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Effect of Contract Farming on the Farmers' Average Return

- The Case of the Grain Industry in the U.S.A.

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Effect of Contract Farming on the Farmers' Average Return - The Case of the Grain Industry in the U.S.A.

Abstract

In the literature, the effect of contract farming on the productivity efficiency or profitability is rarely studied, especially in the crop sector. In this paper, we use a farm-level dataset (Agriculture and Resource Management Survey) to examine the effect of contract farming on the farmers' average return for the corn, soybean and wheat producers. The results of the matching estimation show that without matching, the effect of contract farming on the average returns of the corn and soybean producers might be underestimated, and contract farming might have a negligible (statistically insignificant) effect on the average return of the wheat producer.

Keywords: contract farming; marketing contract; average return; grain industry;

JEL Classifications: Q10; Q13; L14

1. Introduction

Farmers have long used formal contracts for procuring inputs and selling their output. The increased reliance on contract farming happens not only in the U.S., but also in the EU and elsewhere. The percentages of the total value of the U.S. agricultural products covered by marketing contracts and production contracts are 28%, 36% and 38% in 1991, 2004 and 2008 respectively (Macdonald *et al.*, 2004; Macdonald and Korb, 2011). Nowadays, the use of agricultural contracts are ubiquitous, and they are used in livestock, fruits and vegetables, wine grapes, tobacco, and even for the exchange traded commodities such as corn.

From farmers' point of view, there are three main motivations to use contracts in the literature. First of all, risk management is one of the most important motivations for farmers to use contracts. The use of marketing contracts and production contracts help farmers to reduce price and/or production risks (Knoeber and Thurman, 1995; Macdonald *et al.* 2004; Zheng, Vukina and Shin, 2008). Second, other studies show that reducing transaction costs, such as search, measurement and monitoring costs, is also an important incentive for farmers to use contracts (Allen and Luke, 1993; Hobb, 1997; Fukunaga. and. Huffman, 2009). Third, the other studies focus on the effect of contract farming on the production efficiencies or the technology progress. Some positive relationship is found between contract farming and production efficiencies/technology improvement (Knoeber, 1989; Ahearn, Yee and Korb, 2005).

In the literature, there are only a few studies discussing the effect of contract farming on the production efficiencies or profitability. Key and Mcbride (2003) showed the use of production contracts in the hog industry help the diffusion of the new technologies and lead to the improvement of productivity. Morrison *et al.* (2004) found some small impact of contract farming on the productivity improvement in the broiler industry. However, those studies focused only on the livestock sector. There

are much less studies examining the effects of contract farming on the farmers' returns and profitability. It is mainly because of the data limitation. The performance measure of profitability and returns is very difficult to find empirically. The first difficulty is that the farm-level revenue and cost data are hard to get. The second difficulty comes from that most of the farmers in the U.S. are multi-enterprise producers, and it is hard to distinguish the effect of contract farming among enterprises. In this study, we are going to use a farm-level Agriculture and Resource Management Survey (ARMS) dataset, in which we can have farmers' socioeconomic characteristics, total production, total value of production and contractual prices.

By using these micro-level data, it makes it possible to analyze the effect of contract farming on the farmers' average return by enterprise, more specifically corn, soybean and wheat in the grain industry. The goal of this study is to compare the average returns between the farmers using the contracts and the farmers not using the contracts. The estimation difficulty is that those two groups of the farmers might not have the same characteristics such that the estimation results would be biased. As a result, it is natural to use the propensity score matching (PSM) estimation to reduce the biases. PSM is widely applied to estimate the treatment effects in many issues In this study, the treatment is the contract participation. We first estimate a logit model. The dependent variable is whether or not the farmer use contracts to market the enterprise, and the explanatory variables are all observable socioeconomic characteristics between contractual and non-contractual farms/farmers. Then, we use the estimation results from the logit model to calculate the propensity scores. Finally, the impact of contract farming on the farmers' average returns would be estimated.

The rest of the paper is arranged as following. Section 2 describes the data. Section 3 explain the model and empirical approach. Section 4 interprets the results and last section concludes.

2. Data

This study focuses on the grain industry in the U.S. Corn, soybean and wheat are our target commodities because of their popularity and the significance of contract farming. Since production contracts are usually used in the livestock sector and marketing contracts are wildly used in the crop sector (Macdonald *et al*., 2004), in this study, we define that a farm is involved in contract farming if the operator(s) use marketing contracts to sell their product. Marketing contracts are verbal or written agreements between a contractor and a grower to transfer the ownership of the commodity in question at some time in the future. A marketing contract sets a price (or a pricing mechanism) and on outlet before the commodity is ready to be transferred. Contracts often specify product quantities and the range of acceptable quality measures, and delivery schedules. Most Management decisions remain with growers because they retain the ownership of the animal or crops during the growing stage. Growers typically assume all production risk, whereas the pricing mechanism limits their exposure to price risk. The fundamental difference between marketing contracts and production contracts is that marketing contracts involve the transfer of ownership (buying and selling) between the two parties and the ownership of the commodity never changes. With respect to both ownership and control, in a continuum of various marketing arrangements, marketing contracts can be visualized as spanning the interval between spot/cash markets and production contracts.

Data used in this research is from the Agricultural Resource Survey Phase III, for 2004. This survey has been done by USDA's Economic Research Service (ERS) and National Agricultural Statistics Service (NASS) since 1975. ARMS Phase III data are collected at the farm level to obtain information about farm financial statements, production practices and farm operator's household characteristics. The Survey provides rich and detailed source of data on agricultural contracts. Farmers are asked

whether they use production or marketing contracts. They are also asked for the volume of production, receipts, and unit prices or fees for each commodity under contract.

The original dataset includes 20,579 observations. After the missing values and unreasonable negative values are excluded, the total number of observations is 16,771. Table 1 shows the summary statistics of the farm/farmer characteristics. Maximum and minimum are not reported because of the confidential problem. Among our observations, most of the main operators are male (over 95%) and most of the farms concentrate in Midwest and South (about 80%). The farm income is almost twice as much as the off-farm income on average, but the variance for the off-farm income is much less than it is for the farm income. We further screen the data for the analysis. Farmers might produce more than one of our target commodities at the same time. The average return of the commodity is calculated as the total value of the commodity reported divided by the total quantity produced. Table 2 shows the frequencies of farmers producing corn, soybean and wheat, and the percentage of the farm involved in contract farming by crops. The percentage of corn, soybean and wheat producers using marketing contracts are 28%, 22% and 13% respectively. This table shows the significant use of contracts on corn, soybean and wheat.

3. Model and Empirical Approach

The objective of this study is to examine the effect of contract farming on the farmer's the average return. More precisely, we would like to examine whether the use of marketing contracts have any impact on the average return of those farmers who use the cash/spot market only to sell their product. We do observe the average return of those farmers who use cash/spot market only, but we do not observe the average return of the same group of farmers who turn out adopting contract farming. If we

treat contract farming as a program farmers can choose to participate, it is natural to use the matching estimation to solve this problem.

Matching estimation is a wildly used method to compare the treatment effect of participating in some programs (Todd, 2008). Basically it compares the outcome of the program participants with the outcome of nonparticipants with similar observed characteristics. We first assume that there are two potential outcomes, Y_o and Y_1. Y_1 is the outcome of the person participating the program and Y_o is the outcome of the person not participating the program. A person can only either participate or not participate the program, and therefore there will be only one outcome observed. As a result, the treatment effect, $\Delta = Y_1 - Y_o$, is not directly observable. We then define the observed outcome, $Y = DY_1 + (1 - D)Y_0$, where D is a state variable. D = 1 if the person involves in the program, and else D = 0. The key interested parameter to be estimated, the mean impact of treatment on the treated (ATT) then could be written as

$$\Delta_{ATT} = E(Y_1 - Y_o | D = 1).$$

According to Rosenbaum and Rubin (1983), the procedure of the matching estimation can be separated into two steps. In the first step, we estimate a discrete choice logit model to calculate the Pr(D=1|Z), the so call propensity score. The dependent variable defined as 1 if the farm uses marketing contracts and 0 otherwise. The explanatory or the matching variables are the farm characteristics (total acres farmed, farm income, off-farm income, farm assets, location dummies) and the farmer characteristics (age, gender, education level and number of family members). In the second step, by using the estimation result from the logit model, the predicted probability of the farm using marketing contracts are used to match individuals with and without contract farming.

4. Results

Empirical results from the simple logit model are presented in Table 3 by commodities. Midwest is set to be the baseline region, and therefore the regional dummy for Midwest is not included. Because not all corn, soybean and wheat are produce in these five regions, region 1 is excluded in the corn model, and region 4 and 5 are excluded in the soybean model. Among the three commodities, age, education level and total acres farmed have consistent and significant effects on contract farming. Age has a negatively significant effect, which means the younger operator is more likely to use marketing contracts. Education level has a positively significant effect on contract farming, which means the operator with higher education level is more likely to use marketing contracts. Total acres farmed has a positively significant effect on contract farming, which means if the size of the farm is larger, it is more likely to use marketing contracts. Those results are also consistent with the literature (Lambert and Wilson, 2003; Katchova and Miranda, 2004; Macdonald *et al*., 2004). For the regional dummy, corn and soybean farmers in Midwest are more likely to use marketing contracts. For wheat producers, farmers in region 5 is more likely to use marketing contracts compared to the wheat farmers in Midwest, and location does not have significant effect on other 4 regions.

The main results of this study from the matching estimations are presented in Table 4. Results are by commodity. Unmatched samples show the different observable average returns for the group of farmers using marketing contracts and for the group of farmers using the cash/spot market only. From the unmatched samples, the average returns of the treated (contract farming) and control (cash/spot market only) are statistically different. The average returns of those farmers using marketing contracts are consistently higher than the average returns of those farmers using cash/spot market only for corn, soybean and wheat by 7.47%, 1.17% and 1.32% respectively. The results also show that the differences are statistically significant.

Next, we look at the mean impact of treatment on the treated (ATT). For corn, the difference of the average returns between the treated group and matched group increases from 7.47% to 8.37%; for soybean the difference increases from 1.17% to 1.22%. The differences for corn and soybean are still statistically significant. The results show that after controlling farm and farmer characteristics, the impact of contract farming on corn and soybean farmers' average returns could be even larger. If we simply compare the average returns between farmers using contracts and farmers using cash/spot market only, we might underestimate the impact of contract farming on the average return for corn and soybean. For wheat, the story is totally different. With matching, the difference of the average returns between the treated and controlled groups turns out to be statistically insignificant. It means that the impact of contract farming on the average return of the wheat farmers might be neglectable. If simply comparing the average returns between the wheat farmers using contracts and the wheat farmers using the cash/spot marketing only, we might have a misleading conclusion.

5. Conclusion

Contract farming is one of the most important signatures in the modern agriculture. It is proposed to help farmers reduce risks, save transaction costs, and improve production efficiency/profitability. There are a bunch of studies examining those advantages in the livestock sector. However, research in the crop sector is relatively lacking. Because of the data limitation, instead of examining the effect of contract farming on farmers' profitability, the objective of this study is to examine the effect of contract farming on the average returns of the corn, soybean and wheat farmers. Since in our dataset we only observe the average returns under one of the two possible states, farmers using contracts or farmers using the cash/spot market only, it

is nature to use the matching estimation examining the treatment effect (contract farming) on the farmers' average returns.

If we compare the average returns between the group of the farmers using contracts and the group of the farmers using the cash/spot market only, contract farming has positive and significant effects on the average returns of all the corn, soybean and wheat producers. The results of the matching estimation show that without matching, the effect of contract farming on the average returns of the corn and soybean producers might be underestimated, and contract farming might have a neglectable (statistically insignificant) effect on the average return of the wheat producer.

This study provides a different viewpoint of the contract farming from the return side but not the productivity side, and it focus on the crop sector. Productivity efficiencies do not imply profitability, and vice versa. The price or the average return plays an important role to determine the profitability of a farm, and this study shows some implication of the impact of contract farming on the average return. There is still some empirical difficulty to directly estimate the profitability effect of contract farming. This study might also give some inspiration for those issues about the effect of contract farming on the farmers' profitability.

Referece

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Table 1: Summary Statistics for the Dataset:

Variable	Description	Mean	Std Dev
age	operator's age	54.77	12.42
sex	operator's gender	0.95	0.22
education	Education level: 1-5*	2.79	1.05
nfamily	Number of family member	2.83	1.42
total acres	in thousand acres operated	1.13	4.03
income	farm income in 100 thousand dollar	0.78	7.00
offfarm	income in 100 thousand dollar	0.41	1.00
asset	In 100 thousand dollar	11.31	31.58
R1	dummy for North East	0.03	0.18
R2	dummy for Midwest	0.40	0.49
R3	dummy for South	0.37	0.48
R4	dummy for West	0.06	0.24
R5	dummy for Western Mountain	0.14	0.34

Notes: *: 1: less than high school; 2: high school; 3: college; 4: BA or BS; 5 graduate schoo0.46l.: Region 1: ME, NH, VT, MA, RI, CT, NY, PA, NJ; Region 2: WI, MI, IL, IN, OH, ND, SD, NE, KS, MN, IA, MO; Region 3: DE, MD, DC, VA, WV, NC, SC, GA, FL, KY TN, MS, AL, OK, TX, AK, LA; Region 4: ID, MO, WY, NV, UT, CO, AZ, NM; Region 5: AK, WA, OR, CA, HI.

Table 2: Marketing Arrangements frequencies by commodity

Commodity	Cash/Spot Market		Marketing Contracts		Total	
	frequency	%	frequency	%	frequency	%
Corn	3,060	71.76	1,204	28.24	4,264	100
Soybean	3,659	77.74	1,048	22.26	4,707	100
Wheat	2,671	86.60	413	13.40	3,084	100

Table 3: Logit Estimation Results for Corn, Soybean and Wheat

	Corn		Soybean		Wheat	
	Estimate	t-stat	Estimate	t-stat	Estimate	t-stat
age	-0.0243	-7.05	-0.0199	-5.7	-0.0126	-2.56
sex	0.0001	0.00	0.6190	1.59	0.6196	1.18
education	0.1883	4.96	0.1787	4.59	0.2089	3.65
nfamily	-0.0155	-0.61	-0.0397	-1.55	0.0316	0.84
total acres	0.2305	8.46	0.2589	9.02	0.0603	3.74
income	0.0270	2.26	-0.0003	-0.10	-0.0002	-0.29
offfarm	0.0612	1.12	-0.0027	-0.05	0.0535	0.70
asset	-0.0834	-0.52	-0.4250	-1.75	0.0067	0.05
R1	-	-	-1.3483	-2.23	-1.7986	-1.77
R3	-0.7270	-6.65	-0.3840	-4.09	-0.0691	-0.45
R4	-0.9656	-2.44	-	-	0.2168	1.49
R5	-0.4531	-1.05	-	-	0.3489	2.18
constant	-0.3733	-0.90	-1.4087	-3.03	-2.7154	-4.19
log likelyhood	-2407		-2400		-1182	
# of observation	4264		4707		3084	

Table 4: The Effect of Contract Farming on the Farmers' Average Returns

Commodity	sample	Contract farming	Cash Only	Difference	t-stat
Corn	unmatched	2.2620	2.1047	0.1573	9.24
	ATT	2.2620	2.0886	0.1735	9.93
Soybean	unmatched	6.5533	6.4776	0.0757	2.84
	ATT	6.5533	6.4745	0.0788	2.77
Wheat	unmatched	3.4547	3.4098	0.0450	2.71
	ATT	3.4547	3.4315	0.0232	1.41

Unit: $/bushel