Do Product Attributes affect Farmer's Contract Farming Participation? Evidence from Vegetable Production in China

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Abstract:

The rise of contract farming is one of the most important changes in modern agriculture. Yet the adoption of these new forms of organization has varied widely across commodities. Vegetable, with more rich varieties compared with other agricultural sections, as the representative of high value agricultural products plays an important role in the development of agricultural economics and the improvement of farmers' income. With the rapid emergence of contract farming in recent decades, China is leading the developing world in vegetable production. By using household survey data, this study aimed to explore the linkage between production attributes of different vegetables and farmers' decision of contract farming participation, as well as examine the impact of marketing contracts on net returns. The results revealed that the harvest and marketing times, perishability, certification of the vegetables, and price fluctuation have significantly positive effect on vegetable farmers' contract farming participation, respectively. A propensity score matching (PSM) method is employed to estimate the impact of contract farming on net returns of vegetable production, and find out the effect is insignificant.

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Abstract: The rise of contract farming is one of the most important changes in modern agriculture. Yet the adoption of these new forms of organization has varied widely across commodities. Vegetable, with more rich varieties compared with other agricultural sections, as the representative of high value agricultural products plays an important role in the development of agricultural economics and the improvement of farmers' income. With the rapid emergence of contract farming in recent decades, China is leading the developing world in vegetable production. By using household survey data, this study aimed to explore the linkage between production attributes of different vegetables and farmers' decision of contract farming participation, as well as examine the impact of marketing contracts on net returns. The results revealed that the harvest and marketing times, perishability, certification of the vegetables, and price fluctuation have significantly positive effect on vegetable farmers' contract farming participation, respectively. A propensity score matching (PSM) method is employed to estimate the impact of contract farming on net returns of vegetable production, and find out the effect is insignificant.

Key words: contract farming, vegetable production, transaction cost, China

Contract farming has a checkered history throughout the world. It has long been established in developed countries and becomes more popular in developing countries during recent decades, motivated by the belief that contract farming is an important aspect of agriculture institutions that may spurs transition to modern agriculture. At its best, contract farming can provide a

means to manage complex production processes with greater precision than is possible through arm's length market transactions (MacDonald et al., 2004). This can result in higher quality with safer food and at the same time reduce risk and transaction cost. For developing countries, contract farming can overcome imperfections in input and output markets or institutional deficiencies – providing credit, seeds, machinery services, human capital and market access to farmers (Katchova and Miranda, 2004).

However, contract farming has another side – one that can lead to economic serfdom for farmers and a food system that meets the economic objectives of power elites. In developed countries, farmers are concerned about losing their independence and important business decision skills (Schulze et al., 2006). For developing countries, there are also concerns associated with contract farming, including increased instability for nonparticipants in community, disruption of power relations in traditional household culture, overreliance on cash crops that may leave households more vulnerable to food shortages and exploitation from large firms (Key and Runsten, 1999). Under the transitional agriculture background, the changing institutional environment continues to make the contract breach inevitable among the market agents. In China, for instance, the agricultural market is suffering from lower rate of contract enforcement (Guo and Jolly, 2008).

Since 1990, contract farming has expanded rapidly in China. Most of the contracting organizations are food processors. However farmer-owned cooperatives also engage in contracting. During the same period, the number of farmers involved in some form of agricultural coordination -- contracts, vertical integration or alliances increased a lot. These happened in all sections of agriculture and there is no exception for vegetable production. As

a large sector of agricultural production, vegetable commodities mostly are perishable, high valued and need timely processing. However, compared with other sectors such as dairy, livestock and poultry, which are generally has only one or a few categories, there are many varieties of vegetables with different product attributes. The differences between these varieties can be no less than some commodities among different sectors, such as greenhouse vegetables and common open-air vegetables.

Under the transitional agriculture background, vegetable as the representative of high value agricultural products plays an important role on the development of agricultural economics and the improvement of the income of the farmers. Therefore, that whether the contract farming suits all kinds of vegetable production is still a meaningful question to be discussed. Do product attributes of different vegetables effect on the decision of farmers to participant in contract farming? Does contract farming improve the income of vegetable farmers of all the different categories or just some of them?

This paper is organized as follows: The literature on contract participation and impact on farmer welfare is reviewed in the Literature Review. In Contract Framework, we develop a simple model for contract farming participation and its impact on farm net returns. In Data and Descriptive Analysis, we describe the survey and data. In Econometric Analysis, we empirically estimate whether the product attributes of vegetables influence the participation of the contract farming, and the income improvement of the contract farming of different categories vegetable, and provide the results. Conclusions are listed in the last Section.

Literature Review

Compared with traditional marketing, contract farming refers to “agricultural production

carried out according to an agreement between a buyer and farmers, which establishes conditions for the production and marketing of a farm product or products" (FAO, 2013). Typically, the farmer agrees to provide certain quantities of a specific commodity at the specified quality standards and time, and the buyer commits to a specified pricing scheme. The buyer may also supply some inputs or technical support to the farmer (Wang et al., 2014).

There is a rich empirical literature investigating the participation incentives and the impact on farms. The researches for the former have examined farmer's binary choice between participating in advanced agro-food supply chains through the contractual arrangements and selling at the spot market with probit or logit regression (Guo, 2005; Masakure and Henson, 2005; Zhu and Wang, 2007). At the same time, many literatures estimate the probability that a farmer will choose to contract as the first step in a two-step econometric procedure focusing primarily on the impact of contract farming on farmer welfare (Bellemare, 2012; Ito et al., 2012; Katchova and Miranda, 2004; Miyata et al., 2009; Simmons et al,. 2005; Wang et al., 2011).

According to the previous research, the facts that influence the participation of the contract farming can be divided into three parts: demographic factors (age, sex, and education), operational factors (farm size and assets, farmer experience, specialization, risk preference, and credit constraints), market factors (price fluctuation, the distance to market), and environment factors (promoting policy, and local economic and social development level). Unfortunately, these existing analyses on most factors above are failed to be a consensus as to both the sign and significance of each other. For example, education is often included in empirical studies. There are some studies that find it significantly positive (Arumugam et al.,

2011; Hu, 2012), negative (Miyata et al., 2009), or insignificant (Bellemare, 2012; Ito et al., 2012; Wang et al., 2011). Such differences in the relationship between these factors and contract participation can be explained in two possible aspects. One is that the differences arise because of statistical or modeling differences. Another possibility is that institutional differences across countries and across commodities within counties may lead to heterogeneity (Wang, 2014). Such as Katchova and Miranda (2004) and Simmons et al. (2005) found out that the significance of factors on contract participation is depend on commodity.

The impact of the contract farming on farmer welfare has also attracted considerable attention of attention of empirical research. The improvement of farmer welfare is mainly reflected on and measured by farmer income. A large number of studies report a positive income effect from contract farming. These studies document that the increase in farmer income from contract farming may come from several sources, including access to higher-valued commodities, high-end market (Bijman, 2008; Masakure and Henson, 2005; Simmons et al., 2005), better technology and inputs which upgrades their productivity (Miyata et al., 2009), and other supports such as loans and insurance (Bijman, 2008; Michelson, 2013; Zhu and Wang, 2007).

But for those developed countries and areas where the market is more developed, the income effect may not be that significant. For example, in developed countries, the price set-up in contract is often based on market price, so there should be no expected price advantages, and the welfare gains from contract farming may instead come from risk reduction and transaction cost saving (Hennessy, 1996; Key, 2013; Martin, 1997). Wang et al. (2011) found that in China, where there exists an open market, the contracted farmers do not

necessarily have higher profits than non-contracted farmers. Ito et al. (2012) found the income effect of participating in contract farming is effective only for small farms in China.

Same as the influence of factors on contract farming participation, the impact of the contract farming is different between commodities as well. Hu (2012) found that in United States, there are improved returns to corn and soybean farmers, but to wheat farmers, the effect is insignificant. Wang et al. (2011) found that in China, the observed income effect can also be heterogeneous, not uniformly positive, among different commodities. Albeit the literature mentioned above has considered heterogeneity of commodities among the research on participation and the impact of contract farming, the influence of the product attributes lack further discussion in these studies.

Fortunately, some studies using transaction cost approach analyze the product attributes influence. The transaction cost caused by transformation of the agro-food market exchange, can be reduced by entering into a contractual arrangement, although contracting will encounter other types of costs, namely ex ante contracting cost, including drafting, negotiating, and safeguarding agreements, and ex post costs, such as the cost of enforcing the contract (Jia and Huang, 2011). The transaction cost can be measured by transaction assets specificity, transaction frequency uncertainty of transaction (Williamson, 1989). As different commodities have their own attributes, the transaction attributes can be variety as well and will influence the transaction cost through the three aspects mentioned above, and further affected the contract participation and the farmer welfare. Allen and Lueck (1998) formalized a set of variables that affect the transaction costs of farm organization in the agrarian economy, including vertical contracts in the agro-food market. Martinez (2002) found that the

emergence of new, specialized large-scale production technology affected the transaction complexity of marketing exchange in poultry, egg and pork industries. Those that are more perishable and need timely processing like vegetables, tea, and milk, and those that need deeper processing before consuming at home like livestock and poultry, are more likely to be included in contract farming than grains (Hobbs and Young, 1999). Commodities with longer production cycle or requiring more asset-specific production also tend to use contracts (Guo, 2008).

The previous studies therefore contribute to the debate on the heterogeneity of agricultural commodities on contract arrangement and income effect of contract farming. However, to the best of our knowledge, most of the studies generally compared differences among several sectors, such as pork, poultry, diary, grain. Those literatures which considered vegetable section mainly see vegetable as a whole section, and choose one of the vegetable, like cabbage, as a representative. Albeit as a large sector of agricultural production, vegetable commodities mostly are perishable, high valued and need timely processing. However, the differences between different vegetable categories can be no less than some commodities among different sectors, such as greenhouse vegetables and common open-air vegetables. The influence of variety of the vegetables on contract farming participation and the income effect of contract farming among variety of vegetable need further discussion.

Conceptual Framework

The framework employed here is based on the assumption that farmers choose between mutually exclusive contract participation options: in or not. For analytical convenience, it is assumed that farmers are risk neutral and normally consider the net returns from the contract

participation in their decision making process. In the present setting, we refer to the net benefits as net returns from vegetable production, derive under transaction cost. The transaction cost (T) increase the real price of unit inputs (P_i) and decrease the real price of output (P_q) (Key et al., 2000; Iliopoulos, 2013). Therefore, the adjusted input price per unit is $P_i' = P_i + T_i$, while the adjusted output price per unit is $P_q' = P_q + T_q$, for T_i and T_q respectively represent the transaction cost per unit of input (I) and output (Q). Furthermore, let T_f denote the fixed transaction cost for the contract participation. Under these assumptions, the maximum of the net returns of farmer vegetable production is:

$$Max\,\pi = Q\left(P_q + T_q\right) - I(P_i + T_i) - T_f \tag{1}$$

From Equation (1), it is obvious that the net returns from vegetable production are determined by the output and input price per unit, transaction cost for unit input, output and fixed transaction cost of contract participation, and household and farm-level characteristics (Z). Then the net returns of vegetable production can be expressed as

$$\pi = \pi(P, T;\, Z) \tag{2}$$

In which P denotes P_q and P_i, and T includes T_q, T_i and T_f.

Let π_M^* denotes the potential net returns derived from vegetable production from participating contract farming, and π_N^* denotes the expected net returns derived from not participating. Define the difference between the expected net returns from participating a contract and not as $\pi_d^* = \pi_M^* - \pi_N^*$. Then the choice of famer i to participate contract farming or not (C_i) is depended on π_d^*:

$$C_i = \begin{cases} 0, & \pi_d^* \le 0 \\ 1, & \pi_d^* > 0 \end{cases} \tag{3}$$

According to Equation (2),

$$C = C(P, T;\ Z) \tag{4}$$

Follow the framework of Williamson (1989), the transaction cost can be measured by three dimensions: transaction assets specificity, transaction frequency, and uncertainty of transaction. We specify the empirical model of contractual participation transaction cost as a collection of parameters,

$$T = T(H, \delta, \theta, A, V, N;\ Z) \tag{5}$$

In Equation (5), H is the frequency of harvest, δ measures the perishability, θ explains the certification of the vegetable products, A is the asset specificity of the vegetable products, and V measures the price fluctuations. Besides these, the model specifies additional factors that affect transaction cost: the variety of the vegetable products, measured by parameter N. And vector Z denotes other controlling variables.

Predictions

1. Where the frequency of market is high, farmer may participate in contract farming.

The parameter H explains the frequency of harvesting and marketing. Some vegetable products have longer life cycle, and market occurs only limited times per harvest, such as melon and green Chinese onion. Greenhouse vegetables, however, have several harvests per cycle. When similar transaction occurs frequently over a long period of time involving some of the same parties, the one who interacts repeatedly may find it valuable to design and introduce low-cost routines to manage the transactions (Bijman, 2002). Therefore, in order to reduce the transaction cost among repeated games, farmers may prefer to participate in contract farming.

2. Where the products are perishable, contract will be adopted by farmer.

The parameter δ measures the perishability of vegetable productions. Timeliness is an important asset specificity, and Masten et al. (1991) expanded the notion to ‘‘temporal specificity’’. When the optimal dates within which the quality will not change is small, timely marketing is crucial and contracts will be used. Via contract farming, farmers can reduce the uncertainty of the market, and the sale of the products can be guaranteed. At the same time, where timely performance is critical, an opportunistic delay becomes a potentially effective strategy to seek a larger share of the gains. Contract farming offers a likely solution to reduce the losses associated with untimely shipment.

3. When participating in a contract can help the farmer get his/her product certified, he/she may prefer to join in.

The parameter θ explains the certification of farmers' products. In Williamson's transaction cost theory, reputation is one of the dimensions of asset specificity and certification is a type of reputation specificity. If farmers what to get access to higher-end market, to get a certification assuring quality in most of the time is the first step. However, it is very difficult for an individual to get the certification from the government. Via contract farming, farmers may get some support from the firm or cooperative to reach the standard.

4. Where the asset specificity of the vegetable is high, farmer may prefer to participate in contract farming.

The parameter A measures the asset specificity of the vegetable products. As for different categories of vegetable, the asset specificity can be different, such as greenhouse vegetables require extra facilities compared with the vegetables grow in the common open-air. In order to reduce the transaction cost caused by asset specificity, farmers may be willing to participate in

contract farming. Moreover, the contractors may also provide support of the equipment, facilities, and even other financial support.

5. Where the price fluctuation of the vegetable product is higher, farmer may prefer to participate in contract farming.

The parameter V explains the price fluctuations. As one of the most important part of the market risk, the price fluctuation is the problem that farmers mainly concern when they sell their product. By contact with a buyer with settle the contract arrangement about the price, the profit is predictable. Therefore, the market risk is reduced via contract farming. As the price fluctuation is varies among different vegetables, for example, the price volatility of tomato is larger than Chinese chive. Farmers whose vegetable products with larger price movement may prefer to participate in contract farming, in order to reduce the transaction cost.

6. The farmers cultivate more categories of vegetables, may prefer to participate in contract farming.

The variety of the vegetable products is measured by parameter N. As different kinds of vegetables require different facilities, equipment, technology and other inputs, the transaction cost may rise with the diversity of the vegetables, for the transaction can be more complicated and the moral hazard costs is higher. As through contract farming, the transaction cost can be reduced, farmers may choose to participate.

Data and Descriptive Analysis

The data used in this econometric analysis was obtained from a survey of 60 organizations (20 firms and 40 cooperatives) and 420 farmers in 2 provinces of China: Hebei and Zhejiang in July and August 2015. Hebei is one of the most important vegetable production provinces

in the north of China, near the capital, Beijing. Every year, Hebei Province provides a large quantity of facility vegetables for the north of China. Zhejiang province is a large province of high level of economic development. Near Shanghai, it not only has a large demand for vegetable, but also produces high value vegetables at the same time. Therefore, we picked these two provinces as the representative provinces of China vegetable production. A multistage random sampling procedure with purposive selection of counties based on the intensity of vegetable production and random selection of villages, firms, cooperatives and households was employed to select 60 organizations (20 firms and 40 cooperatives) and 420 farmers for the survey. The number of the effective questionnaire is 410, and the effective rate is 97.62%. The survey obtained information on personal and farm-level characteristics, asset ownership, financial situation, access to information, marketing activities, and most important, the detailed information of farmer vegetable production.

In the sample, there are 122 farmers, who used marketing contracts choose different types of contracts, including making contract with cooperatives, firms, middlemen and wholesale market. The percentage is not even reach 30%. Meanwhile, there are 288 farmers, who did not use contract and sold their productions, for example, in the spot market.

From Table 1, we can see that, most of the farmers, who participated in contract farming, contracted with cooperatives and firms, and proportion is 79.51%. About 27.87% of the farmers contracted with middlemen and wholesale market to sell their product. The contract arrangements of these contract types are mainly oral contract, and include only market contract arrangement, such as quantities and price.

Table 1. Contract Farming Participation: with Different Contracted Buyers

Contracted buyers	Cooperative	Firm	Middleman	Wholesale market	Total*
Number	54	43	27	7	122
Proportion (%)	44.26	35.25	22.13	5.74	100

Note: * For there are 9 farmers take 2 contract types at the same time, the total number is not equal the sum of numbers of four contract types, so is the proportion.

Table 2. The Definition of the Variables Used in the Analysis

Variables	Description	Mean	SD
Contract participation	1 if the farmer participate, 0 otherwise	0.297561	0.4577439
Net returns	Gross revenue from vegetable production minus variable input costs (yuan/1000/mu*)	5.364358	6.279483
Harvest	The number of harvest and marketing	2.853659	2.092728
Perishability	Days of the main vegetable can be preserved in normal conditions	26.31463	26.54739
Certification	3 = Organic Food, 2 = Green Food, 1= Safe Food, 0= none	0.4512195	0.8866359
Assets specificity	Total facility vegetable planting area (mu)	5.198415	16.96237
Price fluctuation	Price change level: 1=less than 10%, 2=10%~50%, 3=50%~100%, 4=100%~300, 5=larger than 300%	3.209756	1.254782
categories	Number of vegetable categories	2.531707	1.650434
Age	Age of the farmer (years)	48.9493	10.53898
Sex	1 = male, 0 = Female	0.7829268	0.4127565
Education	Number of years of schooling	2.71	0.8096303
Farm size	Total vegetable planting area (mu)	62.45202	182.6314
Farmer experience	Number of years producing vegetables	15.72439	10.84626
Specialization	The income of total vegetable production	68.73099	30.74787

	divided by the total household incomes (%)		
Risk preference	1~5, 1= risk prefer, 5=risk aversion	3.229268	1.174764
Credit constraints	Difficulty in obtaining loans, 1~5, 1 = very difficult, 5 = no difficulty	3.860976	1.322252
Distance to the market	Distance to markets (km)	13.06466	86.9005
Province	1 = Zhejiang province, 0 = Hebei province	0.5073171	0.5005573

Notes: * yuan is Chinese currency (1$ = 6.87yuan); 1 mu=1/15 hectare

Table 2 presents descriptive statistics for the survey households. For the key variables, we choose the number of harvest and marketing to measure the frequency of the transaction. The number of average times is nearly 3 times per year with rather small standard deviation, which means that most of the farmers harvest and market about in three periods per year. Days of the vegetable can be preserved in normal conditions is used to measure the perishability of the main vegetable of farmers' production and the difference between vegetables is very large. An ordered variable is used to measure the certification of the vegetables. As facility vegetables need extra facilities and use especial equipment, we use the total planting area of facility vegetables to measure the assets specificity. For the price fluctuation, we asked farmer about the price fluctuation range of the local market in recent years, and setting the percentage into ordered variable. And categories measured the variety of farmers' vegetable production.

For the controlling variables, it can be observed that the average age of vegetable farmer is 49, with the average number of producing vegetables, 16, shows that vegetable production needs more planting technique and experience. However, the low education level can make ti difficult for the technology spread. The average planting size of the vegetable production is

quite large, about 62.5 mu, however, the large standard error shows that the polarization is obvious. Vegetable production and marketing contribute 69% of total household income averagely, and the average net returns per mu is 4130 yuan. Two ordered variables are used to measure risk preference and credit constrains, respectively. On average, vegetable farmers are risk aversion and have some difficulties to obtain loans. Distance to the local markets is listed as well. As the economic development of Zhejiang province is better than Hebei province, we let the variable equate 1 if the farmer is in Zhejiang province and 0 otherwise.

Table 3. The Definition of the Variables Used in the Analysis

Variables	participation		Non-participation		t-test
	Mean	S.D.	Mean	S.D.	
Harvest	3.721311	2.808671	2.486111	1.568355	-5.6681***
Perishability	23.84426	25.69819	27.36111	26.87437	1.2271
Certification	.8032787	1.088173	.3020833	.7389576	-5.4108***
Assets specificity	5.990164	21.33808	4.863021	14.75427	-0.6147
Price fluctuation	3.852459	1.203797	2.9375	1.175942	-7.1521***
categories	2.795082	1.808787	2.420139	1.568598	-2.1119**
Age	49.38525	9.303378	48.75694	11.03068	-0.5514
Sex	.8196721	.3860457	.7673611	.4232494	-1.1738
Education	2.819672	.8432169	2.649306	.7910207	-1.9547*
Farm size	126.0697	269.1296	35.50288	120.6088	-4.7080***
Farmer experience	15.36066	10.56039	15.87847	10.97959	0.4415
Specialization	70.75881	29.40617	67.87198	31.30917	-0.8689
Risk preference	3.04918	1.15603	3.305556	1.176292	2.0279**
Credit constraints	4.008197	1.262923	3.798611	1.343872	-1.4694
Distance to the market	12.25246	52.99186	13.40872	97.86474	0.1230
Province	.7213115	.4502028	.4166667	.4938648	-5.8592***
Gross revenue	1148.223	3737.270	223.8322	682.7465	-4.0474***

Average Gross per mu	8.820798	7.454309	10.29785	7.175182	1.8836*
Average cost per mu	3.629778	2.464819	4.860065	6.42528	2.0508**
Average net returns per mu	5.1911021	6.639555	5.437786	6.13061	0.3634

Notes: *, **, *** Significant at 10%, 5%, and 1% levels, respectively.

The mean differences in the characteristics of contract farming participants and non-participants are presented in Table 3. Contract farming participants tend to be better educated than non-participants. They have larger farm size and are more risk-preference and the price fluctuation of the categories they produced are higher than non-participants'. In terms of the production attributes, contract farming participants harvest more frequently and get more certifications for their products. Meanwhile, contract farming participants grows more categories than non-participants.

Differences in gross, input costs and net returns between contract farming participants and non-participants are presented in the lower part of Table 3. As evident from the Table, vegetable production gross of the participants is significantly larger than the non-participants. However, the average gross revenue per mu of the participants is significantly lower than the the non-participants. Although participants spend less input cost per mu than non-participants, the average net returns per mu of the participants is a little lower than the non-participants, though the difference is insignificant.

Econometric Analysis

To analyze the impact of product attributes on contract farming participation, Choice C can be expressed as a function of observable elements in the following lateen variable model:

$$\pi_d^* = \beta \mathrm{T}_i + \mu_i, \quad C_i = 1 \; if \;\; \pi_d^* > 0 \tag{6}$$

where C_i is the binary indicator variable that equals 1 for household i, in case of

participation in contract farming and 0 otherwise; T_i is a vector of variables that measures the transaction attributes of different vegetable productions; β is a vector of parameters to be estimate; and μ_i is an error term assumed to be normally distributed with zero mean. The probability of participating in contract farming can be expressed as:

$$P(C_i = 1) = P(\pi_d^* > 0) = P(\mu_i > -\beta T_i) = 1 - F(-\beta T_i) \quad (7)$$

where F is the cumulative distribution function for μ_i.

In order to estimate the impact of participation on farm net returns, we link the participation decision with the net returns. Considering that the net return is a linear function of explanatory variables X_i, we specify an outcome equation as:

$$Y_i = \alpha X_i + \gamma D_i + \varepsilon_i \quad (8)$$

where Y_i represents the net returns variable; X_i is a vector of explanatory variables, including household, farm-level and location characteristics; D_i is an indicator of contract farming participation. α and γ are parameters to be estimated, and ε_i is the random error term.

However, the decision of contract farming participation is not exogenously determined in the reality, which means farmers may self-select to participate, depending on their inherent characteristics, rather than being randomly selected. Therefore, the common ordinary least square (OLS) method may generate biased estimate. In order to address the issue of selection bias, we employed propensity score matching method (PSM) to analyze the impact of contract farming participation.

PSM method compares outcome (Y_i) between contract farming participants (treated) and those non-participants (controlled) that are similar in terms of observable characteristics, thus

reducing the bias that would otherwise occur when the two groups are systematically different (Dehejia and Wahba, 2002). The PSM method involves two stages. The first step is to generate propensity score (i.e. the probability) of participating contract farming using a probit model:

$$\mathrm{P}(X_i) = \mathrm{P}(C_i = 1|T, Z) = E(C_i|T, Z) \quad (9)$$

The second step is to calculate the average treatment effect on the treated (ATT) based on the estimated propensity score. The average treatment effect on the treated (ATT) can then be estimated as followed:

$$\mathrm{ATT} = \mathrm{E}(Y_1 - Y_0|C_i = 1) = E_{P(Z)|D=1}[E(Y_1|D = 1, \mathrm{P}(Z)) - E(Y_0|D = 1, \mathrm{P}(Z))] \quad (10)$$

There are several techniques have been developed to match the contract farming participants and non-participants of similar propensity score. We used four most commonly used techniques to estimate the ATT: k-nearest neighbor matching (KNM), radius matching (RM), nearest-neighbor matching within caliper (NNM) and kernel -based matching method (KBM).

Result

Table 4 shows the parameter estimates of the contract farming participation by Probit model. For the key variables of product attributes, five of these variables are significant. Marketing frequency, measured by the number of harvest and marketing, is positively correlated with contract farming participation. Compared with spot market trading, contract farming reduces transaction costs of gathering and exchanging information about demand, quality, timing and price, thus reduce the uncertainty and marker risks.

Table 4. Contract Farming Participation: Probit Model

variables	coefficients	Standard Error	z-value

Harvest	0.285	0.061	4.70***
Perishability	-0.005	0.003	-1.73*
certification	0.333	0.086	3.87***
Assets specificity	-0.003	0.004	-0.76
Price fluctuation	0.299	0.064	4.68***
categories	-0.305	0.073	-4.17***
Age	0.013	0.009	1.34
Sex	-0.175	0.191	-0.92
Education	0.235	0.105	2.23**
Farm size	0.001	0.001	2.13**
Farmer experience	-0.007	0.008	-0.86
Specialization	-0.001	0.003	-0.30
Risk preference	-0.120	0.071	-1.68*
Credit constraints	0.060	0.062	0.96
Distance to the market	-0.003	0.002	-1.42
Province	0.784	0.195	4.03***
Number of obs. = 410	Log likelihood = -180.18748		
LR chi2(16) = 138.83	Prob. > chi2 = 0.0000		Pseudo R2 = 0.2781

Notes: *, **, *** Significant at 10%, 5%, and 1% levels, respectively.

The perishability is verified significantly positive in the model. It needs to be noted that, the perishability is measured by the days of the vegetable can be preserved, therefore, although the sign in the table shows negative significant, in fact the perishability has significant impact on participation. If the vegetable can be preserved in normal conditions is longer, the risk of both market exchange and contract enforcement are low. Otherwise, if the vegetable is perishable, in order to reduce risk and transaction cost, farmers may take part in contract farming. This is consistent with the prediction 2.

Prediction 3 is also found significantly positive at 1% level. The certification of the vegetable

has significant positive effect on contract farming participation. Those farmers who want to get access to higher-end market need certifications and contract with cooperatives and firms can help them improve the quality of both input and output, thus reduce the transaction cost.

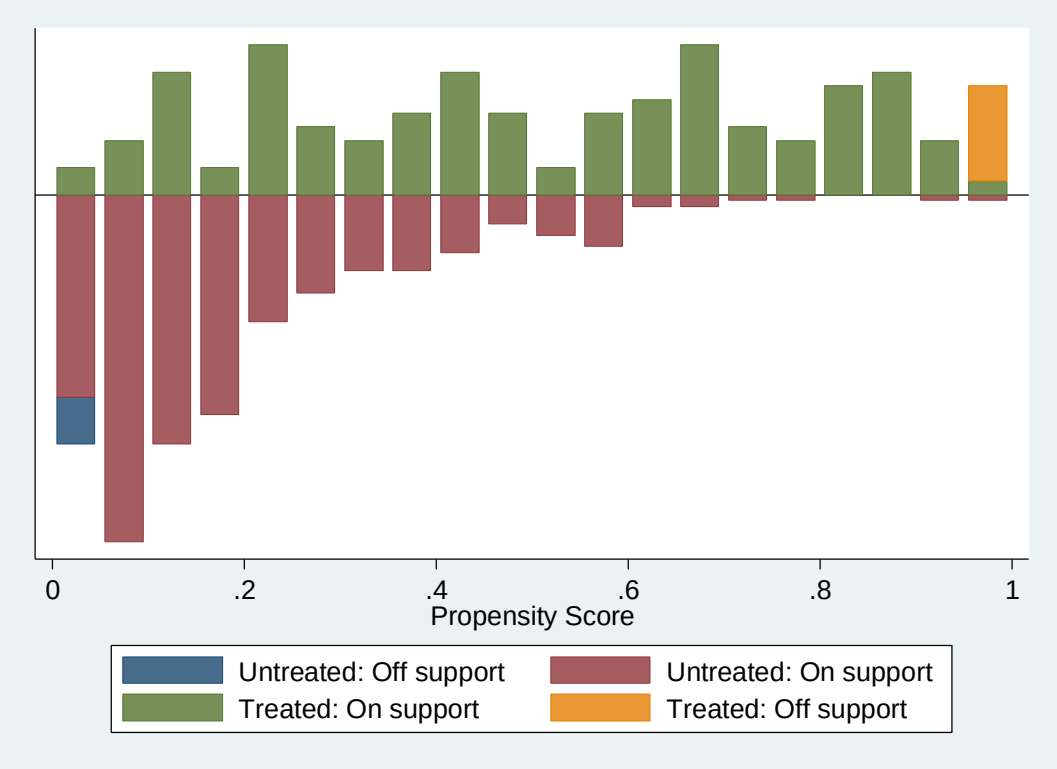
Contrary to Prediction 3, Assets specificity is not verified by the model. The effect of the total facility vegetable planting area on contract farming participation is not significant, which means that farmers grow facility vegetables do not significantly want to take part in contract farming. These might because facilities vegetable are often rather high-value and are easy to sell in the local market, thus there is no incentive for farmers to participate.

Price fluctuation is significantly positive, which means that the prediction 5 is verified in the model. Vegetables with rather large movement of it price in local market have larger market risk during exchange. By join the contract farming, farmer can raise the price stability of their production, and at the same time, reduce the transaction cost of gathering the market information.

The number of the categories of farmers' vegetable production has a significant negative effect on contract participation. This is adverse with our last prediction. A possible explanation is that contracted buyers always ask the farmers to focus on one or two vegetables with high quality and a certain quantity. Therefore, most of the participants grow less categories than the non-participants in order to get focus and reach the quality level and the quantity set by the contract arrangement.

Other attributes are also significant in the model, including education, farm size, risk preference and province. It is worth noting that the risk preference is significantly negative, which is adverse with the common belief that risk- aversion farmers may be willing to

participate in contract farming to reduce market risk. One of the possible explanations is that, under the transitional economic background, the rights sometimes cannot be fully protected, which makes risk-averse farmers wary of contracting. Another explanation is that most of the contracts farming participants are farmers with large cultivating area, this kind of farmers consider more about profit, and are often not risk-aversion.



Picture 1. Propensity Score Matching

Picture 1 and Table 5 show the propensity score matching and the estimate result of ATT by PSM estimation. The results of four methods all show that the impact of contract farming on farmers' net returns is not significant. It means that, the net return of farmers who participate in contract farming is not significant higher than non-participants. The contract farming is not significantly increase farmers' income.

Table 5. The Impact of Contract Farming Participation on Net returns: PSM estimation

Matching Algorithm	ATT	t-statistics	p-value

k-nearest Neighbor Matching (k = 4)	0.047	0.04	0.962
Radius Matching (caliper = 0.05)	-0.154	-0.13	0.859
Nearest-neighbor Matching within Caliper	0.098	0.08	0.919
Kernel Matching	-0.28	-0.22	0.741

Notes: ATT, average treatment effect on the treated.

Consider the contract arrangement of price, there is a possible explanation of the estimate result. As vegetables are mainly high-valued and perishable, the production of vegetables is often near city or a nearby local market, in order to transport and sell when they are still fresh. Therefore, the contracted price is often adopted the market price, thus the participants did not get price advantages compared with non-participants. Risk and transaction cost reduction are the more important reason for contracted farmers.

Conclusion

This study examined the impact of vegetable heterogeneity on farmers' decision of contract farming participation, and further examines the impact of contract farming on vegetable farmers' net returns, using data collected from vegetable producers in Hebei and Zhejiang Province during the July and August 2015 in China. A probit model is used to analyze the contract farming participation, and the PSM technique is employed to estimate the ATT of the impact of contract farming participation on farmers' net returns to address sample selection bias. The results revealed that the heterogeneity of vegetables has significant effect on farmers' decision of contract farming participation, mainly reflected in transactional frequency, assets specificity and uncertainty, driven by the incentive of risk and transaction cost reduction. More specifically, the harvest and marketing times, perishability, certification of the

vegetables, and price fluctuation have significantly positive effect, respectively. In terms of the impact of the contract farming participation on net returns, PSM model shows that the effect is not significant, which means the contract farming is not significantly increase farmers' income. This is possible because under the transitional economic background, the production of vegetables is often near city or a nearby local market for the transport and sale convenience considering the common attributes (high-valued and perishable) of the vegetable compared with other sections such as grain production. Thus, the contracted price is often adopted market price. Therefore, participants do not get direct price advantages compared with non-participants. This indicates that, risk and transaction cost reduction may be the more important reasons for vegetable farmers to participate contract farming.

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