest impact in Sample 1. The overall marginal effects associated with contract production are relatively small in four samples. More specifically, the income effect of contract participation is positively significant in Sample 1, 2 and 3 in that contracting farmers on average have above 3 percent more per labor agricultural earnings taking the log values than those in independent production. The income improvement in Sample 4 drops to 2.2 percent and is at a non-significant level. In addition, we find that both the sample size and its squared term play a very important role in driving results in the linear regression model and the sample selection model. Other covariates, such as age, education level and region, do not significantly influence the farmer's per labor income.

The sample selection treatment effect model used to remove the selection bias produces substantially different results for all four samples in both estimation methods. The Heckman's two-step procedure tends to produce absolutely larger and more significant negative effect for contract production than maximum likelihood estimates, even thought both contracting estimates are insignificant. The estimated significant positive value for the correlation coefficient ρ suggests the overestimation of treatment effect in each case. The bias-corrected income effects under the treatment effect model arise even to be reversed to the insignificant negative level in contrast with the linear regression, whereas other covariates almost keep the same impact on the per labor income. It indicates the selection bias does exist and drives the results a lot. The simple regression results might be misleading if we ignore the selection bias. If we only compare results between simple regression and MLE estimates, we find that the treatment effects of contract farming drop from 5.8% to –1.8% and 3.1% to -1.0% respectively in the Sample 1 and 2. The largest gap of treatment effect occurs in the Sample 3 with 3% versus –1.61%. The homogeneous growers in the Sample 4 have the smallest treatment effect as low as –0.1%.

The simple regression and sample selection treatment effect model fits the Sample 4 well in terms of the adjusted R^2 and log-likelihood values. Due to the homogeneity among growers, we have expected the last sample to produce best-quality estimation results and more powerful implication for assessing income effect of contract farming program. The homogeneous production in our context mainly refers to the crop production and other highly substituted crop production, such as vegetable and fruit production. The parameter estimates and their p-values are very similar between Heckman's two-step procedure and MLE estimation. So it is sensible to make conclusions based on MLE results. The several findings can be summarized here. First, the contract participation did not enhance per labor earnings at all, but it even hurts the farmer's benefits. However, only very weak evidence is found for this opposite effect. Second, the standard deviation Sigma for the error term in the second regression equation is around 0.9, significantly different from zero. The correlation coefficient Rho between the selection equation and regression equation takes significant value of 0.36, indicating that the overestimation takes place for direct regression without any bias correction. In addition, the result provides us with strong evidence that being a large-scale farmer positively raises income per labor after controlling for individual, regional and farm-level characteristics, in a large part due to the dominance of the production efficiency and reduced transaction costs. The coefficient estimates of squared term of land size are tiny in all samples, but highly significant. The farmers with access to remote market are likely to make higher earnings than those targeting local market. Government support strongly raises the income, suggesting the effectiveness of public policy in contract farming program. Other covariates almost remain the same in terms of their impacts on the response variable when compared with the simple linear regression. Finally, when allowing for all types of production like in the Sample 1, contract production becomes even more harmful for growers. The greater gross income dominated in other non-contracting industries, such as the fishery and dairy products, may account for the deterioration.

4.3 Propensity score matching treatment effect results

Nearest neighbor matching and caliper matching specified in Section II are applied respectively to four samples. In addition, we can estimate the selection model based on the Sample 2, and then predict the propensity scores for the Sample 1 to run matching work. The same procedure applies to the Sample 3 and 4. The potential gain in this way will be the more accurate estimates of the propensity scores because the growers who are not offered contracts are excluded from participation decision. This procedure will provide us more control units with quality-improved propensity scores in doing matching. As a result, two extended cases, labeled as the Sample 1+2 and Sample 3+4, are considered in our matching work as well. The matching results are reported in Table 6 and 7.

The nearest neighbor matching results allow us to examine carefully the matched pairs from the lowest propensity score to the greatest. Graphs depicting the estimated propensity scores in an ascending order for matched pairs are presented in Figure 3 to Figure 8 for all six cases. For each case the upper part figure contains two propensity score curves representing the treatment group and the control group. The virtually complete large overlap between the two lines indicates that treated units are well matched to their comparison group counterparts in all samples. The lower part figure provides the score difference between matched pairs. As was observed using histograms, especially for large propensity score values, nearest neighbor matching in Sample 1 works better than that in other three samples, particularly for those treatment units with relatively high propensity scores. After adding two alternative matching cases, the best nearest matching quality goes to Sample1+2. The most outstanding distinction in propensity scores between the two groups can be found in the region from 0.7 to 0.9 in Figure B2 and B5. This suggests that the poorest nearest neighbor matching occurs in Sample 2 and Sample 4. Nearest neighbor matching works satisfactorily well in other cases. The overlap means that other matching algorithms, such as caliper matching, also should work well, but will be affected similarly by the upper tail of the propensity score distributions where there is less complete overlap.

Furthermore, we examined the balance on multivariate covariates in each case using Kolmogorov-Smirnov (KS) and Chi-Square null deviance tests. The null hypothesis for the KS test is of equal balance in the estimated probabilities between treated and control groups. Test results after matching, reported in the Table 4 and 5, turn out to be satisfactory except in Sample 2 and Sample 3+4 in the sense that most imbalances are eliminated through matching. Most matching methods in the Sample 2 and Sample 3+4 fails to achieve balance, given their very small p values. In summary, the matching methods are appropriate for use in drawing conclusions about the average treatment effect on the treated for other matching cases. But the matching results are inconclusive in the Sample 2 and Sample 3+4 due to its balance violation.

The causal effect of contract farming turns out to be consistent in terms of matching methods (nearest neighbor and caliper matching) within each case, except in Sample 2. The large discrepancy of treatment effect in Sample 2, about 360Yuan under nearest matching and above 1300Yuan using caliper matching, is partly due to the violation of balance property, causing the poor performance of matching methods. Including all types of farmers, Sample 1 and Sample 1+2 produce almost the same matching results in terms of magnitude and significance of income effect. The growers under contract production could make about 870Yuan higher earnings than those independent producers using the nearest neighbor matching method, but neither result are statistically significant in 95 percent confidence interval. In contrast, the treatment effects under caliper matching goes up to more than 1000Yuan in a very significant level, much greater than those under nearest neighbor matching. Only a little variation in estimates arises when different calipers are used for these two cases. Estimates range from 1009Yuan to 1127Yuan in Sample 1 and from 1045Yuan to 1236Yaun in Sample 1+2. Generally speaking, the new prediction procedure in cases Sample 1+2 does not shift the matching results very much.

The foregoing matching results could be misleading to some extent because different types of contracts have different production characteristics and gross income levels. For an instance, it is not fair to match a hog contract producer with a tea non-contract producer. To assess the income effect of contract production on the same basis, we could limit our observations within the same production type. For homogeneous growers in our context, who heavily depend on land use, in Sample 3, Sample 4 and Sample 3+4, matching results are presented in Table 6. The income effect using nearest matching method in each case is positive, albeit insignificant. Adding analogous growers without access to contracts, Sample 3 produces the larger and more significant average treatment effect than Sample 4 in both matching algorithms. Matching results seem stable in these two samples, in the range of about 1000 Yuan and 700 Yuan, respectively. But we cannot find strong support for the positive income effect based on matching results in Sample 4. To adjust the radius of the caliper intervals value does not shift the matching results very much for these three cases. Due to its violation of balance property, we cannot expect the alternative procedure used in Sample 3+4 to provide us important insights regarding income effect.

The sample selection treatment effect model leads to weak evidence for the slightly negative income effects, but propensity score matching methods in all cases produce positive income effects. Because different selection bias was removed and strict linear model relations are assumed between gross income and other covariates, estimates in the treatment effect model are conservative and weak for each sample. It indicates that contract-farming program has little impact on the gross income. On contrast, treatment effect estimates from the matching methods turn out to strongly positive, particularly for heterogeneous groups in Sample 1 and Sample 1+2 and homogeneous growers in Sample 3. Those estimates range from 860Yuan to 1200Yuan in heterogeneous groups, although the range of fluctuation is narrower, from 920Yuan to 1140Yuan, in Sample 3. To neglect those growers without chance to access contract markets does not seem to improve estimates based on score matching results. But sample selection treatment effect model and PSM method tend to produce one of the common results, namely income effects are not statistically significant for homogeneous growers who made participation decisions in Sample 4. In this sense, estimates using both methods are consistent, providing us weak evidence that contract production is likely to bring higher earnings to growers. In other words our results did not present strong positive income effects associated with the contract-farming program implemented in China.

One critical issue remains to be addressed in future data collection efforts. The critical issue regarding the estimation results in both the selection treatment model and semi-parametric PSM concerns the limited information available on the response variable. In this study, we have only the total per laborer income information rather than the net household income. We have to subtract the production cost and investment cost from the total revenue when we try to calibrate the net margin of each grower. But we cannot obtain the production cost and investment information from the survey data. A couple of biased factors might occur with using gross income as a proxy variable. On one hand, the overall income effects tend to be overestimated due to larger magnitude of total income. On the other hand, for those growers exercising production contract treatment effects are likely to be underestimated based on matching method. This is because production costs such as input and technology, in some cases, will be mainly provided by the contractors according to the production contracts. If this is true, the collected gross income for these growers should reflect their true net income. Matching them with their corresponding control units with gross income, treatment estimates will be biased and underestimated. As a result, the total income might be a coarse substitute for the net margin because the high total income does not necessarily result in the high net margin. It is an obviously not optimal to assess the income effect by using the total income measure. This drawback potentially could account as well for the relatively poor estimation power of sample selection treatment effect model. It also could contribute to the weak robustness of PSM method in the sense that different specifications tend to cause different treatment effect results. In the future follow-up study, this missing part should be filled carefully in order to produce more accurate inference on income effects of contract farming.

Table 1. Sample Means, Standard Errors and Tests of Equality of Variables

	Sample 1			Sample 2			Sample 3			Sample 4		
Variables	Treatment	Control	t-test	Treatment	Control	t-test	Treatment	Control	t-test	Treatment	Control	t-test
I. Farmer Attributes												
Age	45.04(0.68)	46.13(0.37)	-1.41	45.04(0.68)	46.42(0.28)	-1.55	46.05(0.93)	46.17(0.43)	-0.12	46.05(0.93)	46.36(0.68)	-0.27
Education	2.44(0.07)	2.43(0.04)	0.19	2.44(0.07)	2.28(0.06)	1.84	2.43(0.08)	2.40(0.04)	0.35	2.43(0.08)	2.29(0.06)	1.33
II. Operation Scale												
Size	0.96(0.13)	0.65(0.07)	2.09	0.96(0.13)	0.52(0.04)	3.26	1.11(0.16)	0.59(0.05)	3.09	1.11(0.16)	0.51(0.04)	3.65
Income	0.46(0.03)	0.29(0.01)	4.59	0.46(0.03)	0.28(0.02)	4.35	0.45(0.04)	0.25(0.01)	4.52	0.45(0.04)	0.24(0.02)	4.49
III. External Market												
Price	0.21(0.01)	0.2(0.01)	0.93	0.21(0.01)	0.19(0.01)	1.32	0.2(0.02)	0.19(0.07)	0.83	0.2(0.02)	0.19(0.01)	0.83
Distance	0.34(0.03)	0.38(0.02)	-0.94	0.34(0.03)	0.34(0.03)	0.1	0.43(0.05)	0.40(0.02)	0.62	0.43(0.05)	0.34(0.03)	1.71
Support	0.65(0.03)	0.45(0.02)	5.22	0.65(0.03)	0.45(0.03)	4.54	0.71(0.04)	0.40(0.02)	6.76	0.71(0.04)	0.39(0.03)	6.19
IV. Region												
East	0.69(0.03)	0.5(0.02)	5.2	0.69(0.03)	0.45(0.03)	5.65	0.74(0.04)	0.45(0.02)	6.49	0.74(0.04)	0.4(0.03)	6.83
Central	0.15(0.03)	0.35(0.02)	-6.62	0.15(0.03)	0.44(0.03)	-7.76	0.17(0.03)	0.39(0.02)	-5.59	0.17(0.03)	0.49(0.03)	-7.12
West	0.46(0.03)	0.15(0.01)	0.29	0.16(0.03)	0.11(0.02)	1.52	0.09(0.03)	0.16(0.03)	-2.31	0.09(0.03)	0.11(0.02)	-0.46
Sample Size	196	709		196	326		121	544		121	255	

a. All data are from a 2004 survey of rural farmers in 13 provinces of China. Sample 1 has 905 observations. Sample 2 has 522 observations. Sample has 665 observations. Sample 4 has 376 observations. The complete sample included 1036 units. Restrictions of samples are described in the text.

b. The number in the parenthesis is the standard error.

c. Age measures years of oldness for the master labor in each household. Education represents levels of master's education, with 1 for no any education, 2 for elementary level, 3 for middle school level and 4 for higher level. Land size is based on numbers of hectares.

d. Income is based on multiples of 10,000 Yuan, the Chinese monetary unit, where one dollar is about 8.2 Yuan.

e. Price measures the price fluctuation degree for the product.

f. Distance is dummy variable with 0 for local market and 1 for far-reached market. Support is also dummy variable with 1 representing the presence of government support policy for contract farming program.

g. East, central and west are three location dummies.

h. The t-values are computed by Satterthwaite's method with the unequal variance assumption to examine the mean difference

Table 2: Contract Decisions: Linear Probability, Probit and Logit Models

	Sample 1			Sample 2			Sample 3			Sample 4		
Variables	Linear	Probit	Logit	Linear	Probit	Logit	Linear	Probit	Logit	Linear	Probit	Logit
Constant	0.42	-0.05	0.02	0.69	0.55	1.01	0.24	-0.67	-1.05	0.48	0.06	0.23
	0.00	0.86	0.97	0.00	0.14	0.10	0.01	0.07	0.12	0.00	0.90	0.77
Age	0.00	-0.01	-0.02	-0.01	-0.02	-0.02	-0.01	-0.01	-0.01	0.00	-0.01	-0.02
	0.03	0.02	0.02	0.01	0.01	0.01	0.19	0.23	0.19	0.10	0.11	0.08
Education	-0.01	-0.05	-0.10	0.00	0.01	0.01	-0.02	-0.08	-0.14	-0.02	-0.09	-0.15
	0.31	0.29	0.28	0.87	0.87	0.94	0.32	0.20	0.24	0.34	0.29	0.28
Size	0.05	0.27	0.48	0.12	0.34	0.61	0.11	0.39	0.64	0.20	0.58	1.01
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Size2	-0.01	-0.02	-0.03	-0.01	-0.02	-0.03	-0.01	-0.03	-0.05	-0.02	-0.05	-0.08
	0.00	0.01	0.01	0.10	0.13	0.10	0.00	0.01	0.01	0.02	0.03	0.03
Price	-0.09	-0.32	-0.61	-0.06	-0.16	-0.32	-0.13	-0.47	-0.85	-0.15	-0.44	-0.71
	0.30	0.32	0.27	0.63	0.68	0.62	0.16	0.22	0.20	0.28	0.33	0.35
Distance	-0.06	-0.23	-0.41	-0.06	-0.15	-0.28	-0.04	-0.19	-0.34	-0.03	-0.07	-0.15
	0.04	0.03	0.03	0.20	0.24	0.18	0.18	0.16	0.14	0.60	0.65	0.56
Support	0.09	0.32	0.55	-0.04	-0.12	-0.19	0.14	0.58	0.10	0.08	0.24	0.44
	0.08	0.09	0.10	0.68	0.66	0.67	0.01	0.02	0.02	0.42	0.48	0.46
East	-0.03	-0.13	-0.22	0.03	0.11	0.18	0.02	0.04	0.12	0.07	0.18	0.26
	0.67	0.56	0.56	0.75	0.71	0.72	0.79	0.89	0.83	0.59	0.65	0.71
Central	-0.15	-0.63	-1.17	-0.33	-0.98	-1.67	-0.07	-0.32	-0.59	-0.21	-0.75	-1.33
	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13	0.14	0.01	0.00	0.00

a. The first row for each covariate is the coefficient estimate.
b. The second row is the p-value for each estimate.
c. The response variable is the contract participation dummy variable.
d. Size2 represents the squared term of Size.

Table 3: Linear Regression, Sample Selection Treatment Model Estimation Results

Control Sample	Age	Age2	Edu	Size	Size2	Price	Distance	Support	East	Contract	Sigma	Rho	R^2 or Loglike	Percentage Increase
Sample 1:														
OLS	-0.02	0.00	0.01	0.25	-0.54	-0.04	0.29	0.15	-0.13	0.28	-	-	0.31	0.058
P-value	0.44	0.52	0.96	0.00	0.00	0.86	0.00	0.23	0.37	0.00	-	-		
Two-Step	-0.02	0.00	0.02	0.19	-0.01	-0.08	0.36	0.04	-0.09	-1.50	1.07	0.67	0.31	-0.231
P-value	0.49	0.47	0.62	0.00	0.03	0.76	0.00	0.80	0.55	0.05	0.04	0.03		
MLE	-0.01	0.00	0.01	0.24	-0.01	-0.07	0.33	0.11	-0.14	-0.13	1.00	0.48	-1671.96	-0.018
P-value	0.55	0.61	0.88	0.00	0.00	0.75	0.00	0.36	0.39	0.35	0.00	0.00		
Sample 2:														
OLS	-0.02	0.00	-0.04	0.55	-0.05	-0.12	0.40	0.35	-0.39	0.22	-	-	0.38	0.031
P-value	0.48	0.68	0.33	0.00	0.00	0.65	0.00	0.05	0.07	0.02	-	-		
Two-Step	-0.03	0.00	0.04	0.75	-0.06	-0.23	0.31	0.29	-0.33	-1.39	1.18	0.82	0.38	-0.178
P-value	0.34	0.72	0.50	0.00	0.00	0.52	0.02	0.04	0.22	0.30	0.02	0.03		
MLE	-0.02	0.00	-0.05	0.55	-0.47	-0.20	0.44	0.36	-0.42	-0.06	1.00	0.51	-1006.71	-0.010
P-value	0.56	0.73	0.28	0.00	0.00	0.44	0.00	0.05	0.07	0.61	0.00	0.00		
Sample 3:														
OLS	-0.02	0.00	0.02	0.48	-0.03	-0.27	0.13	0.11	-0.10	0.21	-	-	0.36	0.030
P-value	0.34	0.42	0.56	0.00	0.00	0.23	0.08	0.45	0.53	0.03	-	-		
Two-Step	-0.03	0.00	0.00	0.65	-0.04	-0.47	0.07	0.31	-0.07	-1.29	1.05	0.81	0.37	-0.186
P-value	0.29	0.42	0.98	0.00	0.00	0.11	0.04	0.12	0.69	0.15	0.01	0.02		
MLE	-0.02	0.00	0.03	0.47	-0.03	-0.29	0.16	0.06	-0.11	-1.11	0.92	0.36	-1154.31	-0.161
P-value	0.40	0.47	0.40	0.00	0.00	0.20	0.05	0.63	0.52	0.57	0.00	0.02		
Sample 4:														
OLS	-0.02	0.00	-0.03	0.63	-0.06	-0.24	0.22	0.43	-0.36	0.15	-	-	0.42	0.022
P-value	0.60	0.72	0.56	0.00	0.00	0.43	0.04	0.06	0.19	0.18	-	-		
Two-Step	-0.02	0.00	-0.04	0.67	-0.06	-0.28	0.21	0.45	-0.35	-0.08	0.91	0.15	0.42	-0.011
P-value	0.58	0.72	0.54	0.01	0.01	0.44	0.05	0.07	0.22	0.95	0.01	0.01		
MLE	-0.02	0.00	-0.02	0.63	-0.06	-0.27	0.24	0.42	-0.38	-0.01	0.93	0.36	-696.47	-0.001
P-value	0.65	0.75	0.64	0.00	0.00	0.37	0.02	0.04	0.16	0.98	0.00	0.03		

Note: Age2 represents the squared term of Age; Percentage Increase represents the marginal effect of contract participation in terms of log inc

Table 6: Sample Means for Matched Control Units within Heterogeneous Samples

Control Sample	No. of Treatment Units	No. Of Control Units	Mean Propensity Score	Age	Edu	Size	Size2	Price	Dist.	Supp	East	Central	West	Income Effect
Sample 1:														
Nearest Neighbor	196	196	0.25	44.47	2.37	1.02	5.76	0.22	0.30	0.63	0.65	0.15	0.20	886.95
			0.10	0.51	0.46	0.69	0.43	0.35	0.41	0.57	0.26	0.96	0.23	0.06
Caliper (0.01)	174	312	0.23	45.21	2.37	0.72	3.71	0.23	0.28	0.61	0.63	0.15	0.21	1126.70
			0.08	0.85	0.52	0.72	0.37	0.30	0.18	0.73	0.52	0.73	0.41	0.01
Caliper (0.02)	180	318	0.24	44.92	2.36	0.82	4.70	0.23	0.29	0.62	0.64	0.15	0.21	1075.20
			0.08	0.73	0.45	0.55	0.25	0.39	0.33	0.83	0.44	0.73	0.34	0.01
Caliper (0.03)	184	322	0.24	44.82	2.37	0.86	4.90	0.23	0.29	0.62	0.64	0.15	0.21	1008.70
			0.08	0.72	0.45	0.42	0.20	0.39	0.40	0.73	0.37	0.96	0.34	0.02
Sample 2:														
Neareat Neighbor	196	196	0.45	42.79	2.60	0.70	1.87	0.21	0.34	0.69	0.72	0.14	0.15	364.08
			0.16	0.00	0.12	0.01	0.04	0.79	0.89	0.39	0.57	0.41	0.76	0.56
Caliper (0.01)	136	190	0.41	44.06	2.53	0.45	0.55	0.22	0.38	0.63	0.66	0.17	0.18	1308.50
			0.14	0.03	0.28	0.06	0.16	0.51	0.81	0.59	0.52	0.41	0.29	0.00
Caliper (0.02)	154	209	0.42	43.66	2.54	0.51	1.01	0.21	0.35	0.66	0.68	0.16	0.17	1361.80
			0.14	0.01	0.16	0.02	0.08	0.73	0.97	0.66	0.86	0.41	0.89	0.00
Caliper (0.03)	170	225	0.43	43.09	2.59	0.51	0.98	0.21	0.33	0.67	0.69	0.15	0.16	1290.00
			0.15	0.00	0.10	0.00	0.05	0.83	0.52	0.68	0.76	0.41	0.98	0.01
Sample 1+2:														
Neareat Neighbor	196	196	0.43	44.80	2.59	0.90	4.03	0.23	0.36	0.63	0.69	0.13	0.18	860.12
			0.15	0.77	0.14	0.65	0.98	0.27	0.66	0.59	0.99	0.20	0.66	0.07
Caliper (0.01)	173	369	0.42	44.66	2.57	0.75	3.34	0.22	0.37	0.60	0.67	0.14	0.19	1236.20
			0.14	0.39	0.27	0.96	0.71	0.44	0.63	0.14	0.50	0.52	0.36	0.00
Caliper (0.02)	190	386	0.43	44.72	2.61	0.82	3.63	0.23	0.37	0.63	0.70	0.13	0.18	1077.40
			0.14	0.77	0.11	0.80	0.86	0.40	0.51	0.67	0.89	0.20	0.75	0.01
Caliper (0.03)	191	387	0.43	44.59	2.61	0.82	3.61	0.23	0.37	0.63	0.69	0.13	0.18	1044.50
			0.14	0.60	0.11	0.74	0.88	0.34	0.51	0.59	0.99	0.20	0.65	0.02

Table 7: Sample Means for Matched Control Units within Homogeneous Samples

Control Sample	No. of Treatment Units	No. Of Control Units	Mean Propensity Score	Age	Edu	Size	Size2	Price	Dist.	Supp.	East	Central	West	Income Effect
Sample 3:														
Nearest Neighbor	121	121	0.22	45.91	2.36	0.94	2.53	0.20	0.44	0.72	0.75	0.17	0.09	979.56
			0.13	0.91	0.51	0.14	0.11	0.72	0.92	0.81	0.79	0.92	0.89	0.07
Caliper (0.01)	97	172	0.20	45.92	2.39	0.61	0.80	0.19	0.41	0.67	0.71	0.18	0.11	922.23
			0.10	0.88	0.89	0.59	0.40	0.34	0.96	0.92	0.77	0.92	0.89	0.02
Caliper (0.02)	108	183	0.21	45.88	2.35	0.64	0.87	0.19	0.42	0.70	0.74	0.16	0.10	974.13
			0.10	0.78	0.59	0.49	0.35	0.46	0.71	0.78	0.57	0.73	0.89	0.04
Caliper (0.03)	111	186	0.21	46.14	2.35	0.68	1.03	0.19	0.44	0.70	0.74	0.17	0.09	1143.80
			0.11	0.77	0.44	0.31	0.24	0.53	0.62	0.78	0.57	0.73	0.89	0.02
Sample 4:														
Nearest Neighbor	121	121	0.42	45.52	2.39	0.95	3.06	0.19	0.35	0.67	0.71	0.13	0.16	759.13
			0.20	0.68	0.72	0.17	0.27	0.38	0.22	0.28	0.43	0.08	0.06	0.20
Caliper (0.01)	69	87	0.34	46.74	2.40	0.41	0.29	0.17	0.36	0.65	0.65	0.20	0.15	568.18
			0.15	0.72	0.88	0.08	0.12	0.03	0.60	0.41	0.56	0.06	0.66	0.10
Caliper (0.02)	89	107	0.36	45.58	2.36	0.46	0.46	0.17	0.38	0.64	0.66	0.15	0.09	797.47
			0.15	0.92	0.73	0.06	0.08	0.05	0.76	1.00	0.81	0.03	0.16	0.05
Caliper (0.03)	96	114	0.37	46.23	2.37	0.59	1.04	0.19	0.36	0.63	0.68	0.15	0.17	740.22
			0.17	0.76	0.98	0.43	0.81	0.36	0.87	0.51	0.81	0.03	0.16	0.08
Sample 3+4:														
Nearest Neighbor	121	121	0.39	45.74	2.39	0.91	2.48	0.20	0.45	0.69	0.75	0.13	0.12	598.81
			0.19	0.81	0.77	0.06	0.10	0.82	0.78	0.53	0.73	0.08	0.38	0.25
Caliper (0.01)	85	152	0.34	44.96	2.42	0.46	0.54	0.18	0.35	0.64	0.69	0.16	0.15	807.25
			0.15	0.70	0.93	0.02	0.05	0.07	0.88	0.63	0.70	0.03	0.38	0.02
Caliper (0.02)	105	172	0.37	45.26	2.42	0.66	1.23	0.20	0.41	0.67	0.74	0.13	0.13	602.21
			0.17	0.80	0.94	0.05	0.18	0.68	0.76	0.65	0.52	0.02	0.38	0.17
Caliper (0.03)	111	178	0.37	45.59	2.42	0.70	1.41	0.20	0.42	0.67	0.74	0.13	0.13	582.72
			0.18	0.89	0.99	0.08	0.21	0.99	0.88	0.51	0.52	0.02	0.38	0.20

Table 4: Multivariate Tests of Balance for Heterogeneous Samples

Multivariate	Sample 1				Sample 2				Sample 1+2			
Tests	NM	C-0.01	C-0.02	C-0.03	NM	C-0.01	C-0.02	C-0.03	NM	C-0.01	C-0.02	C-0.03
KS Test	0.13	0.14	0.12	0.11	0.42	0.37	0.27	0.32	0.13	0.10	0.11	0.10
P-value	0.63	0.36	0.02	0.96	0.00	0.00	0.07	0.00	0.31	0.91	0.30	0.25
Chi-square	5.27	6.22	7.30	6.48	58.65	14.45	19.24	24.86	5.34	7.26	6.25	6.76
P-value	0.87	0.78	0.71	0.78	0.00	0.23	0.06	0.01	0.95	0.81	0.91	0.87

a. NM represents for the nearest matching;
b. C-0.01 is for caliper matching with 0.01 radius, and C-0.02, C-0.03 are defined the same manner;
c. P-values for KS test are the bootstrapping p-values based on 1000 repetitions.

Table 5: Multivariate Tests of Balance for Homogeneous Samples

Multivariate	Sample 3				Sample 4				Sample 3+4			
Tests	NM	C-0.01	C-0.02	C-0.03	NM	C-0.01	C-0.02	C-0.03	NM	C-0.01	C-0.02	C-0.03
KS Test	0.12	0.16	0.10	0.11	0.23	0.22	0.20	0.23	0.15	0.22	0.16	0.16
P-value	0.78	0.02	0.70	0.39	0.07	0.97	0.57	0.40	0.08	0.06	0.04	0.13
Chi-square	3.16	1.31	1.70	2.82	6.97	8.27	6.56	4.50	4.95	7.27	4.71	4.91
P-value	0.98	0.99	0.99	0.98	0.86	0.69	0.85	0.96	0.09	0.07	0.10	0.08

a. NM represents for the nearest matching;
b. C-0.01 is for caliper matching with 0.01 radius, and C-0.02, C-0.03 are defined the same manner;
c. P-values for KS test are the bootstrapping p-values based on 1000 repetitions.

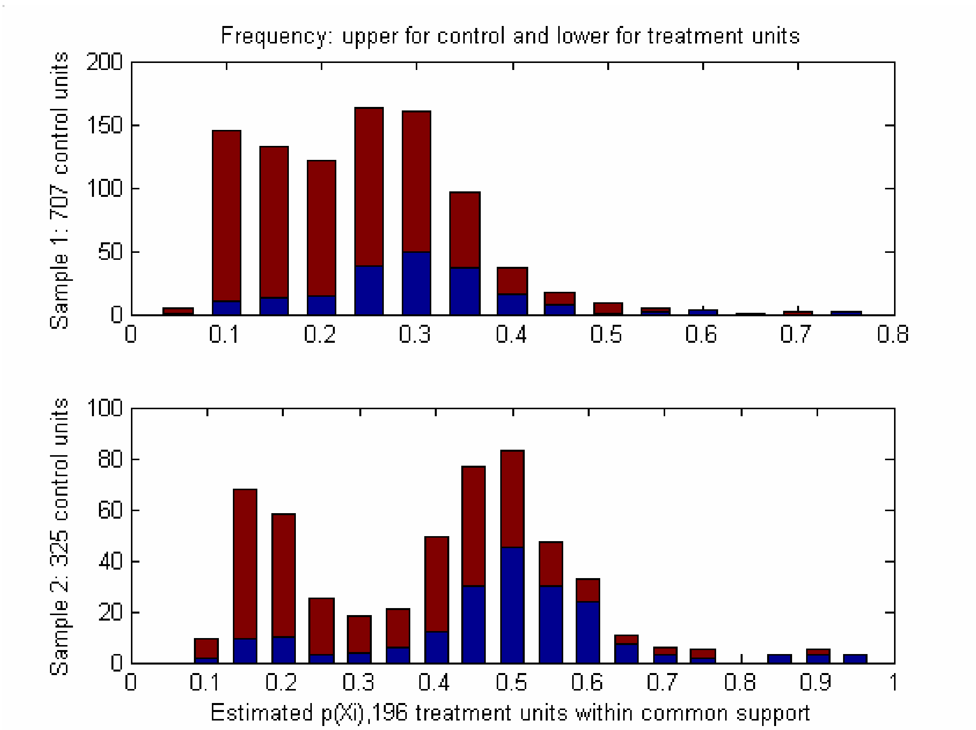

Figure1: Histograms of Propensity Scores for Sample 1 and Sample 2

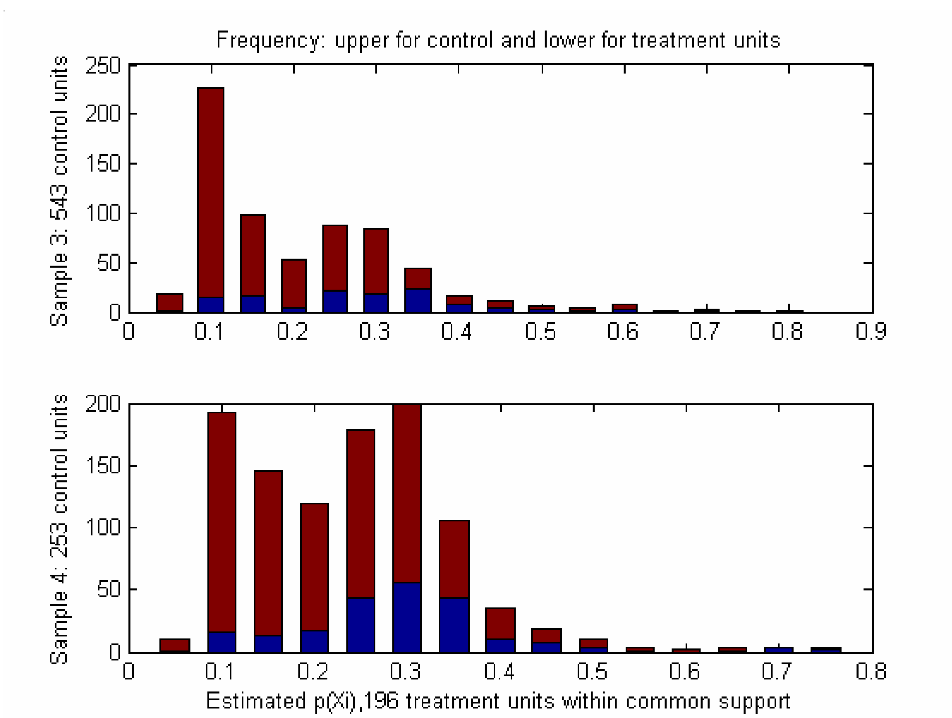

Figure 2: Histograms of Propensity Scores for Sample 3 and Sample 4

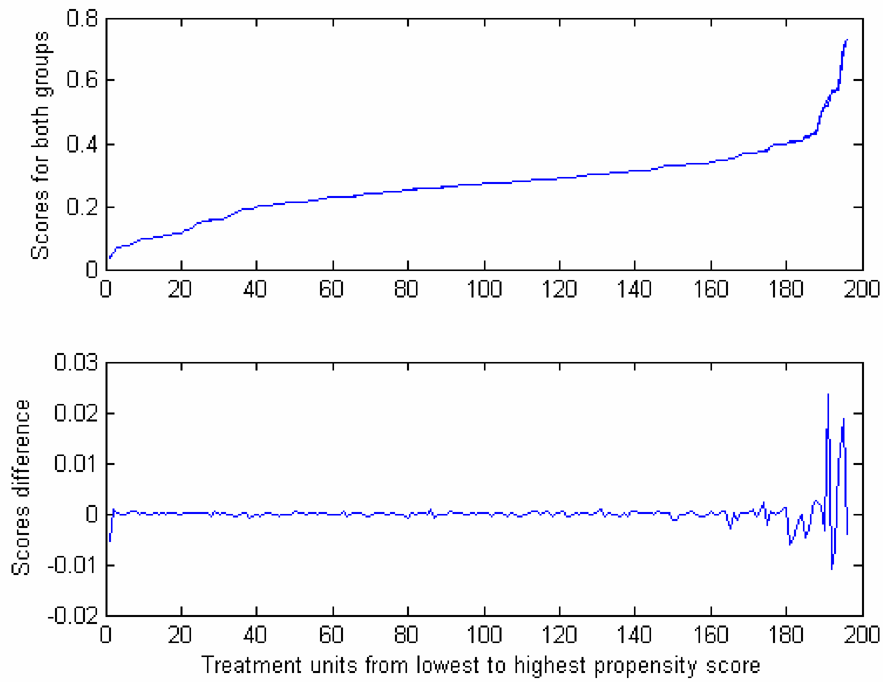

Figure 3: Nearest Matching in Sample 1

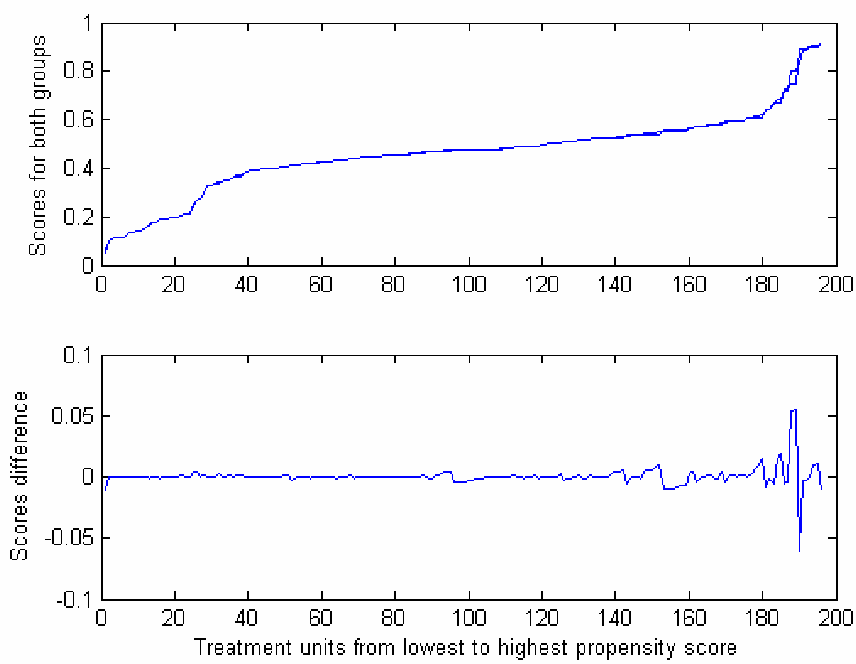

Figure 4: Nearest Matching in Sample 2

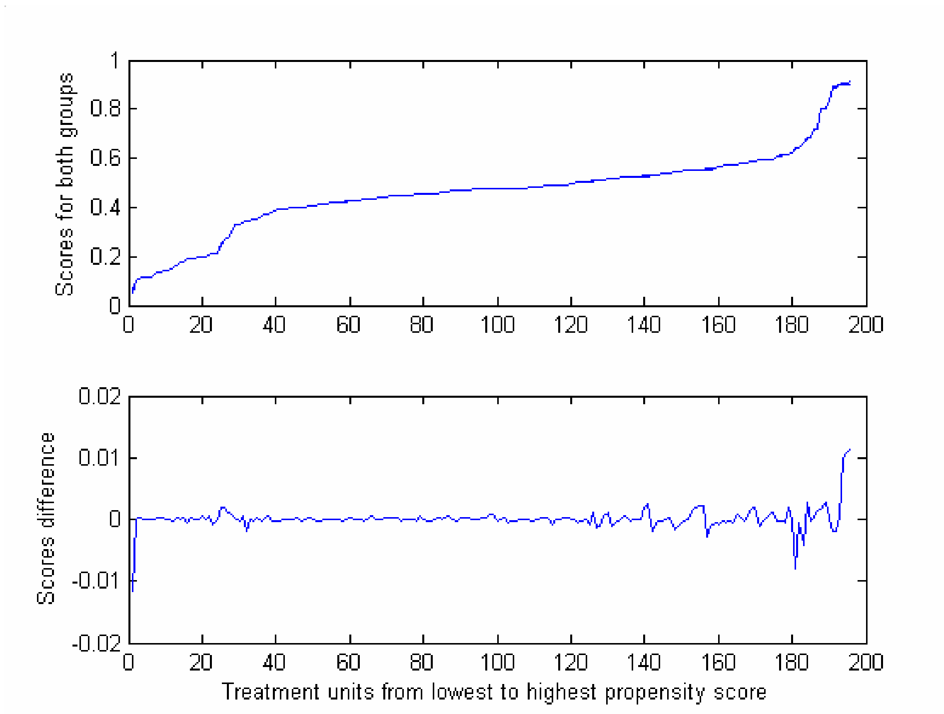

Figure 5: Nearest Matching in Sample 1+2

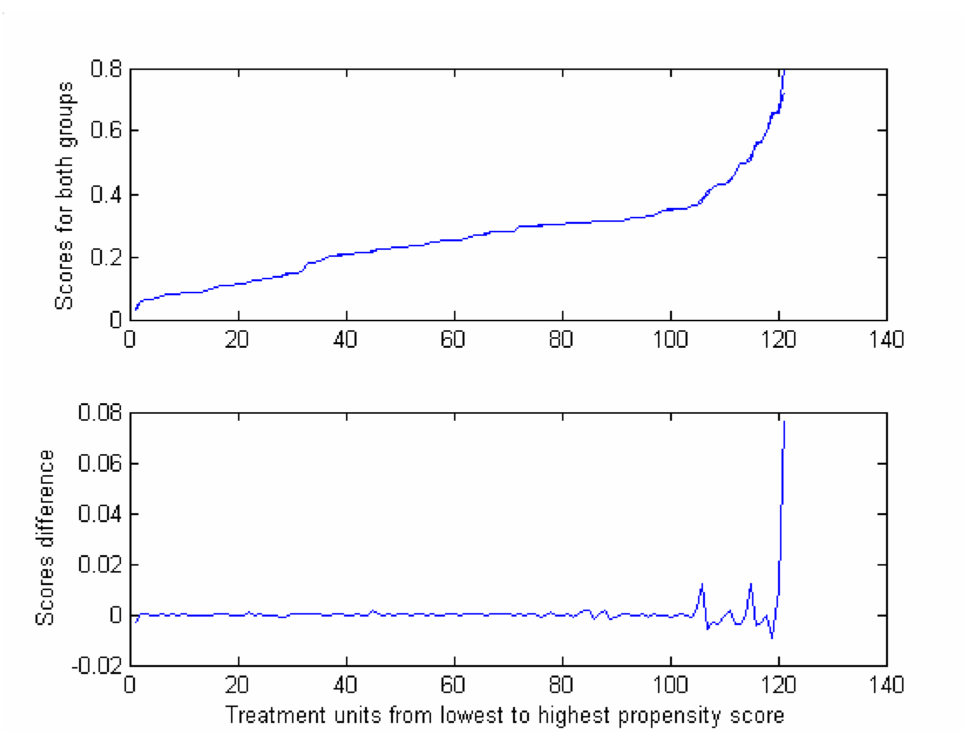

Figure 6: Nearest Matching in Sample 3

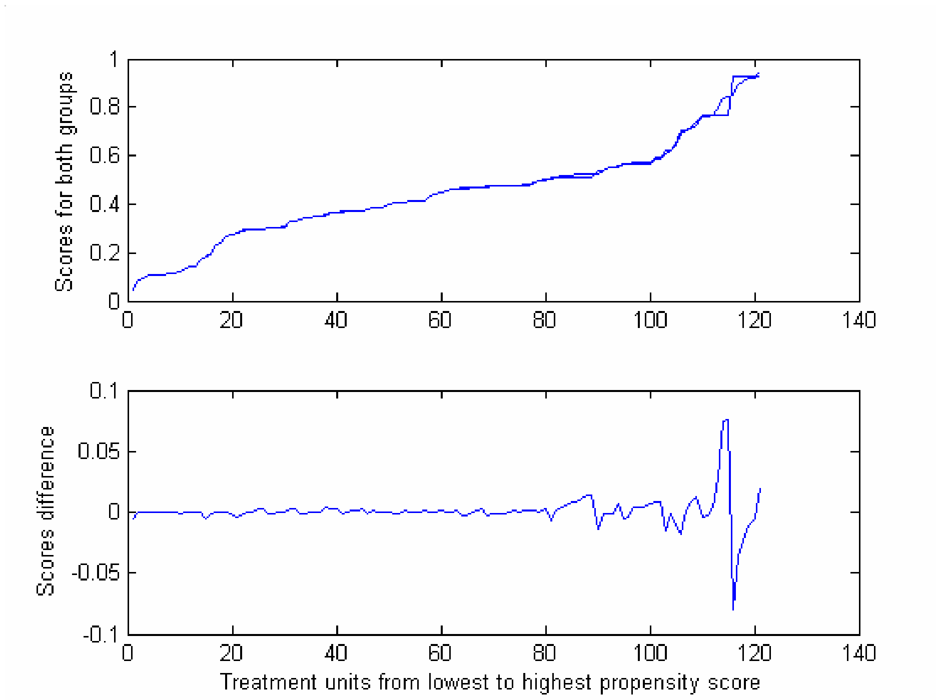

Figure 7: Nearest Matching in Sample 4

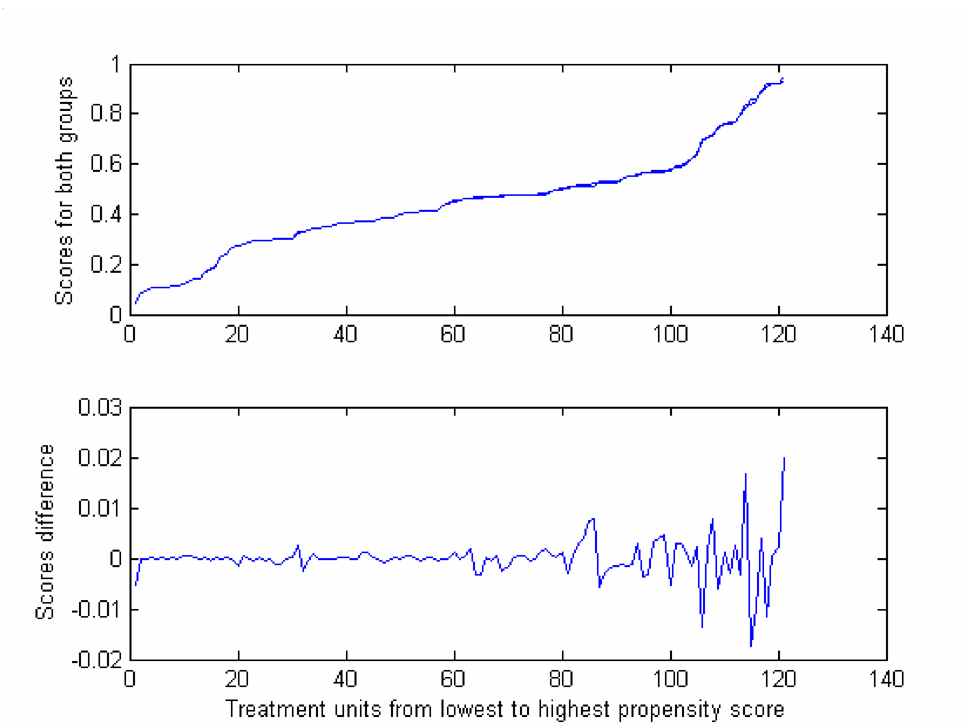

Figure 8: Nearest Matching in Sample 3+4

5. Summary and Discussion

In this paper, we assessed the income effect of contract farming based on different restrictions of the available sample using the treatment effect model from econometrics and the propensity score matching method. In large part due to the selection bias associated with the survey data, we conclude that the income effect results are not fairly robust across the samples by means of the two methods. In order to evaluate the income effect, the total income per labor has to be used as the proxy variable for the net income per labor. Mis-measurement might arise when we evaluate the income effects. Missing information on investment amounts in each household also accounts for the poor performance. But the available information still allows us to draw a definite conclusion in terms of the income effects of contract farming.

We cannot find evidence from estimates in the sample selection treatment effect model that contract production tends to bring higher income to growers than independent production. Even worse, contract participation in each sample becomes harmful to rural growers in terms of income welfare. Both Heckman's two-step procedure and MLE confirm the significant positive estimates of the correlation coefficient, which leads to the overestimation of income effects in the simple regression model without removing any selection bias. However, propensity score matching estimates do suggest the presence of the income improvement gained from the contract-farming program. The average contract contribution to income reaches 1000Yuan in the full Sample 1. As the homogeneous producers are concerned, the smaller income effects with reduced significance are found to be averagely 750Yuan in Sample 4. This result is closer to that in the treatment effect model; in the sense we cannot find the strong evidence for the income effect.

A couple of conclusions are drawn regarding the classified samples. The initial purpose trying to obtain better estimation and matching results through classification is largely achieved. We find that the overall performance of the sample selection treatment effect model in Sample 4 is better than that in other samples in terms of adjusted R^2 and log-likelihood values. The smallest gap of percentage increase due to contract between direct regression and treatment effect model implies that the refined sample per se removes some biases. Even though the largest sample size in Sample 1 and Sample 1+2 contributes to producing the best matching results, they could be misleading. The consistent positive income effects are present for homogeneous growers who focus on grain and vegetable production in Sample 3. For the homogeneous farmers with the same production characteristics, the contracting individual makes a better income than the independent individual without contracts, consistently averaging to 1000Yuan. The last refinement in Sample 4 produces less income effects, but they are closer to the results using treatment effect model.

Finally, it must be noted that even though income effects are not consistent and robust across different samples, the overall performance of both estimation methods turns out to be satisfactory. One of our essential goals is to try various estimation tools to examine the direction and sensitivity of income impact from the contract participation, based on reasonable sub samples. Because different assumptions are made and different selection biases are considered to be removed, we cannot simply conclude that one method is superior to the other. However, our two classes of estimation methods both indicate that contract-farming program does not substantially raise income for the homogeneous farmers.

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CHAPTER 4. FARM SIZE AND CONTRACT EXCLUSION IN CHINA

Abstract

Contract farming has the potential to improve the welfare of smallholders; however, smaller farmers can be excluded from contracts because agribusinesses prefer to award contracts to larger, better-off farms. The main goal of this paper is to understand what types of barriers or mechanisms prevent small farmers from participation in the contract farming program in China. To explore the underlying exclusion mechanism, this paper develops an applied contract model that takes into account hidden information and other driving factors. Two pricing strategies, common pricing strategy and differentiating pricing strategy, are identified in the model. The former strategy offers the same output price in contract, whereas the latter provides two sets of lump-sum offers dependent on the output quantities. The model demonstrates that the common pricing mechanism, accepted widely by contracting firms, could lead to the exclusion of small-scale farmers from the contract production program. Two hypotheses have been implied by the conceptual model. Using a unique set of spatially sampled farmer and firm survey data, we find that small-scale farmers are more likely to be excluded from contract farming in China. Moreover, the common pricing strategy appears to be one of the driving factors that have significantly resulted in contract exclusion. The primary policy recommendation from this, accordingly, is that the Chinese government should encourage contracting firms to implement a differentiating pricing strategy. This might be accomplished by setting some contract pricing guidelines and redesigning the grant distribution mechanism.

1. Introduction

Over the past three decades, China has achieved remarkable growth in its agricultural and rural industries by reforming its agricultural system, and has made significant progress in alleviating poverty. The first step of China's agricultural reform package was the structural reform of its internal agricultural economy. The household responsibility system, a family based production system, was fully established about twenty years ago. Many agricultural technological innovations and improvements have been encouraged by the government since then. The second step was to further engage with world markets. China's accession to the WTO in 2001 represented a dramatic movement toward completing its agricultural reform. In terms of GDP numbers, China's progress in reducing rural poverty and improving farmer income is impressive.

With most past polices gradually losing effectiveness, however, China's agriculture is facing considerable challenges in terms of low agricultural prices due to large stocks of products, slow income growth, lack of technological advancement and increasing competition from foreign farm imports. Under these circumstances, millions of small-scale farm households in China have been unable to operate effectively, that is to respond quickly to changes in domestic demand and to withstand fully the pressure from increasingly competitive markets. According to the National Bureau of Statistics of China, there are about 200 million small farmers in rural areas of China. Those small households, engaged in mostly farming, are among the poorest in China and live in relatively poor parts of the nation. These poor rural areas cover most of the western and central regions. The average farm size in China is very small, at less than 0.7 hectares per household in 2006. Evidence from China suggests that, despite steady economic growth and consolidations occurring over recent decades, small farms still dominate in rural areas. Small farmers are usually not well organized, since historically, farmer-owned cooperatives and associations have not been developed. For most smallholders, market access has become increasingly difficult, and their incomes continue to lag behind the rest of the economy.

Small rural households, characterized by their low incomes and poor productivity, constitute a majority of the labor force. They present a critical issue for China's government. Tens of millions of small farmers are struggling to earn livelihoods and produce agricultural goods for developing markets. Due to their limited farm size, it is hard for them to achieve economies of scale. The poverty of the small farmer in China is still a growing issue, even though China's progress in alleviating poverty has, indeed, been remarkable. In 2004, the

National Bureau of Statistics of China acknowledged that the number of rural people living in extreme poverty actually increased, from 28.2 million in 2002 to 29 million in 2003, despite rapid GDP growth during the same period. In addition, poor small farmers contribute to potential political instability. Finally, a labor migration trend from the rural community to the city has created a number of social issues, such as higher crime rates and greater environmental damage in urban areas. Much of this is believed to be due to the farmer laborers' generally poor education.

How can the Chinese government reconcile the limits imposed by a fragmented production system with the goal of improving the quality and competitiveness of agricultural products and increasing small-scale farmers' incomes? One of the public strategies implemented by China is to encourage contract farming programs. As a result, a large number of agribusinesses have been created and supported by the government with the purpose of making agricultural production more profitable and competitive. Among different kinds of agribusinesses, the dominant type of institutional innovation in China is the so-called "dragon-head-driven" agribusiness company. Dragon-head companies are agribusiness firms designated by central, provincial or local governments because of their economic strength, operation scale, high levels of technology and good management practices, as well as their potential to improve local small farm incomes. The basic policy after the firm has been selected is to require them to agree to develop production or marketing systems for local farmers – systems that include market access, technology, technical assistance, credit and other inputs. For most of the dragon-head firms, their systems involve the use of contracts to collect the raw inputs from farmers. In exchange for their active role in rural community development, the dragon-head firms are usually able to receive support from all levels of government and, since 2002, financing from the Agricultural Development Bank of China. In some cases the dragon-head firms that are engaged in contracting are also encouraged to develop "bargaining associations" for farmers, in an attempt to create some degree of countervailing power.

Direct benefits from contracting accrue to smallholders from improved access to markets, improved technology, better management of risk and opportunities for employment of family members. Indirect benefits occur from the empowerment of women and increased commercial acumen on the part of smallholders. On the other hand, an agribusiness firm can secure the source and quality of the material needed for its production by expanding activities through contract farming. Contract farming has the potential to improve the welfare of smallholders; however it is not a sufficient condition for such improvement. Smaller farmers can be excluded from contracts by agribusiness firms that award contracts to larger farms. Smallholders can also be adversely affected by the second-round effects of contracts on incomes and prices, and suffer from narrowing of markets that lie outside of contracts. Institutional developments that might ameliorate this type of exclusion are anti-trust legislation, policies to directly improve the contracting environment, policies to address specific problems smallholders face in entering contracts, and participation by NGOs in contract facilitation.

One of the primary concerns about contract farming in China is whether it is an effective means to transfer technology, particularly to smallholders, and actually raise their income level as a consequence. Contract exclusion is not unique to China; it has been recognized in other developing countries. Under some circumstances, the contracting growers are degraded to become captive workers for extremely poor wage rates. With increasing levels of contract farming taking place in some developing countries, agricultural economists are concerned with an essential issue with regards to whether smallholders tend to be bypassed by contract farming (Glover and Kusterer, Key and Runsten). This concern is critical in China, because agriculture production in China is so fragmented, and a large proportion of farmers are small, with depressed farm income. Initial incentive to spread contract production is to benefit small growers and raise their potential to be more profitable. However, if contract terms such as delivery prices and investment requirements, developed by contracting firms, favor large-scale better-off farmers, they will create such a high threshold for access to the contracts that small-scale farmers will eventually be forced out of contract production.

The main goal of this paper is limited to one major theme: the extent to which and the reasons why small-scale poor farmers are prevented from participation in China's rapidly evolving contract farming program. Within this theme are three main objectives. First, we discuss a number of driving factors that lead to contract exclusion in other countries. Second, we seek to identify a potential exclusion mechanism by the development of a conceptual model, and to test whether such mechanism has taken effect in China. The last objective of this study is to provide evidence-based policy advice concerning the implications and opportunities for smallholder participation in the contract farming program in China, during a boom period in contract production and a restructuring of contract markets.

We address contract exclusion both from theoretical and empirical perspectives. We investigate processing firms' fundamental incentives to contract with farmers. Wealth effects, production efficiency, financial constraints, transaction costs and bargaining power may contribute jointly to a firm's final decision to choose with what type of farmers to contract. We develop a principle agent model to study the potential exclusion mechanism through which smallholders tend to be bypassed by contractors. Several pricing strategies and their welfare effects are analyzed in detail in the model. In the following empirical work, two hypotheses derived from the model are tested by using the survey data collected in China. We are able to examine whether or not smallholders have been bypassed in China, and how contract decision and management play a role in this possible exclusion.

The remainder of this article is organized as follows: section 2 reviews the literature with regard to the contract exclusion problem. Section 3 discusses a variety of pricing strategies that could affect contract exclusion. Section 4 develops two hypotheses and tests them using the survey data collected in China. Section 5 provides concluding remarks and policy recommendations.

2. Literature Review

There has been a long debate on to the impact in many developing countries of contract farming programs that help small-scale growers enter domestic or export markets, the proceeds of which contribute to rural development and poverty alleviation strategies (Glover, 1990). The potential benefits of contract farming are being given renewed attention in the wake of economic reforms that have reduced public expenditures for such items as credit programs, stable crop price supports, input subsidies, and government research and extension programs. While contract farming promises significant benefits for growers in many cases, recent studies have highlighted circumstances in which members of the rural population have realized only limited gains, or have been directly or indirectly harmed by contract farming programs. In some cases, contract farming has been criticized as being a tool for agribusiness firms to exploit an unequal power relationship with growers.

However, less attention has been given to whether contract farming will even reach small farmers who are the direct targets of poverty reduction programs. This should be a higher priority issue, because smallholders cannot receive the potential benefits if they are excluded from participating in the contract farming system. As a result of exclusion due to size, contract farming benefits may primarily go to relatively few large-scale growers instead of a huge number of smallholders. For example, Singh (2000) argues that the evidence suggests the vast majority of contract farming schemes exclude small farmers.

One of the earliest studies to identify the exclusion of smallholders from the contract farming program come from Glover and Kusterer (1990). Their work demonstrate that agribusiness firms do seem to prefer large farmers, due to their obvious lower transaction costs, although in some cases, the contracting firms seek out small farmers. The main reason for their frequent exclusion seems to be the inconvenience of finding many small farmers, and then furnishing them with contracts, inputs, and technical assistance. This is an obvious disadvantage from the perspective of transaction costs.

Key and Runsten (1999) demonstrate how market conditions are likely to be associated with particular grower characteristics under contract farming. They find that recent experiences in Latin America have been mixed regarding the extent to which agro-industrial firms have incorporated smallholders into the production process. Despite the highly labor-intensive nature of most processed crops, many firms shun smallholders, preferring to contract with larger capitalized growers (Runsten and Key, 1996). Often, these large-scale contract farmers hire-in seasonal laborers, who are themselves smallholders. Although most firms appear to favor contracting with larger growers, there have been several examples of agro-industrial firms contracting simultaneously with both large and small landholders. Bivings and Runsten (1992) suggest that governments could reinforce the labor cost advantages of small family farms by enforcing labor laws, the minimum wage, and workplace health standards on large farms. The diseconomies of scale suffered by small growers can be reduced by eliminating policy distortions and institutional biases that work against smallholders, and by promoting research into cropping technologies that reflect the relative prices of labor, capital and land faced by smallholders. The principal agent model proposed by Key and Runstern includes participation and enforcement constraints. However, there is no specified model analysis that could address exclusion problem. This paper does provide us a number of insights and sound arguments with respect to which type of grower should be selected in a specific market situation.

Warning, Key and Hoo (2002) explore the reasons behind the general exclusion of small farmers from contract farming, and examine several cases in which small farmers have participated – successfully or unsuccessfully - in contract farming schemes. They try to identify the features of the successful schemes that led to positive social performance, with an eye toward informing policy development. Transaction cost is still the most significant factor considered in the interpretation for exclusion. Contracting firms face a variety of fixed, per-grower transactions costs, including screening applicants, negotiating the contracts, providing information on required production methods and standards, delivering inputs, monitoring grower behavior, and enforcing contract terms. A firm, thus, tries to minimize these fixed transaction costs in the production of a given quantity of product by choosing fewer growers, each with greater production. Warning, Key and Hoo consider only transaction cost: choosing the large grower seems to be a natural consequence under this argument.

Sartorius (2002) explores ways that small farmers can be cost effectively incorporated in modern agricultural supply chains. The results demonstrate that small-scale farmers can successfully compete with larger growers with respect to production and cost efficiency. The results also illustrate that small-scale farmers generate higher transaction costs than medium and large-scale farmers. A series of proposals are then developed to reduce the transaction costs of small farm contracts. Sartorius concludes that small-scale farmers can be successfully incorporated in agribusiness supply chains, but only if special measures are taken to reduce differential transaction costs. It is suggested that agribusiness should install sophisticated costing systems, encourage the formation of farmer associations and ensure that the raw commodity characteristics are suited to smallholder production systems. These results provide many useful policy implications for making contract farming programs reach smallholders by trying to develop an applicable strategy.

Throughout these discussions, we find that most of the previous research tries to provide a reasonable explanation of why contract exclusion occurs by studying some specific cases. The vast majority of studies rely on simple descriptive analysis rather than identifying and developing a specific exclusion mechanism through which smallholders are actually bypassed. Our emphasis is on developing an exclusion mechanism by incorporating hidden information into a contract model. Since the contracting firms have significant power, in many cases, to set the contract terms and other access conditions, if they strongly prefer to select large-scale farmers, they can develop a pricing term or a minimum transaction volume term that is acceptable only to large farmers. More specifically, we attempt to investigate pricing mechanisms that can easily be implemented in the contract by the contracting firms. This pricing strategy could play an important role in excluding small farmers from the contract farming program in real practice.

Several incentives explain why we want to focus on the pricing strategy in the development of the mechanism. First of all, the pricing provision in the agricultural contract has been identified as one of the most important factors that determine both parties' willingness to sign contracts in China. Guo, Jolly and Zhu (2007) have shown that the pricing provision in the contract plays a critical role in the implementation of contracts in rural China. As we know, price significantly influences how much benefit the farmer can receive from participating in the contract. Second, the pricing term can easily be used as an alternative tool for excluding small farmers, when quantity screening or other instruments are prohibited by contract law. In most market-oriented economies, the price provision in the contract is free to be set by one of the contracting parties. Finally, from the policy implication perspective, it is possible for the government to improve the performance of the contract farming program by monitoring the pricing article in each contract. The government could distribute more tax and financial credits to those contracting firms with pricing strategies more accessible to the small-scale farmer. The contract model with hidden information would be very useful and powerful in replicating the real situation faced by farmers throughout the contracting decision process. The empirical field data collected in China can eventually be used to test whether the pricing design has a significant impact on the occurrences of exclusion.

3. Contract Exclusion Conceptual Model

In this section, we develop an applied contract model with hidden information in order to analyze different pricing strategies that are likely to be carried out by contracting firms to exclude small farmers. Several key factors that could affect contract exclusion, such as transaction costs and production efficiency, are incorporated into the conceptual model to produce a realistic situation. A number of simple results with some assumed parameter values are examined to illustrate the results when a closed solution for the model does not exist.

3.1 Basic contract model

In this model, we only consider the transaction between an agro-processing business and a pool of farmers who decide whether to accept a contract. The agri-business firm is a principal, and he sets the terms of contracts. There are two dominant types of contract, in general: the production contract and the marketing contract. In a production contract, most of inputs, services and technology are provided and managed by the contracting firm. The farmer just supplies of the land and labor. The relevance and importance of each type of contract varies from product to product and over time, and the two types are not mutually exclusive. In our model, we assume that it is a type of production contract, and the production cost is ultimately provided by the business firm, $C_1 = c \cdot q$, in which the lower case c is the unit production cost associated with the output level. The farm population consists of two types of contracting farmers: large-scale farmers with proportion β and small-scale farmers with proportion $(1-\beta)$. Proportion β is the given exogenous variable. Furthermore, the farmer receives the transfer $w(q)$ from the firm by providing output level q.

Contract production requires a certain initial investment to build the facility and purchase equipment. This fixed capital cost is typically incurred by the contracted farmer. Assume that large farmers are more likely to adopt the new technology in order to achieve production efficiency, based on the fact that large, better-off farms have more free capital to invest. In addition, assuming that the production function takes the traditional Cobb-Douglas function form $q_i = Ak^{\alpha_i}$ and $i = l, s$, representing two different technologies for large-scale and small-scale farmers, we have $\alpha_s < \alpha_l < 1$.

The transaction cost incurred in the process of contract production is proportional to the output level for both types of farmers. The firms will pay for this cost, $C_2 = t_i q$ and $i = l, s$. Assume $t_l < t_s$ to be consistent with the well-accepted fact that larger farmers tend to incur a lower unit transaction cost. As a result, the overall margin for the contracting firm is $\widetilde{P}_i = (P - t_i)$, and P is the prevailing output price on the market. Therefore, we have $\widetilde{P}_l > \widetilde{P}_s$. In addition, we assume that the farmer, depending on the type, has the initial wealth a_i, and $a_l > a_s$, since the large farmer is wealthier. Finally, the reservation utility is assumed as $\overline{u}_i$, for large-scale and small-scale of farms. Since a large farm's initial wealth is greater than a small farm's, we must have $\overline{u}_l > \overline{u}_s$.

3.2 Common pricing strategy—contract exclusion

Suppose that farm type is directly observed by the contracting firm. This assumption was true in China before the contract farming program was in force, when the size of the farm had been assigned by the local village authority and renting land was prohibited. In this case, the contracting firm would determine a set of $\{q_i, w(q_i)\}$ to solve its maximization problem

$$\max_{q_i, w_i} \widetilde{P}_i q_i - w_i$$

$$u\left(a_i + w_i - (q_i / A)^{\frac{1}{\alpha_i}}\right) \geq \overline{u}_i . \tag{1}$$

The minus term in the above condition is the required capital input as the inverse form of the production function. The Lagrange equation takes the form

$$\xi = \widetilde{P}_i q_i - w_i + \lambda \left[u\left(a_i + w_i - (q_i / A)^{\frac{1}{\alpha_i}} \right) - \overline{u}_i \right], \tag{2}$$

The first order condition gives us the following results

$$\partial\xi \big/ \partial q_i = \widetilde{P}_i - \lambda \left[u'(\cdot)(A)^{-1/\alpha_i} (\alpha_i)^{-1} (q_i)^{(1-\alpha_i)/\alpha_i} \right] = 0$$

$$\partial\xi \big/ \partial w_i = -1 + \lambda u'(\cdot) = 0 \tag{3}$$

We are able to solve the above equations and obtain the solution as $q_i = \left(\widetilde{P}_i \alpha_i A^{1/\alpha_i}\right)^{\frac{1-\alpha_i}{\alpha_i}}$. The optimal output level for each type of farmer relies largely on its own characteristics, such as the production efficiency and transaction cost level. Under this pricing strategy, we will achieve the first best welfare outcome and no contract exclusion will occur, since all farms have been selected by the firm.

Suppose the information to clearly identify the type of farm is not available to the contracting firm, or it requires additional efforts that are associated with high additional costs in most cases. In current practice in China after several agricultural reforms, the farmer can freely rent farm land from another farmer without any local government permission, even though the local government still owns the property rights to the land. In this case, it would be very difficult to tell which farm is large and which is small. In addition, there is no third-party, like the independent agent or government agent in China, who was able to provide farm size information. Put another way, the procuring or monitoring cost is very high in order to obtain farm size information. In the following model, hidden information is assumed, and assumed to be prevailing in the following mechanism designs.

If the firm can no longer observe the type of farmer, it has to offer the same contract to everyone. The simple case is the common pricing strategy, also called the linear pricing strategy. In this case, the firm's contract specifies a common price w for each unit of output q_i. Given this contract, the farmer chooses q_i to maximize

$$\max_{q_i} u\left[a_i + wq_i - \left(q_i / A\right)^{\frac{1}{\alpha_i}}\right] \text{ where } i = l, s$$

FOC: $$u'(\cdot)\left[w - (A)^{-1/\alpha_i}(\alpha_i)^{-1}(q_i)^{(1-\alpha_i)/\alpha_i}\right] = 0 \quad (4)$$

As a result, the output solution takes the form $q_i = \left(w\alpha_i A^{1/\alpha_i}\right)^{\frac{\alpha_i}{1-\alpha_i}} = D_i(w)$, and $i = l, s$.

We know that $\frac{\alpha_i}{1-\alpha_i}$, $(\alpha_i)^{\frac{\alpha_i}{1-\alpha_i}}$ and $A^{\frac{1}{1-\alpha_i}}$ are increasing functions of the production coefficient α_i. So the optimal production output for the large-scale farmer will be typically greater than that of the small-scale farmer when the linear price w is greater than 1.

To obtain the optimal maximum utility, we plug the solution back into the contracting farmer's objective function:

$$u\left[a_i + w\left(w\alpha_i A^{1/\alpha_i}\right)^{\frac{\alpha_i}{1-\alpha_i}} - \left(w\alpha_i A^{1/\alpha_i}\right)^{\frac{1}{1-\alpha_i}}(A)^{-1/\alpha_i}\right]$$

$$= u\left[a_i + (wA\alpha_i)^{\frac{1}{1-\alpha_i}}\left(\frac{1}{\alpha_i} - 1\right)\right] \tag{5}$$

For example, when $A = 0.8$, $\alpha_l = \frac{1}{2}$ and $\alpha_s = \frac{1}{3}$, we will have $u_l = u\left(a_l + 0.16w^2\right)$ and $u_s = u\left(a_s + 0.275w^{1.5}\right)$. So which type of utility is greater would depend on the relative value between the output price w and production coefficient A, and the difference between initial wealth. For instance, the former will be greater than the latter if $a_l + 0.16w^2 > a_s + 0.275w^{1.5}$. In the meantime, if we perform a sensitivity analysis, we will have the following result:

$$\partial D_i(w) \Big/ \partial w = \left(\alpha_i A^{1/\alpha_i}\right)^{\frac{\alpha_i}{1-\alpha_i}}\left(\frac{\alpha_i}{1-\alpha_i}\right)(w)^{\frac{2\alpha_i - 1}{1-\alpha_i}} > 0 \tag{6}$$

Basically, this says that each type of farmer is willing to produce more output if offered a higher linear price. That is common sense. Finally, with a common price contract, the firm's problem is to maximize

$$\max_w \beta\left(\widetilde{P}_l - w\right)D_l(w) + (1-\beta)\left(\widetilde{P}_s - w\right)D_s(w)$$

FOC: $-\beta D_l(w) + \beta\left(\widetilde{P}_l - w\right)D_l'(w) - (1-\beta)D_s(w) + (1-\beta)\left(\widetilde{P}_s - w\right)D_s'(w) = 0$

$$w = \frac{\beta\widetilde{P}_l D_l'(w) + (1-\beta)\widetilde{P}_s D_s'(w) - \beta D_l(w) - (1-\beta)D_s(w)}{\beta D_l'(w) + (1-\beta)D_s'(w)} \tag{7}$$

We are able to derive simple case results with the above parameter values, and further assuming $\beta = 0.2$. As a result, the output will be priced in a highly dimensional function $1.28w + 0.624w^{1/2} - 0.208\widetilde{P}_s w^{-1/2} = 0.64\widetilde{P}_l$. If we know the market price, the output unit price will be solved.

Ignoring the transaction cost difference for a simple illustration, we will have the same margins for both types of farmers such that $\widetilde{P}_l = \widetilde{P}_s = \widetilde{P}$. In addition, if we define $D(w) = \beta D_l(w) + (1-\beta) D_s(w)$, the firm's objective function will be reduced as

$$\max_w \left(\widetilde{P} - w\right) D(w) \quad . \tag{8}$$

In this case, the contracting firm is performing like a monopoly in the market and the monopoly price is given by $w_m = \widetilde{P} - \dfrac{D(w)}{D'(w)}$.

In this solution, we have $w_m < \widetilde{P}$; that is, $D'(w) > 0$, since the monopoly firm can make a profit only by setting a price short of marginal price and $D'(\cdot) > 0$. This is true by taking derivatives with respect to the common price

$$D'(w) = \beta D_l'(w) + (1-\beta) D_s'(w) > 0 \tag{9}$$

We should be aware that, depending on the values of $\left(\beta, \widetilde{P}_l, \widetilde{P}_s, A, \alpha_l, \alpha_s\right)$, it may be optimal for the contracting firm to set the common price so low that only the large-scale farmers would decide to accept the contract. On this circumstance, the small-scale farmer would reject the offer and be excluded from the contract program. If we go back to look at the reservation utility, it is easy to see the situation under which the exclusion occurs

$$u\left(a_i + wD_i(w) - \left(D_i(w)/A\right)^{\frac{1}{\alpha_i}} \right) \geq \overline{u}_i$$

$$a_i + wD_i(w) - \left(D_i(w)/A\right)^{\frac{1}{\alpha_i}} \geq \widetilde{u}_i$$

$$w \geq \left(\frac{\alpha_i \left(\widetilde{u}_i - a_i\right)}{1-\alpha_i} \right)^{-\frac{1}{1-\alpha_i}} / \left(A\alpha_i\right) \quad . \tag{10}$$

Since the utility function is a monotonic increasing function, its inverse function can be formed to calibrate $\widetilde{u}_i$. Therefore, the common price must be no less than a certain level specified in the above formula. Please note that this lower band expression is not a monotonic function of technical coefficient variable α_i. In our numerical example, if $\alpha_l = \dfrac{1}{2}$ and $\alpha_s = \dfrac{1}{3}$, we are able to obtain $w_l \geq \dfrac{2}{A}\left(\widetilde{u}_l - a_l\right)^{-2}$ and $w_s \geq \dfrac{8.485}{A}\left(\widetilde{u}_s - a_s\right)^{-\frac{3}{2}}$. We find the inequality condition that $\frac{8.49}{A}(\widetilde{u}_s - a_s)^{-3/2} \geq \frac{2}{A}(\widetilde{u}_l - a_l)^{-2}$ if $4.25(\widetilde{u}_l - a_l)^2 \geq (\widetilde{u}_s - a_s)^{3/2}$. This indicates that the unit price minimum requirement, threshold to enter the contract, for a small-scale farmer is likely to be higher than that for large-scale farmer. In other words, the small-scale farmer is more likely to be screened by the contracting firm when $w_l \leq w \leq w_s$ is satisfied. It should be noted, however, that neither type of farmer will accept the contract if the offered unit price is too low to reach the reservation utility for either type. In other words, no optimal solution will exist for unit price w.

If we continue to solve for the common price, we are able to further obtain

$$D(w) = \beta w^{\frac{\alpha_l}{1-\alpha_l}} \left(\alpha_l A^{\frac{1}{\alpha_l}} \right)^{\frac{\alpha_l}{1-\alpha_l}} + (1-\beta) w^{\frac{\alpha_s}{1-\alpha_s}} \left(\alpha_s A^{\frac{1}{\alpha_s}} \right)^{\frac{\alpha_s}{1-\alpha_s}}$$

$$D'(w) = \beta \left(\alpha_l A^{1/\alpha_l}\right)^{\frac{\alpha_l}{1-\alpha_l}} \left(\frac{\alpha_l}{1-\alpha_l} \right) (w)^{\frac{2\alpha_l - 1}{1-\alpha_l}} + (1-\beta)\left(\alpha_s A^{1/\alpha_s}\right)^{\frac{\alpha_s}{1-\alpha_s}} \left(\frac{\alpha_s}{1-\alpha_s} \right) (w)^{\frac{2\alpha_s - 1}{1-\alpha_s}} \tag{11}$$

In our numerical example, the above results are $D(w) = \beta\left(\frac{1}{2} wA^2\right) + (1-\beta)\left(\frac{1}{3} wA^3\right)^{\frac{1}{2}}$ and $D'(w) = \beta\left(\frac{1}{2} A^2\right) + (1-\beta)\left(\frac{1}{3} A^3\right)^{\frac{1}{2}}\left(\frac{1}{2} w^{-\frac{1}{2}}\right)$, so the ultimate common price becomes

$$w = \widetilde{P} - \frac{\beta\left(\frac{1}{2} wA^2\right) + (1-\beta)\left(\frac{1}{3} wA^3\right)^{\frac{1}{2}}}{\beta\left(\frac{1}{2} A^2\right) + (1-\beta)\left(\frac{1}{3} A^3\right)^{\frac{1}{2}}\left(\frac{1}{2} w^{-\frac{1}{2}}\right)} \tag{12}$$

Defining $m = \beta\left(\frac{1}{2} A^2\right)$ and $n = (1-\beta)\left(\frac{1}{3} A^3\right)^{\frac{1}{2}}$, the above function will take the reduced form

$$2m\left(w^{-\frac{1}{2}}\right)^3 + \frac{3}{2} n \left(w^{-\frac{1}{2}}\right)^2 - \widetilde{P} m \left(w^{-\frac{1}{2}}\right) - \frac{1}{2}\widetilde{P} n = 0 \tag{13}$$

The optimal linear price is a cubic function with respect to $w^{-\frac{1}{2}}$, and it is difficult to obtain the closed solution for it due to the complexity. The general solution takes the functional form $w = h\left(\tilde{P}, \beta, A, \alpha_l, \alpha_s\right)$. The small-scale farmer would typically not be selected by the agribusiness firm when $w_l \le w \le w_s$.

3.3 Differentiating pricing strategy—second best outcome

Under a differentiating pricing strategy, the firm will offer two types of take-it-or-leave-it offers designed with incentives to stimulate the small-scale and large-scale farmer to accept its respective offer. So the contracting firm basically provides two sets of offers with different output levels, and total revenue $\{(q_s, w(q_s)), (q_l, w(q_l))\}$. Subject to the participation and incentive conditions, the farmer would only be able to accept the offer that is consistent with his type. Patrick and Dewatripont (2005) have shown that social welfare generally would be improved under this pricing strategy when compared to the linear pricing strategy, the so-called second best outcome. Due to the complexity of the second best outcome, we are not trying to develop a full derivation of the ultimate solution, but to implement the method proposed by Patrick and Dewatripont (2005) and derive a general result that helps us understand the potential benefit the small farmer could obtain from this pricing strategy. In this case we find that this pricing strategy typically results in more participation of small-scale farmers, in the sense that small farmers can always accept the offer that better fits their interests. In this case, the objective function for the firm becomes

$$Max \qquad \beta\left[\tilde{p}_l q_l - w(q_l)\right] + (1-\beta)\left[\tilde{p}_s q_s - w(q_s)\right]$$

$$q_i = \arg\max u\left[a_i + w_i q_i - \left(q_i \big/ A\right)^{\frac{1}{\alpha_i}}\right]$$

$$u\left[a_i + w_i q_i - \left(q_i \big/ A\right)^{\frac{1}{\alpha_i}}\right] \ge \bar{u}_i \quad . \tag{14}$$

The indicator i represents the type of farmer, large or small. We find that there are four total restriction conditions in the above optimization problem. We know there are several approaches to solving this problem, but we use only the simple discrete-step method to demonstrate that the result is what we need. In the first step, the revelation principle will be applied to the above problem. Let $w(q_i)=w_i$, for $i=l,s$, then the problem can be fully rewritten as

$$\max_{w_i,q_i} \quad \beta\left[\tilde{p}_l q_l - w_l\right]+\left(1-\beta\right)\left[\tilde{p}_s q_s - w_s\right]$$

$$u\left[a_l + w_l - \left(q_l \big/ A\right)^{\frac{1}{\alpha_l}}\right] \geq u\left[a_l + w_s - \left(q_s \big/ A\right)^{\frac{1}{\alpha_l}}\right]$$

$$u\left[a_s + w_s - \left(q_s \big/ A\right)^{\frac{1}{\alpha_{sl}}}\right] \geq u\left[a_s + w_l - \left(q_l \big/ A\right)^{\frac{1}{\alpha_s}}\right]$$

$$u\left[a_l + w_l q_l - \left(q_l \big/ A\right)^{\frac{1}{\alpha_l}}\right] \geq \bar{u}_l$$

$$u\left[a_s + w_s q_s - \left(q_s \big/ A\right)^{\frac{1}{\alpha_s}}\right] \geq \bar{u}_s . \tag{15}$$

The first two restriction conditions indicate that the large-scale farmer would be better off to choose the large-scale type of offer; likewise, the small farmer would choose the small-scale type of offer. In the second step, since the utility function $u(\cdot)$ is a monotonic increasing function, we are able to remove the utility function and obtain the following inequalities:

$$w_l - \left(q_l \big/ A\right)^{\frac{1}{\alpha_l}} \geq w_s - \left(q_s \big/ A\right)^{\frac{1}{\alpha_l}} \text{ and } w_s - \left(q_s \big/ A\right)^{\frac{1}{\alpha_s}} \geq w_l - \left(q_l \big/ A\right)^{\frac{1}{\alpha_s}}$$

$$a_l + w_l q_l - \left(q_l \big/ A\right)^{\frac{1}{\alpha_l}} \geq \tilde{u}_l \text{ and } a_s + w_s q_s - \left(q_s \big/ A\right)^{\frac{1}{\alpha_s}} \geq \tilde{u}_s . \tag{16}$$

We know from the empirical experience that the first and the last constraints usually bind. Then we can reduce our restrictions from four to two conditions, where only the second and third constraints are in effect:

$$\max_{w_i,q_i} \quad \beta\left[\tilde{p}_l q_l - w_l\right]+\left(1-\beta\right)\left[\tilde{p}_s q_s - w_s\right]$$

$$w_l - \left({q_l}/{A} \right)^{\frac{1}{\alpha_l}} \geq w_s - \left({q_s}/{A} \right)^{\frac{1}{\alpha_l}}$$

$$a_s + w_s q_s - \left({q_s}/{A} \right)^{\frac{1}{\alpha_s}} \geq \tilde{u}_s . \tag{17}$$

We are only interested in the non-corner solution, so the above two constraints would bind, as well. We substitute the output variables (q_s, q_l) for the revenue variables (w_s, w_l) to leave only two variables available in the above maximization equation system, and we have the following reduced objective function:

$$\max_{q_l, q_s} \beta \left[\tilde{p}_l q_l - \left({q_l}/{A} \right)^{\frac{1}{\alpha_l}} + \left({q_s}/{A} \right)^{\frac{1}{\alpha_l}} - \frac{\tilde{u}_s - a_s + \left({q_s}/{A} \right)^{\frac{1}{\alpha_s}}}{q_s} \right] + (1-\beta) \left[\tilde{p}_s q_s - \frac{\tilde{u}_s - a_s + \left({q_s}/{A} \right)^{\frac{1}{\alpha_s}}}{q_s} \right] \tag{18}$$

The ultimate solution for variables (q_s, q_l) can be derived directly from the first order condition applied to the above objective function:

$$\frac{\partial \xi}{\partial q_l} = \tilde{p}_l - \left(\frac{1}{A} \right)^{\frac{1}{\alpha_l}} \left(\frac{1}{\alpha_l} \right) (q_l)^{\frac{1-\alpha_l}{\alpha_l}} = 0$$

$$\frac{\partial \xi}{\partial q_s} = \beta \left[\left(\frac{1}{A} \right)^{\frac{1}{\alpha_l}} \left(\frac{1}{\alpha_l} \right) (q_s)^{\frac{1-\alpha_l}{\alpha_l}} - \frac{\left(\frac{1}{A} \right)^{\frac{1}{\alpha_s}} \left(\frac{1}{\alpha_s} \right) (q_s)^{\frac{1-\alpha_s}{\alpha_s}} - \left(\tilde{u}_s - a_s + \left({q_s}/{A} \right)^{\frac{1}{\alpha_s}} \right)}{q_s^2} \right]$$

$$+ (1-\beta) \left[\tilde{p}_s - \frac{\left(\frac{1}{A} \right)^{\frac{1}{\alpha_s}} \left(\frac{1}{\alpha_s} \right) (q_s)^{\frac{1-\alpha_s}{\alpha_s}} - \left(\tilde{u}_s - a_s + \left({q_s}/{A} \right)^{\frac{1}{\alpha_s}} \right)}{q_s^2} \right] = 0 \tag{19}$$

Basically, we are able to solve two unknown variables from the above two equations. Due to the complexity of this highly dimensional function, it is difficult to obtain a solution with closed forms for variables (q_s, q_l). After output levels (q_s, q_l) are solved, we can substitute them back to get the solution for pricing variables (w_s, w_l).

So far, we have developed the differentiating pricing strategy through the above several discrete solving steps. The optimal solution for the output level and its associated revenue (q_i, w_i) in terms of the type of farmer has been derived even though the closed form of solution cannot be obtained. Given the offer, in accordance with this strategy, the small farmer would like to take his best offer and sign the contract with the contracting firm. So, ideally, the whole proportion of small farmers, specified as β, should be involved in the contract farming program. As a result, social welfare would be considerably improved when compared to that of the common pricing strategy, largely due to the higher involvement rate of the small farmers.

In this section, we have identified a potential mechanism that could cause the exclusion of small-scale farmers from the contract farming program. Pricing strategy turns out to be an effective tool that the contracting firm can utilize to limit contracts to large-scale farmers. Due to their technical efficiency and lower transaction costs, large-scale farmers are more likely to accept a contract price that is found unprofitable for small farmers. As a result, in the common pricing strategy, small farmers are more likely to be excluded from contract farming. Within the model, a series of factors, such as production efficiency and transaction cost, are taken into account at the same time.

Our finding indicates that differentiating pricing can potentially be developed as an effective tool to achieve the second best outcome and, thereby, make contracts more accessible to small farmers. According to this mechanism, the government should redesign its current policy and distribute tax credits and financial supports to contracting firms based on the pricing terms underwritten in the contracts. The itemized pricing terms, with one type of benefit offer and transaction quantity for the large-scale farmer and the other for the small-scale farmer should be the standard sample for contracting firms to follow. Depending on their different types of products, those awarded offers should vary from one industry to the other, and there is no one rule of thumb for all contracting products. However, differentiating pricing should be established to determine the offers. If the contracting firm adopts a differentiating pricing contract, it should be eligible to receive financial support and tax credits from the government. In the contract farming program in China, the government has historically allocated supporting grant based on simple participation proportion statistics, a ratio between small contracted farmers and total contracted farmers. Since this ratio has been provided directly from the contracting firm, it has been very difficult for the government to determine whether or not the contracting firm has honestly reported the participation rate of small farmers. This criterion may not be effective in most cases, since the contracting firm has a strong incentive to split its large-scale farm partners into small pieces by obtaining contract signatures from the large partners' relatives. Due to the high density population in the rural area of China and to loose legal restrictions, it is very easy for large farms to obtain agreements to sign contracts from their nearby relatives. Some government officials, interviewed through the survey conducted by Guo, Jolly and Zhu (2007), have confirmed the prevalence of such trickery played by large farms. However, the contract, containing the transaction price is in a standard legal format and can easily be inspected by a third party and the government. Therefore, the findings from the differentiating price strategy would be very helpful in composing a sample contract that would improve the benefits received by the small farmer.

In the next section, two hypotheses are derived from this contract model, and we empirically test these hypotheses by using survey data from rural China.

4. Hypothesis Testing

Contract farming offers an effective means to increase farm income and promote rural economic development. On the other hand, if smallholders are excluded from contracts, contract farming will serve worsen income distribution and lead to asset inequalities. The paper outlines a number of disadvantages associated with a variety of market imperfections when agro-industrial firms write contracts with smallholders. Small holders can be excluded from contracts due to selection bias. As a result, contracting firms can exclusively award contracts to large farmers.

In this section, we empirically investigate whether or not an exclusion mechanism, driven by the pricing strategy presented in the previous section, exists. We use rural survey data collected in China. In order to achieve this goal, two sets of hypotheses have been established and tested. The first hypothesis is whether or not small farmers tend to be bypassed by the contract farming program in China. A positive test result would direct us to investigate the second hypothesis of whether or not the pricing strategy has played a significant role in facilitating such exclusion. The fundamental goal is to test the second hypothesis, but it largely relies on the preliminary test result from the first hypothesis. If there were no evidence supporting the exclusion of small farmers in China's contract farming program, we would not see a need to investigate any driving mechanisms that could lead to exclusion.

4.1 Hypothesis 1: Are small farmers excluded from China's contract farming program?

4.1.1 Data source

In order to explore the potential exclusion mechanism, we first must hypothesize that exclusion does exist in China's contract farming program. This hypothesis can be tested by applying a regression model to rural farm level data collected in China.

Farm level data were collected through a survey conducted by more than 60 undergraduate students from Zhejiang University in China when they returned to their home villages during winter break in February 2004. In total, farmers from 13 provinces and 47 counties were included in the survey. The survey included questions about the farm household characteristics, farm production status and the household's involvement with the contract farming program. Survey interviewers were well-trained before they returned home. Students returned 1820 surveys, of which 1035 were complete and usable.

Farmers involved in the survey can be classified into three groups: farmers who have contracts, farmers who decided not to contract and farmers who were not offered a contract. Basically, the latter two groups of farmers are excluded from contract farming. The three groups are tagged "Offered/Accepted," "Offered/Rejected" and "Not Offered," respectively. In addition, contracts studied in the survey cover a wide range of industries, such as vegetable farming, fisheries and hog production. Thus farmers are expected to be heterogeneous in terms of production characteristics and farm income. To test the first hypothesis, we include the entire 1035 observations in the sample.

4.1.2 Specification of the estimation equation

A Multinomial Logit model (MNL) can help us determine how individual characteristics affect their likelihood of being in certain categories of a dependent variable. In the multinomial logit model, the independent variables contain characteristics of individuals, whereas they are the attributes of the choices in the conditional logit model. If instead, we are interested in how the characteristics of the categories affect an individual's likelihood of falling within them, the conditional logit model should be chosen. In the conditional logit approach, each individual is given a value for each of the different potential options available to him/her. However, in our sample we have no such choice characteristic variables available. For example, we don't know how much more land a farmer who rejected the contract would pursue if he accepted the contract. Only one state outcome has been observed for each individual in the sample.

A multinomial logit regression model (Greene, 1993) has the following form:

$$p_{ij} = \frac{\exp\left(\beta_{ij}{}' x_i\right)}{\sum_j \exp\left(\beta_{ij}{}' x_i\right)} \tag{20}$$

where p_{ij} is the likelihood of the contract participation choice, i is the ith individual and j (j=1, 2 or 3) is the jth category of the dependent variable. We have three contracting choices for each individual: 1 stands for "Not Offered," 2 for "Offered/Rejected" and 3 for "Offered/Accepted."

We are fitting the log-odds of membership in each category of the dependent variable versus some baseline category as a linear function of covariates $x_{ij}\left(j = 1,2,..p\right)$:

$$\log\left(p_{ij} \big/ p_{i1}\right) = \beta_{0j} + \beta_{1j}x_{i1} + \beta_{2j}x_{i2} + \ldots + \beta_{pj}x_{ip}\,. \tag{21}$$

The first category ($j = 1$, "Not Offered") is treated as the baseline category in our estimations.

Studies from Lajili et al. (1997), Sartwelle et al. (2000) and Key (2003) find that a farmer's choice to enter into contract farming could be affected by farm characteristics, operation features and market attributes. Six independent variables have been included in the regression model: (1 and 2) In the farmer attribute category we use the age and education level of the head of a household as explanatory variables, since the participation decision is mainly determined by household head. We expect that both younger farmers and lower-education farmers are more likely to accept contracts, because they want to rely more on the contract farming program to market their products. (3 and 4) The farm size and farm income of each household are collected, as they play a positive role in accepting contracts. (5 and 6) Market characteristic variables, the distance from the household to the target market as well as the government support dummy, have been included. The longer the distance to the target market, the more likely farmers will sign contracts to market their products. The existence of the government support policy provided to the contract farming program should positively affect the contract decision.

As a result, the above estimation equation can be written in a more general form:

$$Y = f\,(Age,\ Education,\ Size, Income, Distance, Support), \qquad (22)$$

where Y is the log-odds ratio and six variables are used to explain the contract choice decision.

Table 1 reports descriptive characteristics of the sample, categorized into three groups that are based on the farm's type. The notes below the table describe how each variable was estimated in the sample. The table highlights some differences among the three types of farmers. Contracting growers are slightly younger and more educated than the independent growers who either rejected the offer or were not offered contracts, but the disparities are not significant in the sample. The average farm size of contract farmers is almost twice than that of the other two independent farmers. Farmers with contracts have an income on average, 2,000 Chinese Yuan (1$us is approximately 7.5 Yuan) higher than those farmers who have been excluded from contract production.

4.1.3 Results

We report the coefficient estimates and their respective p-values with respect to the base outcome ("Not Offered") in Table 2. Thus, we have two groups of estimates: "Offered/Rejected" farmers versus "Not Offered" farmers, and "Offered/Accepted" farmers versus "Not Offered" farmers. Tests are also conducted to determine whether the assumption underlying the multinomial logit specification is appropriate.

Maximum likelihood estimates are obtained, and the baseline category is the "Not Offered" category of farmers. The result indicates that production size is a positive and significant factor in affecting a farmer's contract decision. The coefficient estimate tells us how the log-odds of falling into the category as of farmers who accepted contracts and farmers who rejected contracts, versus farmers who were not offered contracts, changes with every change of the explanatory variables. Values above zero indicate that higher values of the explanatory variable increase the predicted probability for a given group, compared to the "Not Offered" outcome. Coefficients less than zero indicate the opposite. We can see that in the "Offered/Accepted" versus the "Not Offered" group, large-scale farmers are more likely to join in contract production than relatively small farmers. In other words, small farmers tend to be excluded from the contract farming, probably due to contracting firms' selection bias. The exclusion can be driven either by the variety of factors like those discussed in the first part of the paper or by the pricing mechanism demonstrated in the contract model section. The same result is found for "Offered/Rejected" versus "Not Offered," in which the coefficient estimate for the amount of land is 0.014, with a p value less than 0.05. As a result, we find evidence that small farmers are more likely to be excluded from China's contract farming program. The hypothesis testing indicates a positive result. Therefore, it is natural to test the second hypothesis on the role that pricing strategy plays in driving the exclusion. We want to identify whether the pricing strategy demonstrated in the previous section, has been utilized as an effective exclusionary tool.

In addition, well-educated independent farmers take advantage of their own production resources and local markets to sell their products, based on results from both comparison groups although the effect is not significant. We expected farmers facing a greater distance to target markets to be more likely to exercise contracts in order to reduce their pricing and marketing risks. However, both comparison groups present estimates, other things being equal, of the inverse effects of these two market characteristics, and at a significantly statistical level. A higher education level and the availability of government support seem to have an inconclusive impact on the likelihood of contract acceptance.

The most serious assumption within the multinomial logit framework is the assumption of the independence of irrelevant alternatives (Greene, 1993). This assumption is that the relative odds between any two outcomes are independent of the number and nature of other outcomes being simultaneously considered. The clearest case of a violation of this property is when certain outcomes serve as substitutes for others. Specifically, we have conducted a

Hausman test of the maintained assumption of Independence of Irrelevant Alternatives (IIA). If two alternatives are more similar to one another than to the third alternative, as might be supposed if individuals first are chosen to be offered contracts and then decide whether to accept or reject the contract, we would expect the IIA test to reveal such similarities. The fact that we are unable to reject the null hypothesis that the MNL model is appropriate for our data lends further credibility to the use of this specification. The test result is reported in Table 3.

4.2 Hypothesis 2: Has the linear pricing strategy led to contract exclusion?

4.2.1 Data source

The firm level data were gathered by mail in rural China in 2004(Guo, Jolly and Zhu). The survey was mailed to 111 agribusiness dragon-head firms in Zhejiang province under the name “Contract Farming Project”. A total of 80 usable copies of the survey were returned. During the same period, between July and August 2004, we interviewed an additional 36 firms. So there is firm-level survey data from 116 total firms.

Out of 116 dragon-head firms included in the survey, 100 were involved in contract farming. The contracting experience varies across firms. Out of the total, 65 firms have engaged in contracting for more than three years, 31 firms are between one and three years and only four firms have less than one year of experience. In addition, these 100 agribusiness firms operate in a variety of marketing and production industries. This may reduce the quality of survey data, because different production requirements and characteristics appear across industries. We are not able to focus on a specific industry, due to the lack of enough observations. Among the 100 agribusiness firms included in the survey, 63 firms signed production contracts with farms. The type of contract largely depends on the categories of delivered goods. Our data suggest that a marketing contract is commonly used in the fruit, vegetable and tea processing industries, whereas production contracts are more common in meat and dairy processing industries.

4.2.2 Model and selected variables

The test of the first hypothesis suggests that large-scale farmers are more likely to be targeted by contracting firms than small-scale farmers. This finding motivates us to take a step further and examine the influence of the pricing mechanism on contract exclusion.

Based on the mechanism design studies in the contract model, we hypothesize that common pricing strategy should be more likely to result in exclusion. The second hypothesis tests whether or not the linear pricing strategy has been employed by contracting firms to implement the exclusion of small farmers, conditional on the fact that such exclusion did occur in rural China.

A Logistic regression model has been applied to the sample, with exclusion type of the contracting firm as the dummy dependent variable and a series of independent variables discussed below. The general model takes the form

$$Y_i = F(X_i;\beta) + \varepsilon_i \qquad \text{and} \qquad Y_i = 0\ ,1 \tag{23}$$

where Y_i is binary choice in which 1 stands for the firm that excludes small farmers and 0 for the firm that doesn't. We use X_i to represent all of the explanatory variables.

These firm-level dependent and independent variables are illustrated in Table 4. Contracting firms have been grouped into two classes: the exclusion type that mainly conducts its contracting business with large farmers and the non-exclusion type that exercises contracts with small farmers. Large-scale farmers are those farmers who have 20 hectares of land or total investment assets of more than 100,000 Chinese Yuan. We have clearly specified this qualification in the survey, so each contracting firm can calculate its proportion of small farmers to its total targeted farmers. In the survey, we ask each contracting firm "what is your current proportion of small contractees to the total contractees." Three choices are provided: A is 0 to 25%, B is 25% to 50%, and C is over 50%. Contracting firms who answered "A" or "B" are identified as exclusionary type contracting firms, and all other firms are non-exclusionary type contracting firms. The dummy value 0 represents the non-exclusionary type of contracting firm and 1, exclusionary type.

Three types of variables are expected to influence a firm's decision about whether or not to exclude small farmers: (1) contracting environment, including tax load and support policy (Key and Runsten, 1999); (2) contracting experience, represented by years of contracting service (Glover and Kusterer, 1990); (3) market characteristics (Singh, 2002). Moreover, based on results from the contract model section, we hypothesize that different pricing mechanisms should influence a firm's exclusion type. We have summarized independent variables in Table 4. The simple firm-level tax load variable is calculated by dividing the total tax paid by the total profit for each firm. We expect this variable to positively affect the firm's exclusion type. The second variable is the duration of contracting experience, determined by the number of contracting years. The longer the firm has been contracting with farmers, the higher the likelihood the firm will contract with small farmers, because of more chances to receive government supporting grant. The average duration of contracting experience is slightly less than 3 years. As a market variable, the absolute price fluctuation percentage degree has been collected. It is expected to negatively affect the contracting firm being an exclusionary type. The government support dummy variable, which is 1 for receiving government support and 0 for receiving no support, is one of the independent variables because it can affect the firm's contracting decision. Receiving government support could make contracting firms more likely to be the non-exclusionary type.

The key variable investigated here is the pricing variable that is used by contracting firms. This is a dummy variable, where value 0 means that linear pricing is being used by the firm, and 1 means that differentiating pricing is being used. In the survey we ask the question, "Which type of pricing term is being used in your firm?" Two choices are provided: A. One uniform price for all farmers; B. Differentiated prices based on the amount of collected goods. Choice A corresponds to linear pricing and choice B to differentiating pricing. Therefore, the pricing dummy is 1 if B is chosen by a contracting firm and 0 otherwise. Each firm is required to report its pricing structure. Since, discussed in the contract model section, differentiating pricing tends to reduce exclusion, the expected sign of this pricing dummy variable is negative.

4.2.3 Results

As illustrated in the model section, linear pricing can be used as an instrument to exclude small-scale farmers, but differentiating pricing can reduce the exclusion, involving more small-scale farmers in contract farming. This hypothesis is tested by using a discrete choice model, and the results are reported in Table 5. Maximum likelihood estimates have been obtained, and the overall fitting of the logistic regression is good, because most of coefficient estimates are strongly significant, with p-values less than 0.05.

First of all, the firm-level income tax rate significantly increases the probability of being an exclusionary type of contracting firm. This result is consistent with our initial expectation, because contracting firms can receive tax credits from the government by raising the participation percentage of small farmers. The government tax reduction policy, with the purpose of supporting the dragon-head firms, was initially based on the participation rate of small farmers. These participation ratio statistics were provided by contracting firms and were very likely to be overstated in order to receive tax credits. This finding provides evidence that the tax credit policy plays a significant role in influencing a firm's contracting decision. To be qualified for tax credits, contracting firms have to meet requirements established by their local government. In most rural areas, the minimum requirement is about a 70 percent participation rate of small farmers. The tax credit is in a range from 4 percent to 8 percent in most provinces, depending on the type of dragon-head firm and the availability of government grant. Local government has the authority to establish such tax credits.

Second, the result suggests that longer contracting experience, represented by the duration of contracts, should make contracting firms more likely to contract with small-scale farmers. Consistent with expectation, the coefficient estimator for this covariate is -1.17, with p value less than 0.05. Since most farms were small at the beginning of contract production in China, contracting firms had few opportunities to contract with large farmers, even though they may have wanted to. As time moves on, they like to renew contracts with those old customers, in spite of their small scale, because they have built up the trust with them. Such trust is very important, since it helps to reduce breaches of contract and, therefore, improves contract enforcement. Contract enforcement is a serious issue in China, since small farmers can easily breach their contracts without any economic loss or legal penalty. Guo, Jolly and Zhu (2007) found that contract violation is strongly associated with the farm size. Therefore, the contracting firm is more likely to have become the non-exclusionary type if the contracting duration is longer.

Third, the test results indicate that linear pricing has been utilized to exclude small farmers from contract farming. The point estimate of the pricing dummy variable is -0.98, with p value 0.02. The negative sign with a small p-value implies that linear pricing would significantly reduce the probability of being a non-exclusionary firm. In other words, the non-exclusionary type of contracting firm is more likely to use differentiating pricing strategy. This result suggests pricing strategy can be a potential mechanism for exclusion.

The evidence from China has supported the proposition drawn from the contract model, that the common pricing strategy will result in contract exclusion. If contract offers cannot meet small farmers' minimum utility reservations, small farmers will decide not to contract, but large farmers will still agree to contract and procure the contracting benefits because of their lower transaction costs and higher productivity. Given the current situation in China, government policy has not been effective in reducing contract exclusion, as found in the test of Hypothesis 1. Differentiating pricing strategy, however, could be used to increase small farms involvement into the contract production by providing more flexible pricing terms.

Finally, the empirical result suggests that government support provided to the contracting firm does not significantly influence the probability of its being a non-exclusionary type of contracting firm, but its negative sign shows that the support does help to increase the participation rate of small farmers. This finding is consistent with our expectation, but the insignificant performance of the estimate might be due to the limitations of the sample. Our sample is restricted to one area of China, and the sample size is also very limited.

5. Conclusions and Policy Implications

With the most small-scale farms in the world, China's government struggles to improve farm income and to promote rural development. Historical trends suggest that small farms will continue to dominate the agricultural landscape for at least the next two to three decades. In the longer run, the process of economic development will increase per capita income, diversify economic opportunities, and allow agricultural workers to leave farming in order to pursue employment opportunities in other sectors of the economy. The contract farming program is one of the current rural development programs that the Chinese government is strongly encouraging. Thousands of dragon-head agribusiness firms have been designated as the source to provide the contracts. As seen in other developing countries, contract farming has the potential to improve the welfare of smallholders. However, smaller farmers can be excluded from contracts because agribusiness firms find it advantageous to award contracts to large, better-off farmers. The main goal of our paper is to examine whether or not exclusion appears to exist in China's contract farming program, and if so how firms use contracts to carry out the exclusion.

Table 1 Sample Mean and Standard Error

	Offered/Accepted	Offered/Rejected	Not Offered
I. Farmer Attributes			
Age	46.01(0.95)	46.26(0.88)	46.24(0.84)
Education	2.38(0.09)	2.19(0.16)	2.14(0.18)
II. Operation Scale			
Size	1.21(0.19)	0.41(0.08)	0.40(0.09)
Income	0.44(0.07)	0.21(0.09)	0.19(0.07)
III. External Market			
Distance	0.41(0.07)	0.38(0.06)	0.37(0.04)
Support	0.74(0.07)	0.37(0.05)	0.31(0.06)
Sample Size	220	390	425

a. All data are from a 2004 survey of rural farmers in 13 provinces of China, totaling 1035 observations.
b. The number in parenthesis is the standard error.
c. Education represents levels of farmer's education, with 1 for no education, 2 for elementary level, 3 for middle school level and 4 for higher level.
d. Size is in hectares.
e. Income is based on multiples of 10,000 Yuan, the Chinese monetary unit, where one us dollar is about 7.5 Yuan.
f. Distance is a dummy variable, with 0 for a local market and 1 for a distant market. Support is also a dummy variable, with 1 representing the presence of a government support policy for contract farming programs.

Table 2 Contract Decision Multinomial Logit Regression Results

Category	Variable	Coeff.	Std. Err.	z	P>|z|
1					
Offered/Rejected	Age	0.003	0.007	0.400	0.692
vs	Education	-0.240	0.074	-3.250	0.001
Not Offered	Income	-0.017	0.000	-1.170	0.244
	Size	0.014	0.006	2.470	0.014
	Distance	-0.409	0.154	-2.660	0.008
	Support	0.217	0.152	1.430	0.154
	Constant	0.597	0.401	1.490	0.136
2					
Offered/Accepted	Age	-0.016	0.009	-1.740	0.082
vs	Education	-0.191	0.090	-2.130	0.033
Not Offered	Income	0.012	0.000	2.760	0.007
	Size	0.023	0.001	3.410	0.001
	Distance	-0.405	0.181	-2.240	0.025
	Support	0.971	0.184	5.260	0.000
	Constant	0.120	0.486	0.250	0.805

Table 3 Hausman Tests of IIA Assumption

Category	Chi2	df	P>Chi2	evidence
1	1.354	6	0.969	for H0
2	1.555	6	0.982	for H0

Notes H0: Odds(Outcome-J vs Outcome-1) are independent of other alternatives

Table 4. Variables for Firm-level Data

Variable	Definition	Mean
Dependent	*y* is a dummy variable, defined as the type of firm contractors, where 0 stands for small-scale farmer contractor and 1 for large-scale farmer contractor.	0.73
Independent	*TaxRate* is defined as the ratio of the firm's income tax to the total profit from the last year	0.28
	Duration is defined as the number of years the firm has exercised contracts to collect the goods from farmers	2.73
	Fluc is defined as the absolute percent change in the market price of the materials collected from farmers in the past three years	0.08
	Pricing is a dummy variable, defined as pricing strategy implemented by the contracting firm, where 0 stands for a linear pricing strategy and	0.33
	1 for differentiating pricing strategy	0.32
	Gov. is a dummy variable defined as whether the contracting firm	

Table 5. Exclusion and Pricing Strategy

	Constant	TaxRate	Duration	Fluc.	Pricing	Gov.
Coeff.	4.39	0.07	-1.17	-2.44	-0.98	-0.05
p-values	0.01	0.05	0.03	0.49	0.02	0.89

a. The second row for each covariate is the coefficient estimate.
b. The third row is the p-value for each estimate.
c. The response variable is the contracting firm exclusion type dummy variable.

The paper has developed an applied principle-agent model with hidden information and other driving factors included, to show that the pricing mechanism written into the contract could eventually exclude small-scale farmers from contract production programs. This exclusion mechanism has been ignored by the literature, probably due to the difficulty in modeling it into the contract farming practice. Most of the previous research analysis tried to provide a reasonable explanation of contract exclusion based on transaction cost theory and the analysis of specific case studies. Their conclusions rely on simple descriptive analysis, rather than identifying and developing a specific exclusion mechanism through which smallholders are actually bypassed.

In our paper two types of pricing mechanisms, linear pricing and differentiating pricing have been studied in terms of whether they could potentially cause contract exclusion within a principle-agent model framework. As shown in the conceptual model, linear pricing makes firms more likely to contract with large-scale farmers. In other words, contracting firms using linear pricing are more likely to exclude small farmers. Differentiating pricing, also called the second best pricing strategy, could reduce exclusion by encouraging more small-scale farmers to become involved in contract production. Using this pricing mechanism would encourage small farmers to accept a contract with a firm. Ideally, the entire farming population could be involved in the contract farming program. The model also suggests that social welfare will be improved by adopting the second best pricing strategy. Our policy recommendation is that government should encourage more firms to implement a differentiating pricing strategy by establishing contract pricing regulations and redesigning its grant distribution requirements. In order to reduce contract exclusion, government should allot its tax credits and financial support based on the transaction pricing terms written in the contract.

Finally, two hypotheses have been formalized and examined empirically, using contract farming data from China. Two levels of data, farm-level and firm-level, were collected through separate surveys conducted in rural China. Our results, using farm-level data show that farm size has a positive influence, with a strong statistical significance, on the probability of being involved in the contract production program. In other words, we do find that the contract exclusion is occurring in China. The second hypothesis focuses on whether or not a linear pricing mechanism embedded in the contract model has been used for contract exclusion in rural China. We find evidence supporting the role of linear pricing in increasing the contracting firm's probability of being an exclusionary type firm, consistent with contract theory.

The fundamental goal of China's contract farming program is to distribute more benefits to small farmers. From the results of the conceptual model and empirical hypothesis testing for China, we are able to prepare evidence-based policy advice concerning the exclusion of small farms from the contract program. Our primary recommendation is thereby that the government should promote the occurrence of the second best outcome, implementing more practicable policies. Standard contracts with two types of pricing offers should be a requirement in order to receive government tax credits and financial support.

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CHAPTER 5. GENERAL CONCLUSIONS

This dissertation has focused on studying the general contract farming progress made in China, evaluating the income effect of contract farming program, and investigating the potential mechanism used to implement the exclusion. Three parts of papers develop a variety of theoretical models and statistical methods to study these key issues. Part I paper examines the extent and performance of contract farming from the perspectives of Chinese farm households and contracting agricultural firms. Part II is an applied empirical paper, in that it is attempting to test whether or not the contract farming production has improved the rural farmer's income. Part III paper investigates the contract exclusion problem within a contract model framework and empirically tests whether or not the common pricing has resulted in contract exclusion. The whole dissertation is structured in a way that those significant issues have been addressed from both the theoretical and empirical perspectives.

A number of material results and conclusions have been drawn from three papers. First, the farm-level survey indicates that the actual proportion of farms engaged in contract farming is relatively low and significantly less than the proportion of farm households willing to produce under contract. A lack of contract opportunities is the most frequently cited reason, particularly for smaller farms. Farmers identify price stability and market access as the key advantages to contracts, while firms consider improved product quality as the critical incentive for contract use. Public policies that encourage the adjustment of the agricultural structure so as to improve farmers' options for specialization and commercialization should be made right now. Second, we cannot find evidence from estimates in the sample selection treatment effect model that contract production tends to bring higher income to growers than independent production. Even worse, contract participation in each sample becomes harmful to rural growers in terms of income welfare. Both Heckman's two-step procedure and MLE confirm the significant positive estimates of the correlation coefficient, which leads to the overestimation of income effects in the simple regression model without removing any selection bias. However, propensity score matching estimates do suggest the presence of the income improvement gained from the contract-farming program. As the homogeneous producers are concerned, the smaller income effects with reduced significance are found to be averagely 750Yuan in Sample 4. This result is closer to that in the treatment effect model; in the sense we cannot find the strong evidence for the income effect. Finally, in the mechanism design the common pricing is able to motivate the contracting firms to exercise the contracts more likely with the large size rich farmers, whereas the differentiating pricing could reduce the exclusion by encouraging more small-scale farmers involved in the contract program. The hypothesis test does find that the common pricing has significantly increased the contracting firm's probability of being an exclusionary type of firm, which is consistent with what we have found from the contract model. Therefore, our policy implication is that the government should encourage more firms to implement the differentiating pricing strategy by establishing some contract pricing regulations and redesigning its grant distribution mechanism.

APPENDEX A: PROFILES OF FIRM AND FARM HOUSEHOLDS

Zhongsu Limited is a provincial dragon-head food processing firm headquartered in the city of Lanxi in Zhejiang Province. Its products and brand name, are well known throughout coastal China. The company was founded as a village enterprise in Dongyang county in 1983 by a farmer named Zhongshu. Originally, it processed pork – ham for the local rural market. As the firm grew, it introduced new product lines and expanded into urban markets. One of the newer products is salt radish.

Salt radish is processed from water radish. Prior to 2000, Zhongsu purchased water radish from middlemen who assembled supplies from hundreds of small farms. The supply of water radish and its quality fluctuated wildly from year to year. In order to serve an increasingly quality conscious consumer and to stabilize production levels, Zhongsu decided to try contracting directly with farmers. However, because water radish is produced on many small farms, the company found the cost of locating producers and monitoring production to be excessive. Zhongsu contacted the local government of Yongchang town, a water radish growing area and asked it to serve as an intermediary between the farmers and the company. There are no farmer cooperatives or bargaining associations in this area, so the local government decided to serve as Zhongsu's agent.

Under the contract (see Appendix A) Yongchang town locates farmers, supervises planting methods and delivers the output from 200 ha. to the processing plant. In return Zhongsu offers participating farmers a 3 percent premium over the local water radish price. Zhongsu has had a generally favorable experience contracting water radish and has expanded its contracting activities to other crops and regions.

Huang Yougeng farms in Yongchang town with his wife and 17 year old son – a student in the local high school. His wife works full time in a local textile factory. Farming is Huang Yougeng's primary occupation although he does some temporary work in town. The farm is 0.16 ha. Before 1995 he grew rice. However, high prices for water radish lead him to shift his production from rice to water radish in 1996. As a small farmer, he sold his water radish crop to a local middleman and accepted the vagaries of a very volatile market and, in his view, a good deal of exploitation by the middlemen when supplies were ample. Moreover if the wholesale market for water radish was weak, middlemen might not come to his village at all. Huang Yougeng heard about Zhongsu's contracting activities in 2002. He knew nothing about the company or contracting. But he did feel comfortable entering into a contract with the local government. Although the contract does not offer risk protection, having market access and a premium over the local paying price provided a sufficient incentive for Huang Yougeng to continue with his contract since 2002.

APPENDIX B: AGREEMENT ON PLANITING WATER RADISH

Contractor: Zhongsu Limited Company, City of Lanxi

Contractee: The Government of Yongchang Town

In order to bring along and encourage farmers to develop contract farming and optimize agricultural structure, thus to ensure that farmers receive the substantial economic benefits, both contractor and contractee, through friendly consultation, have reached the following agreement on the water radish planting acreage of the farmers and the purchase of the yields:

1. Contractor will entrust contractee with the responsibility for planting techniques and acreage in some villages. Contractee will provide the farm households and the planting acreage which should be over 3,000 mu.
2. Contractee should be in charge of examining and supervising the farmers and to market to the contractor the entire planted water radish crop.
3. The quality standard of the water radish sold by the farmers should meet the demands determined by contractor.
4. Contractor offers a favorable price for the delivered goods: higher by three percent than the local market price at delivery time.
5. On the expiration of the contract, contractor takes priority of renewing it if desired.
6. This agreement will be valid for two years.
7. This agreement becomes effective on the date of signing.

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