**Factors influencing Chinese farmer demand for vegetable price insurance
in Beijing-Tianjin-Hebei region**

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Abstract

This study investigates whether vegetable price index insurance could be applied to the Beijing-Tianjin-Hebei (BTH) region of China and identifies farmers' interest in the insurance. Vegetable price index insurance is growing rapidly in China and was recently introduced in the Shanghai region. Although the BTH region is an important region for vegetable production and consumption, no such insurance is currently available in the region.

Survey data from 455 farmers in the BTH region were collected during July-August 2016. Factors influencing farmer demand for vegetable price index insurance in the region are identified by estimating a probit model. Four categories of factors are considered: location, demographics (gender, age, education, and experience), farm characteristics (size, organization membership, yield, and net income), and risk cognition (market price sensitivity, other insurance purchased, price risk type and recent loss experience from low price). The results should assist the Chinese government structure and promote a vegetable price insurance that will be an effective method to maintain vegetable prices in the region and promote vegetable production by farmers.

Key words: insurance demand, price index insurance, vegetable price, probit model

JEL classification: G22 (Insurance), Q14 (Agricultural Finance)

Introduction

The demand for local vegetables is high in China because of deficiencies in the transportation, infrastructure, and storage facilities of fresh vegetables. Since vegetable prices are susceptible to major price variability, the Chinese government concentrates on how to maintain the market price of vegetables.

Agriculture risk includes price risk and production risk caused by natural disaster, weather events, etc. From the aspect of a farmer, price risk may have the most direct impact on influencing revenue. Price insurance plays an important role in stabilizing fluctuations in agricultural product market prices, as well as farmer income under a rapidly growing macro-economy (Zhao, 2016). The price insurance is a feasible method to address this risk.

Vegetable price index insurance is growing rapidly in China. A price index insurance

product was recently implemented in the Shanghai region with some measure of success (Sun, 2012). Two kinds of vegetable price insurance were launched in the region for different vegetables depending the method of production. The duration of insurance is one production season. If a farmer purchases the insurance at the beginning of one planting period and the market price is lower than the estimated cost of production, the farmer receives a payout. The payout is the difference between the target price and the actual price times 70 percent of the last three year's average production. Comparable price related insurance products available in the United States include insurance associated with output price and insurance associated with revenue. Insurance associated with output price is mainly used to avoid the risk from market price fluctuations, and price index insurance is such an insurance product (Wang, 2014).

Like Shanghai, Beijing is a large city and it also has the distinction of serving as China's capital. Although the importance of production agriculture in Beijing is much less than other industries, Beijing's demand for agricultural production is enormous. Tianjin and Hebei states are near the state of Beijing and they can jointly supply vegetables to the region. The Beijing-Tianjin-Hebei (BTH) region is a critically important economic area in China. There can be large differences between the demand and supply of vegetables in the BTH region as the result of unstable supply and variable market prices. Thus, price insurance is essential to encourage production in the region. Although vegetable price index insurance was successfully launched in Shanghai, people in BTH region prefer to eat fruit-type vegetables like tomato rather than the green-type vegetables like cabbage in Shanghai. Correspondingly, vegetable production in the BTH region and Shanghai also differ. Therefore, it would not be appropriate for the Chinese government to simply introduce the same insurance in the BTH region as is used in Shanghai. It is very important to identify farmer interest in price insurance and to determine if it can be applied to the BTH region. Identifying factors associated with farmer interest to purchase vegetable price insurance will assist the government in developing a viable insurance product and in supporting farmer revenue.

Literature on agriculture price insurance and farmer willingness to insure (WTI) is rather scant. It was recognized that the agricultural risk environment in Europe changed due to the World Trade Organization (WTO) agreement, and governments have increasingly withdrawn from disaster assistance for catastrophic events. Insuring farmers' incomes is rather problematical for reasons of asymmetric information and the risks due to price fluctuations (Miranda and Gonzalez-Vega, 2011). In the United States, crop insurance stands as the most prominent risk-sharing mechanism for agricultural yield risk, while price risk protection has traditionally been afforded through forward pricing instruments, such as futures contracts, and through price-oriented government programs, such as deficiency payments (Coble and Knight, 2002). Most of the price insurance research is focused on crop or other basic production. Insurance for vegetables is relatively new. Over time, agricultural insurance has more likely changed to control market risk in addition to production risk.

The second part of the literature reviews is about the willingness to insure (WTI). Hill, Hoddinott, and Kumar (2013) researched willingness to pay for weather-index insurance using 15 years of panel data from the Ethiopian rural household survey. The result found risk aversion is associated with the thought processes of the person purchasing insurance. Fraser (1992) presented a method for estimating a producer's willingness-to-pay for crop insurance. The impact of crop insurance on a producer's expected income and variance of income is evaluated

in a model including price and yield uncertainty, as well as producer risk aversion. Similar to other studies on farmers' willingness to pay, Fraser selected four categories of variables including risk averse, personal information, farm features, and risk cognition.

The study presented here identifies factors influencing farmers' willingness to insure (WTI) vegetable price in the BTH region of China. Of special interest is to identify individual farmer characteristics so the government may better structure and promote the insurance.

Data

A survey of farmers in the BTH region was conducted during July-August 2016. The region includes 28 villages and 7 counties where farmers were randomly selected from the vegetable planting area to participate in the survey. Prior to the survey, a pre-test was undertaken in one village of Beijing. The survey resulted in data from a total of 455 farmers included in the sample (n=455). The numbers of observations for Beijing, Tianjin, and Hebei are 153, 150, and 152.

At 93%, the majority of survey respondents had never heard of the price insurance product prior to being surveyed. The vegetable price insurance product was explained to all the farmers. After the explanation of the insurance, 63% of farmers thought the price insurance is useful or very useful in guaranteeing their revenue would be greater than their production costs. Finally the farmers were asked if they would be willing to purchase vegetable price insurance. The number of farmers indicating they are willing to insure is 292 (64%) with the remaining 163 farmers not willing to insure. Therefore, well over half of farmers surveyed in the BTH region think they will purchase vegetable price insurance if the government offered such a product.

Data were collected from the respondents. As has been done in previous studies, the data are grouped into farmers' demographics, farm characteristics, and risk cognition. A description of the variables included are presented in Table 1.

Table 2 summarizes how farmers answered the willingness to insure question for different factors. The joint analysis shows that Hebei has the greatest share of farmers (72%) that are willing to buy price insurance, followed closely by Beijing (69%), and lastly Tianjin (51%). Hebei has the largest amount of vegetable production in the BTH region. Farmers in Hebei are likely more dependent on farm income than farmers in Beijing and Tianjin since Hebei is relatively more rural and farmers have fewer opportunities for non-farm income than farmers in Beijing and Tianjin.

Two-thirds of farmers in the survey are male and a greater share of males than females are willing to insure. The average farmer age is 52 with more than 90% of farmers being between 30 and 70 years of age. A greater share of farmers less than 50 years of age are willing to insure than are farmers over 50 years of age. About 60% of the farmers surveyed had what may considered to a medium level of education for farmers in China. A greater share of farmers with medium or high levels of education are willing to insure than are farmers with a low level of education.

A majority (68%) of the farmers surveyed are members of at least one marketing or other farm organization. Farmers that have marketing assistance through a membership to farm organizations may be less likely to purchase price insurance than farmers without the assistance. The average area cultivated by farmers is 7.25 mu (0.48 hectare or 1.19 acre). About

70% of the farmers have 3 to 12 mu (0.20 to 0.80 hectare or 0.49 to 1.98 acre) of cultivated land. The share of farmers interested in purchasing vegetable price insurance increased as the farm size category became larger.

The farmers surveyed have an average of 17 years of experience in planting vegetables. Nearly half (48%) of the farmers had between 10 and 20 years of experience, although there is no clear change in the share of farmers willing to buy insurance by experience category shown in Table 2. Farmers with more experience in planting and marketing vegetables may be better at marketing vegetables and perceive less of a need to purchase vegetable price insurance. However, farmers with more experience may have a better understanding of market price variability and be more willing to purchase price insurance.

Risk aversion is another key factor that may influence the purchasing decision. The farmers were asked about the number of insurance products they already had. If farmers had one or more other insurance products, they were considered to be risk averse. About 59% of farmers had one or more insurance products, and a much greater share of these risk averse farmers (73%) is interested in buying price insurance than the share of farmers that had no other insurance (51%).

Nearly 90% of the farmers surveyed are responsible for making decisions related to the farm. However, about the same share of farmers willing to buy price insurance is a decision maker as the share of farmers not willing to buy is a decision maker. The percentage of farmers who say they pay close attention to market prices is 96%, although a slightly greater share of farmers willing to buy insurance say they pay close attention to market prices than the share of farmers that are not willing to buy.

Methodology

The probit model was selected as the econometric method to identify factors that influence the WTI, i.e., willingness to purchase insurance. The probit model emerges from the popular assumption of a normal cumulative density function (CDF). The probit model is one of the better-known discrete choice models and it together with the logit model are almost exclusively used in econometric applications (Greene, 2012). The probit model is based on utility theory or rational choice perspective on behavior, as developed by McFadden. The probit model is an extension and improvement of the linear probability model (Gujarati, 2003), which in the context of WTI takes the following regression form:

$$Y_i = \beta_1 + \beta_2 X_i + \varepsilon_i$$

where, X_i represents the explanatory variables related to the ith farmer's socio-economic characteristics. The dependent variable, Y_i, is equal to 1 if the farmer is willing to insure vegetable price and 0 otherwise. The β_1 is the intercept. The value of the parameter β_2 measures the marginal impact of a unit change in the farmer's socio-economic characteristic on the probability of WTI. ε_i is a random error term. To avoid the serious weakness of having predicted values of Y_i fall outside the (0,1) range, they are to be interpreted as probabilities. However, the survey did not actually observe the probabilities, but the survey did observe the outcomes (Y_i=1 or Y_i=0). Each Y_i is a Bernoulli random variable. Hence the Probability can be written as,

WTI is Pr (Yi=1)=Pi
not WTI is Pr(Yi=0)=(1-Pi)

Pi/(1-Pi) is simply the odds ratio in favor of willingness to insure vegetable price, i.e., it is the ratio of the probability that a farmer is willing to insure to the probability that a farmer is not willing to insure.

The natural log of the probability ratio results in:

$$Li = \ln\left(\frac{Pi}{1-Pi}\right) = \beta1 + \beta2Xi + \varepsilon i$$

where Li is the log of the odds ratio, is linear in X, and linear in the parameters.

Results

A probit model following Greene (2012) was estimated to assess the willingness to insure (WTI) vegetable price using the variables described in Table 1. The results of the estimation are presented in Table 3.

Results indicate farmers in Hebei are significantly more likely to purchase price insurance relative to farmers located in Tianjin. This is expected since Hebei is a more intensive agricultural area relative to Tianjin (and Beijing) and is developing its agricultural industry to meet the demand from the whole BTH region.

The only farmer demographics that appear to be an important factor in farmer willingness to insure is farmer experience. The willingness to insure significantly increases as farmer experience increases, as measured by number of years the farmer has planted vegetables. Farmers with more experience have had a greater opportunity to see market price variability over the years. They may better recognize the usefulness of price insurance to limit the impact of unexpectedly low prices. All other demographic variables were statistically insignificant.

Farm characteristics, surprisingly, do not appear to be an important factor in farmer willingness to insure. Farm size, yield, net income, and organization membership are statistically insignificant in the probit model.

Farmer risk cognition is an important factor in farmer willingness to insure. A more risk averse farmer, as indicated by a farmer having at least one other insurance product, has significantly higher willingness to insure than a less risk averse farmer. A farmer's perception of the effectiveness of price insurance in controlling price risk is another significant risk cognition factor. As a farmer's expectation of the price insurance effectiveness increased, the farmer is more likely to be willing to insure. The final risk cognition variable found to be significant is a farmer's attention to market price. Farmers who say they pay close attention to market prices are more likely to be willing to insure than farmers who do not pay close attention.

Conclusions

Results indicate location, farmer experience, risk aversion, perceived effectiveness of price insurance, and attention to market price are significant in explaining probability of farmer interest in purchasing vegetable price insurance. Most of the farmer risk recognition factors influence a farmer's decision to purchase price insurance.

There is interest in China to maintain a sufficient supply of fresh vegetables in order to

support vegetable demand in large, densely populated cities. Especially for Beijing and Tianjin, where vegetable production has decreased rapidly in last decade. Furthermore, these large cities have experienced a large increase in non-agricultural industry, such as finance, information technology, and other services, that attract people to live and work there. The vegetable supply plays an important role in supporting this transformation. Price insurance is one method that may be used to protect farmer revenue and encourage vegetable production, particularly in Hebei, where there is additional production capacity.

The study offers valuable information that may be used by authorities to lessen price risk and encourage a supply of fresh vegetables. Programs may be developed to educate farmers about the usefulness of insurance. Additional information on market price and market price variability may lead to more risk recognition by farmers. Then farmers will be in a better position to decide whether they want to purchase vegetable price insurance.

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Table1. Variable description

Category	Variable	Code	Definition and Measurement
Location	City name: Beijing	BJ	1 if Beijing, 0 otherwise
	City name: Tianjin	TJ	1 if Tianjin, 0 otherwise
	City name: Hebei	HB	1 if Hebei, 0 otherwise
Demographics	Gender	GENDER	1 if respondent is male, 0 otherwise
	Age	AGE	Age of respondent in years
	Low Education	LEDU	1 if respondent had junior high education or less, 0 otherwise
	Medium Education	MEDU	1 if respondent had some high school but no college education, 0 otherwise
	High Education	HEDU	1 if respondent had more than a high school education, 0 otherwise
	Experience	EXPERENCE	Number of years farmer has planted vegetables
	Decision-maker or not	DEC_MAKER	1 if respondent makes planting decision, 0 otherwise
Farm characteristics	Size	SIZE	Cultivated land area in mu
	Organization member	ORG	1 if the farmer is a member of at least one marketing or other farm organization, 0 otherwise
	Yield	YIELD	Vegetable yield per area for entire last year in kg per mu
	Net income	NI	Net income per mu from vegetable production for entire last year in RMB per mu
Risk cognition	Variation of Market price	PVAR	Respondent assessment of degree (1-5) of market price variability, 5 is the highest degree of variation
	Risk averse degree	RISK_AVERSE	1 if the farmer has one or more other insurance products, 0 otherwise
	Effectiveness of price insurance	EFF_INS	Respondent assessment of degree (1-5) of price insurance effectiveness, 5 is the most effective
	Attention to market price	ATTENT	1 if farmer pays attention to market price, 0 otherwise
	Revenue sensitivity to market price	REV_ SENSITIVE	1 if respondent considers farm revenue is highly sensitive to market price, 0 otherwise

Table 2. Farmer willingness to insure vegetable price by various factors

Whether buy insurance or not	Variable / Observations	Location			Gender		Age (years)			
		Beijing	Tianjin	Hebei	Male	Female	≤30	30-50	50-70	>70
Yes=1	Number	106	77	109	199	93	12	125	155	0
	Percent	69.28	51.33	71.71	68.15	31.85	4.11	42.81	53.08	0
No=0	Number	47	73	43	104	59	5	56	97	5
	Percent	30.72	48.67	28.19	63.80	36.20	3.07	34.36	59.51	3.07

Whether buy insurance or not	Variable / Observations	Education			Organization membership		Size (Mu)			
		Low	Medium	High	Yes	No	≤3	3-6	6-12	>12
Yes=1	Number	47	184	61	199	93	64	106	102	20
	Percent	16.10	63.01	20.89	68.15	31.85	21.92	36.30	34.93	6.85
No=0	Number	38	95	30	110	53	45	65	47	6
	Percent	23.31	58.28	18.40	67.48	32.52	27.61	39.88	28.83	3.68

Whether buy insurance or not	Variable / Observations	Experience (planting years)			Risk aversion		Decision maker		Attention to market price	
		≤10	10-20	>20	Yes	No	Yes	No	Yes	No
Yes=1	Number	78	141	73	197	95	262	30	285	7
	Percent	26.71	48.29	25.00	67.47	32.53	89.73	10.27	97.60	2.40
No=0	Number	44	76	43	73	90	146	17	154	9
	Percent	26.99	46.63	26.38	44.79	55.21	89.57	10.43	94.48	5.52

Source: survey data

Notes: Mu is Chinese area unit. 1 Mu = 666.67 meter^2 = 0.06667 hectare = 0.1647 acre

Table 3. Probit results for farmer willingness to insure (WTI) vegetable price

Explanatory variable	Coef. Est.	p-value
BJ	0.1927	0.416
HB	0.5065***	0.006
GENDER	0.0745	0.635
AGE	-0.0015	0.854
MEDU	0.2006	0.331
HEDU	-0.0644	0.793
EXPERENCE	0.0171*	0.083
DEC_MAKER	-0.2066	0.394
ORG	0.2131	0.228
SIZE	0.0205	0.199
YIELD	-5.830 e-06	0.217
NI	1.740 e-06	0.672
PVAR	0.0246	0.773
RISK_AVERSE	0.5209***	0.002
EFF_INS	0.8540***	0.000
ATTENT	0.8561**	0.025
REV_SENSITIVE	0.2062	0.328
CONSTANT	-4.5771***	0.000
Number of observations	455	
LR chi2(17)	184.85	
Prob > chi2	0.0000	
Log likelihood	-204.41569	
Pseudo R^2	0.3114	

*denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level