



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

**China's small-scale hog production and implications for trade:  
Evidence from a farmer survey**

Qingbin Wang and Guangxuan Zhang

Department of Community Development and Applied Economics  
The University of Vermont  
Burlington, VT 05405

Selected paper prepared for presentation at the 2012 Agricultural and Applied Economics Association (AAEA) Annual Meeting, Seattle, Washington, August 12-14, 2012.

Copyright 2012 by Wang and Zhang. All rights reserved. Preliminary draft and please do not cite.

# **China's small-scale hog production and implications for trade: Evidence from a farmer survey**

Qingbin Wang and Guangxuan Zhang

## **Abstract**

Using primary data of 3,327 Chinese farmers and their villages collected through a survey in 2010, this study identifies the factors that affect farmers' decision to raise hogs and the factors that determine the hog farmers' production scale and discusses the likely future of small-scale hog production and its potential impacts on China's pork market and trade. Estimation results of a Heckman model suggest that labor availability, the opportunity of earning income from nonfarm jobs, and the existence of large-scale hog farms and processing facilities in the local area are among the major factors of the participation and scale decisions. As China's demand for pork has been increasing at a relatively stable rate, China's pork imports from the U.S. and other nations are increasingly determined by its domestic pork supply, especially the production of small-scale hog farmers due to its sensitivity to price, disease, subsidy, and other factors.

Keywords: China's pork market, U.S. pork exports, Heckman model

## **1. Introduction**

As a result of the continued growth in China's pork demand and fluctuations in its domestic production, China has significantly increased its import of pork and pork variety meats from the U.S. in the past five years, from less than 0.1 million metric tons (mmt) in 2006 to 0.40 mmt in 2008, then dropped to 0.26 mmt in 2009, and increased again to 0.29 mmt in 2010 and reached 0.35 mmt in the first ten months in 2011. The rapid growth in China's pork imports from the U.S., along with its increasing role in the global markets for many other food products, has brought about an increasing need for information on the Chinese pork markets, especially information from empirical studies based on primary data. While several recent studies have examined the impacts of demand side factors, such as consumer income and concerns about pork safety, on China's pork market, there is a dearth of information on the factors responsible for the fluctuations in China's pork supply, especially information on how small-scale farmers make decisions about hog production. Information on the supply side factors is very important for analyzing China's pork market and trade behavior because China's demand for pork has been

increasing at a relatively constant rate and its pork imports are increasingly determined by the fluctuations of its domestic supply.

The major objective of this study is to collect primary data through a survey of Chinese farmers, identify the factors that affect farmer decision to raise hogs and the factors that determine the hog farmers' production scale, and discusses the likely future of small-sale hog farmers and their potential impacts on China's pork market and trade.

## 2. Development and trends of China's pork market and trade

While pork has been the primary meat in the Chinese diet for thousands of years, the per capita pork consumption has increased in both urban and rural China in the past three decades. For example, per capita pork consumption increased from 16.68 kg in 1985 to 20.50 kg in 2009 in urban China, and increased from 10.54 kg in 1990 to 13.96 kg in 2009 in rural China. Although the per capita poultry consumption has increased more significantly, pork is still the primary meat in the Chinese diet. For example, in 2010, pork accounted for about 60% of per capita meat consumption in urban areas and 71% of per capita meat consumption in rural areas.

Figure 1 presents the details of the increase in China's pork production. The number of slaughtered hogs increased 151%, from 257.2 million heads in 1986 to 645.4 million heads in 2009. At the same time, pork output increased 172%, from 17.96 mmt in 1986 to 48.9 mmt in 2009. The difference in increase percentages indicates that pork production per hog increased over the period.

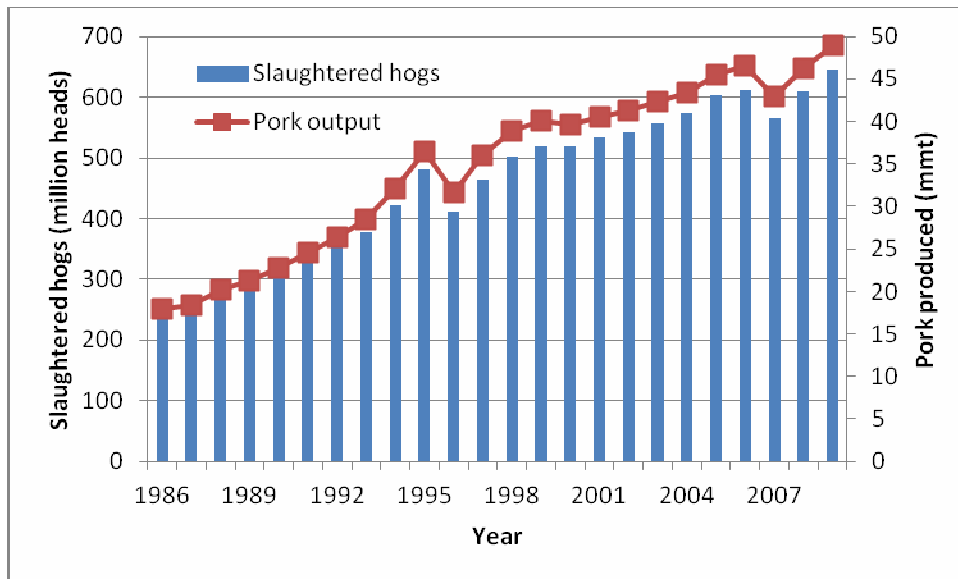
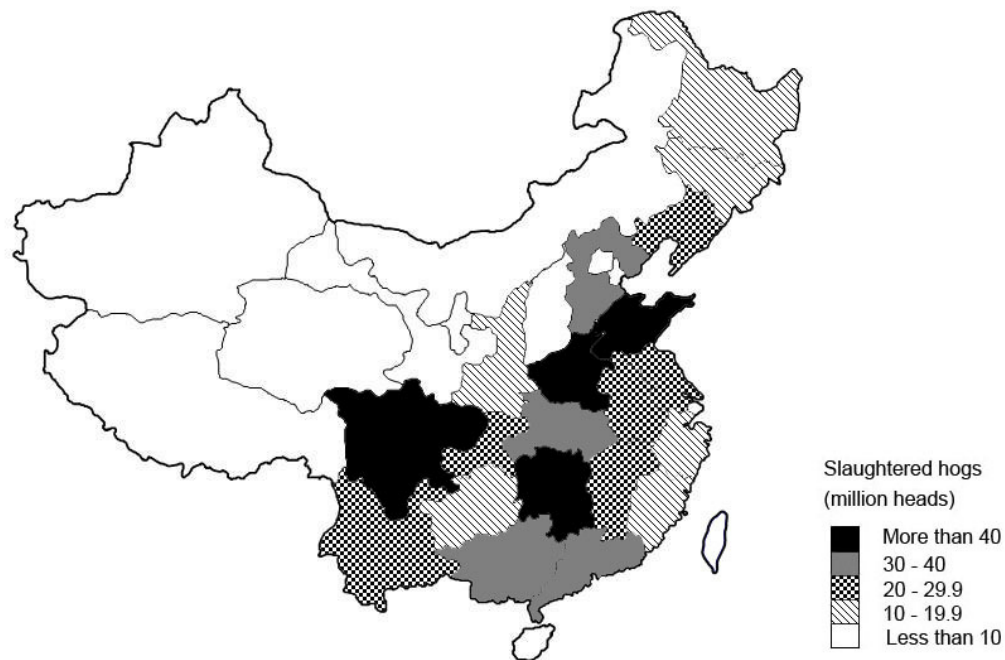


Figure 1. China's annual pork output, 1986–2009

Pork production is not equally distributed in China. Figure 2 shows the geographic distribution of China's pork production in terms of numbers of slaughtered hogs in 2009. It is

clear that China's pork production is concentrated in Sichuan, Hunan, Henan, Shandong, Hubei, Guangdong, and Hebei provinces. All of these provinces are also the top 10 provinces in terms of grains production, and most of them are close to big pork markets such as Beijing and Hong Kong. Pork production in China's northwest area is limited. One of the reasons is that many minority Chinese live in that area and pork is not a major meat in their diet.



**Figure 2. China's hog production by region, 2009**

China's pork production consists of three kinds of hog farms. There are two kinds of household hog farms, backyard hog farms and specialized hog farms, and one kind of commercialized hog farm. Backyard hog farms have a long history in China's rural areas. Farmers use their spare time and agricultural by-products to raise a few hogs per year in their backyard as a sideline. Specialized hog farms began to grow starting in the 1980s, when the rural economy was liberated from collective economy. The difference between backyard hog farms and specialized hog farms is that the family members of the specialized hog farms are chiefly engaged in raising hogs. Commercialized hog farms are operated on a large scale by companies and have more financial and technical investments. The difference between household hog farms and commercialized hog farms is obvious. But there is no clear-cut distinction between backyard hog farms and specialized hog farms. The number of hogs raised is an important index, but there is no absolute standard (Fuller et al., 2002; Somwaru et al., 2003). In general, backyard hog farms raise no more than 10 hogs per year, and the limitation for specialized hog farms is a few hundred hogs per year.

Household hog farms were the predominant production model in China. There is no new, concise data about the relative proportions of the three kinds of hog farms in terms of the number

of hog farms and share of pork output. The most recent data showed that household hog farms that raised 1 to 49 hogs per year accounted for 96.30% of the hog farms and 47.42% of the total output in 2004 (Mérey, 2006). Some researchers contend that backyard hog farms will gradually disappear and be replaced by specialized hog farms and commercialized hog farms (Fuller, et al., 2002; Somwaru, et al., 2003). Other researchers contend that household hog farms may continue to dominate China's pork production because backyard hog farms enjoy relative cost advantages and because of the complementary relationship between planting and hog raising (Pan & Kinsey, 2002). However, there are no empirical data that support the ideas of either side.

Another hot topic is whether China's pork production can meet the growing domestic demand. The consensus recognition is that such factors as land scarcity and labor scarcity limit China's ability to continue increasing its pork and other livestock production (Fuller, et al., 2002; Geissler, 1999; Hayes, 1997; Lohmar & Gale, 2008). Although it is not impossible that China's pork production will achieve further growth, future gains in China's pork production will not come as easily as in the past (Lohmar & Gale, 2008). It is likely that while China's hog production will continue to increase, China will also increase pork imports to supplement the domestic supply.

China's growing food market has expanded its agricultural imports significantly in the past three decades. From 1985 to 2009, China's food imports increased from \$3 billion to \$32.6 billion (NBSC, 1991 & 2010). The United States has captured great agricultural export opportunities in China. In 2009, the Chinese mainland imported \$13.1 billion in agricultural products and became the second largest destination of U.S. agricultural exports, after Canada. In the same year, China's agricultural exports to the United States totaled \$2.9 billion (USDA/ERS, 2010).

The United States increasingly benefits from China's pork market, especially in the most recent years. The United States is the second largest pork production country but the largest pork exporter in the world. U.S. pork exports to China have recently increased dramatically. As shown in Figure 3, U.S. pork and pork variety meat exports to China (including Hong Kong) increased from 0.09 mmt in 2006 to 0.40 mmt in 2008, which accounted for 19.5% of U.S. pork exports in 2008 (USMEF, 2010). Although U.S. pork exports to China fell to 0.26 mmt in 2009, the dramatic increase in 2008 suggests that there is an important shift underway that represents an opportunity for the U.S. pork industry to expand its pork market potential in the Chinese market.

There is no doubt that the pork trade between China and the United States depends on the politics and negotiations between the two countries. For example, in the recent past, China has successfully prevented the importation of U.S. pork by restricting the use of ractopamine, a feed additive to promote leanness in hog production (Ortega & Wang, 2009). However, as China's economy becomes more market-oriented, the balance between consumption and production will play a more important role in determining trade between the two countries.

China's pork consumption will likely continue to increase, and import levels will likely be determined by China's pork production capability. As shown in Figure 4, the impressive increase of U.S. pork exports to China in 2008 coincided with the significant decrease of China's pork production in 2007. When China's pork production recovered in 2008 and 2009, U.S. pork

exports to China decreased accordingly in 2009. The incident implies that when China’s pork production cannot match the increase in pork consumption, the United States has a better chance of expanding pork exports to China.

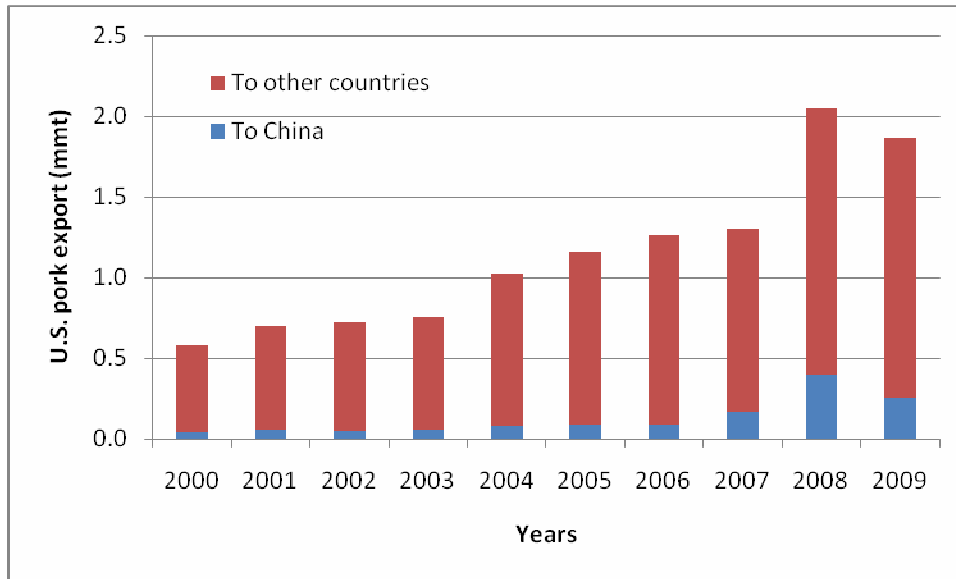


Figure 3. U.S. pork exports, 2000–2009

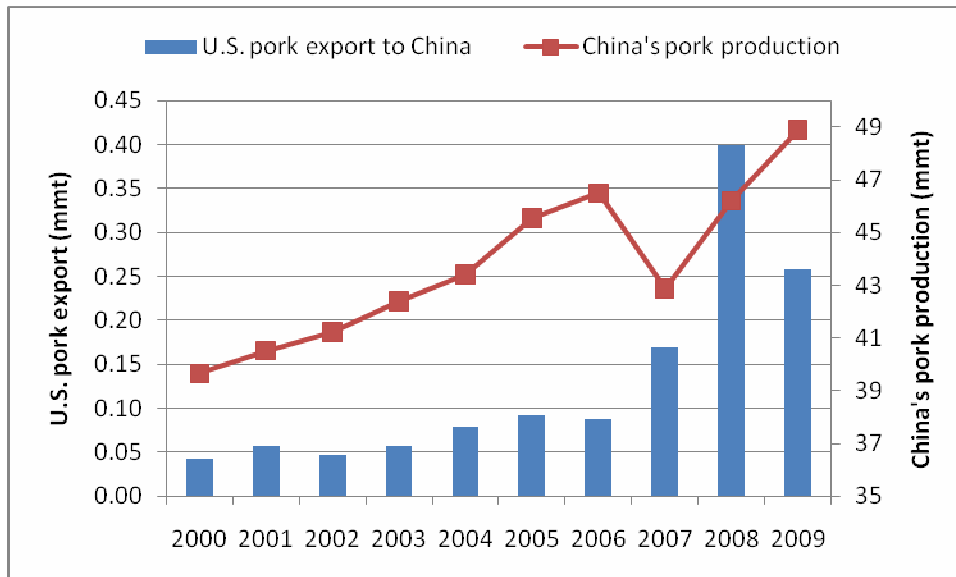


Figure 4. U.S. pork exports and China’s pork production, 2000–2009

Although China has become a significant market for U.S. pork, there is very limited information about the Chinese pork market, especially on the supply side. To improve the understanding of China’s hog production and to help inform U.S. pork producers, this study investigates China’s household hog farms and discusses the implications for trade. This is likely one of the first studies to provide detailed information about China’s household hog farms.

### 3. Theoretical and empirical models

Household hog farmers' decisions about hog production can be divided into two stages: a participation decision, about whether or not to raise hogs, and a raising scale decision, about the raising scale for the farmers who have decided to raise hogs (Costales et al., 2007). The participation decision can be conceptualized into the following model:

$$\begin{aligned} \text{Maximize:} \quad & \pi = P_h \cdot f_h(L_h, K_h) - WL_h - IK_h \\ \text{s.t.} \quad & L_h \leq \bar{L} \\ & K_h \leq \bar{K} \end{aligned}$$

where  $\pi$  is the profit.  $P_h$  is the price of hog.  $f_h$  is the hog production function and  $L_h$  and  $K_h$  are the labor input and capital input for hog production, respectively.  $W$  is the average income that farmers can earn from other jobs, and  $I$  is the average return of capital from other investment.

Based on the model, whether or not a farm household raises hogs depends on the marginal profit of hog production. A farm household would not raise hogs unless the marginal profit of labor and capital on hog production were greater than returns from other jobs. That can be represented as the following:

$$\begin{aligned} MR_{L_h} &= \frac{P_h \cdot \partial f_h(L_h, K_h)}{\partial L_h} > W \\ MR_{K_h} &= \frac{P_h \cdot \partial f_h(L_h, K_h)}{\partial K_h} > I \end{aligned}$$

When the hog production is profitable enough for farmers, they raise hogs. The production scale will be determined by the following model:

$$\begin{aligned} \text{Maximize:} \quad & \pi = P_h \cdot f_h(L_h, K_h) + P_i \cdot f_i(L_i, K_i, LD) + WL_w - W(L_h + L_i) - I(K_h + K_i) \\ \text{s.t.} \quad & L_h + L_i + L_w \leq \bar{L} \\ & K_h + K_i \leq \bar{K} + WL_w \end{aligned}$$

where  $\pi$ ,  $P_h$ ,  $f_h$ ,  $L_h$ ,  $C_h$ ,  $W$ , and  $I$  are defined as above.  $P_i$  is the price of agricultural product.  $f_i$  is the production function of agricultural product and  $L_i$ ,  $K_i$ , and  $LD$  are the labor input, capita input, and land input, respectively.  $L_w$  is the amount of labor that is spent on non-farm jobs.  $\bar{L}$  and  $\bar{K}$  are the total amount of labor and the capital the family own.

By solving the set of equations, the optimized land and capital inputs for hog production can be derived as the following:

$$L_h = g_L(P_h, P_i, W, I, \bar{L}, \bar{K}, LD)$$



$$C_h = g_c(P_h, P_t, W, I, \bar{L}, \bar{K}, LD)$$

Substituting the above back into the hog production function  $f_h$  will yield optimized hog production scale:

$$Q_h = f_h(L_h, C_h) = f(P_h, P_t, W, I, \bar{L}, \bar{K}, LD)$$

As illustrated in the two models, farmers' participation and scale decisions about hog production are influenced by four sets of factors. The first set refers to the household resources available for hog production. The second set is related to the opportunity cost in the use of household resources for engagement in other jobs. The third set pertains to the productivity of hog production, and the fourth set refers to the hog market. In the following empirical analysis, these four sets of factors are presented with appropriate variables.

Theoretically, the ordinary least squares model is applicable to determining factors that influence the raising scale of hog farms when all households participate. However, some households may prefer not to raise hogs for various reasons. If the ordinary least squares regression is estimated while excluding nonparticipants from the analysis, a sample selectivity bias is introduced into the model. Such a problem can be addressed by following a two-stage procedure, as suggested by Heckman (1979).

In this study, therefore, the Heckman model is employed to investigate the factors that influence household farmers' decisions about both whether or not to raise hogs and raising scale. In the context of this study, the Heckman model can be presented as the following:

Participation decision:

$$D^* = \alpha + \sum b_i X_{1i} + u \quad u \sim N(0,1) \quad (1)$$

$$D = \begin{cases} 1 & \text{if } D^* > 0 \\ 0 & \text{if } D^* \leq 0 \end{cases} \quad (2)$$

Raising scale decision:

$$S^* = \alpha + \sum \beta_i X_{2i} + v \quad v \sim N(0, \sigma^2) \quad (3)$$

$$S = \begin{cases} S^* & \text{if } D = 1 \\ 0 & \text{if } D = 0 \end{cases} \quad (4)$$

where  $D^*$  is a latent index variable that denotes binary censoring,  $D$  is the observed value representing the farmers' participation decision (i.e.,  $D = 1$  if the respondent household raises hogs). The actual raising scale of the respondents  $S$  equals the unobserved latent value  $S^*$  only when  $D = 1$ .  $\alpha, b_1, b_2, \dots, b_n$  are the coefficients to be estimated and  $u$  is the error term for the

first equations set.  $\alpha, \beta_1, \beta_2, \dots, \beta_n$  are the coefficients and  $v$  is the error term for the second equation set. The explanatory variables for two decision stages,  $X_{1i}$  and  $X_{2i}$  are not necessarily the same.

Heckman proposed a two-step method to estimate the coefficients based on the assumption that the two error terms  $u$  and  $v$  are correlated and that the first stage decision dominates the second one. This procedure first estimates equation (1) using a Probit model and then computes the inverse Mills ratio, or lambda. Finally, equation (3) is estimated with lambda as control variables (Wodajo, 2008). However, if the error terms are independently distributed or have no strong correlation, the estimation can be simplified. Equation (1) can be estimated with Logistic regression, and equation (2) can be estimated with ordinary least squares (OLS).

#### 4. Data and descriptive analysis

This study conducted a farm survey in February 2010 to collect primary data about China's household hog farms. The survey was conducted in the rural areas of two provinces. As shown in Figure 5, one is Jiangsu Province, located along China's eastern coast. The other is Shaanxi Province, located inland.

Jiangsu has better economic conditions than Shaanxi. In 2008, Jiangsu's GDP was 3,031 billion yuan, or \$436.5 billion, the third highest of the 31 provinces in mainland China. Per capita income was 39,485 yuan, or \$5,685. In the same year, Shaanxi's GDP was 685 billion yuan, or \$98.7 billion, the 19th highest in China. Per capita income in Shaanxi was 18,212 yuan, or \$2,622. The per capita income in Jiangsu was more than two times the per capita income in Shaanxi. In that year, more than half of Jiangsu's populations were urban residents; the proportion was lower in Shaanxi, at 42.1%.

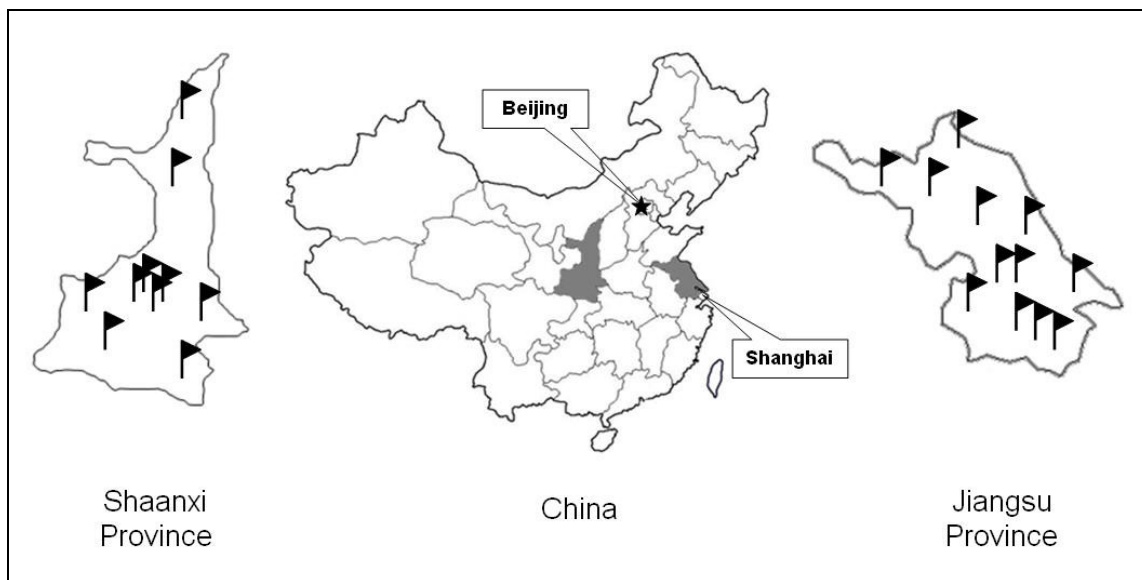


Figure 5. Sample geographic distribution

Jiangsu also has more arable land, although its total land area is less than that of Shaanxi. The output of both grains and pigs in Jiangsu were more than those in Shaanxi in 2008. The disparity of the two provinces' agriculture is also reflected in the difference in income. In 2008, the per capita net income of Jiangsu's rural households was 7,356 yuan, or \$1,059. It was more than two times the per capita net income of Shaanxi's rural households, which was 3,136 yuan or \$452.

Undergraduate students from Yangzhou University (YZU) and Northwest A&F University (A&F) completed the survey in Jiangsu and Shaanxi, respectively. Sample selection was based on selection of the undergraduate students. Three rules were imposed in the selection of students. First, the student must come from a rural area in the province where the university is located. Second, there must be some households in the student's village who raise hogs or dairy cows. Third, the student must have the interest, time, and energy to complete the survey in his or her home village. Once the students were selected, the sample villages were determined. Then the students randomly selected 30 to 50 households in the village to interview. In the end, 76 undergraduate students at YZU and 45 undergraduate students at A&F participated in the survey. All the students were from different villages. At the end of survey they were compensated for their time and effort. The flags in Figure 5 summarize the distribution of sample villages on the county level.

The survey consists of two questionnaires. The first is a village survey questionnaire about the village's background and economic information. The students completed this village survey questionnaire after consultation with people who were more likely to have that information, such as village administrators. The second survey is a farmer questionnaire, which collects information about raising hogs, information about not raising hogs, information about raising dairy cows, and household information. The farmer survey questionnaire was completed by students when they interviewed sample households.

The survey yielded 2,266 respondents from 76 villages in Jiangsu. Of those, 2,056 respondents from 71 villages are identified as valid. We had 1,444 respondents from 45 villages in Shaanxi, among which 1,271 respondents of 40 villages are valid. In the end, the survey yielded 3,327 valid observations from 111 villages. The effective rates of individual sample are 90.7% and 88.0% in Jiangsu and Shaanxi, respectively. Although the villages that have hog farms, or milk cow farms, or both, were selected into the survey, all valid respondents came from villages with hog farms.

Table 1 summarizes the background and hog raising information for the sample villages. According to the survey data, the average size of sample villages in Jiangsu Province is 600 households per village, more than twice the average size of sample villages in Shaanxi Province. A large portion of the sample villages are located in the countryside in both provinces, but more sample villages in the survey are located in town areas in Jiangsu Province than in Shaanxi Province. The sample villages in Jiangsu are closer to market than the villages in Shaanxi. The average distance between the village and the local market was 3.3 kilometers in Jiangsu and 7.2 kilometers in Shaanxi. The survey reveals that a significant portion of the labor force in surveyed areas had fled to the cities. Of the 71 sample villages in Jiangsu Province, 24% have had more

than half of the labor force in the village migrate to work in the cities. In Shaanxi Province, as much as 42.5% of villages had more than half of their labor force migrate to work in cities.

The survey data indicate that although raising hogs is not the choice of most households in the surveyed villages, specialized hog farms are popular in surveyed areas. The average proportion of households that raise hogs in each village is 24.9% in Jiangsu and 38.4% in Shaanxi. Meanwhile, 64.8% of sample villages in Jiangsu and 55.0% of sample villages in Shaanxi have middle-size hog farms that raise 16–100 hogs each year; 23.9% of sample villages in Jiangsu and 17.5% of sample villages in Shaanxi have large-size hog farms that raise more than 100 hogs each year.

**Table 1. Summary information of the surveyed villages**

	<b>Jiangsu</b>	<b>Shaanxi</b>	<b>Total</b>
(Total village samples)	(71)	(40)	(111)
<b>Average village size</b> (# of households)	600	282	487
<b>Location</b>			
Countryside	77.5%	92.5%	82.9%
Town	15.5%	5.0%	11.7%
City	7.0%	2.5%	5.4%
<b>Distance to market (km)</b>	3.3	7.2	4.7
<b>Proportion of migrant workers</b>			
Less than 10%	9.9%	0.0%	6.3%
10%–20%	22.5%	20.0%	21.6%
21%–30%	14.1%	10.0%	12.6%
31%–40%	14.1%	20.0%	16.2%
41%–50%	15.5%	7.5%	12.6%
51%–60%	8.5%	27.5%	15.3%
More than 60%	15.5%	15.0%	15.3%
<b>Ability to get loans</b>			
Very easy	5.6%	5.0%	5.4%
Easy	53.5%	30.0%	45.0%
Hard	36.6%	57.5%	44.1%
Very hard	4.2%	7.5%	5.4%
<b>Proportion of hog farms</b>	24.9%	38.4%	29.8%
<b>Having middle-size hog farms*</b>	64.8%	55.0%	61.3%
<b>Having large-size hog farms**</b>	23.9%	17.5%	21.6%
<b>Slaughterer in the village</b>	36.6%	30.0%	34.2%
<b>Local hog coop. organizations</b>	23.9%	17.5%	21.6%
<b>Subsidy for hog production</b>	53.5%	45.0%	50.5%

Notes: \* Proportion of villages having hog farms that raise 16–100 hogs

\*\* Proportion of villages having hog farms that raise more than 100 hogs

There are four other findings based on the village information. First, local slaughterers still play an important role in the survey areas. Based on the survey data, 36.6% of sample villages in Jiangsu and 30.0% of sample villages in Shaanxi have slaughterers in the village. Traditionally, these slaughterers operate at a small but sufficient scale to meet the pork demand in a local area such as a village. Second, there is no hog raising cooperation organization in most of surveyed areas. Only 23.9% of the sample villages in Jiangsu and 17.5% of the sample villages in Shaanxi have cooperation organizations in the local area. Third, only about half of the sample villages in both provinces are able to get government subsidies for hog production. The subsidies are issued through cash, no-interest loans, insurance, compound feedings, or medicines. Finally, it is comparatively easier to secure an agricultural loan from a bank in Jiangsu Province than in Shaanxi Province. In Shaanxi, for the farmers of 65.5% of the sample villages, it is hard or very hard to get loans.

The background information of sample households is summarized in Table 2. According to the survey data, the average household size is close in two provinces. On average, each household has about four or five family members. Most family members are adults, and about two families support one senior citizen. The highest educational level of family members is more than high school for more than half of the sample households in both provinces. About one quarter of sample households have family members with a college or higher degree.

Table 2. Summary information of the surveyed farmers

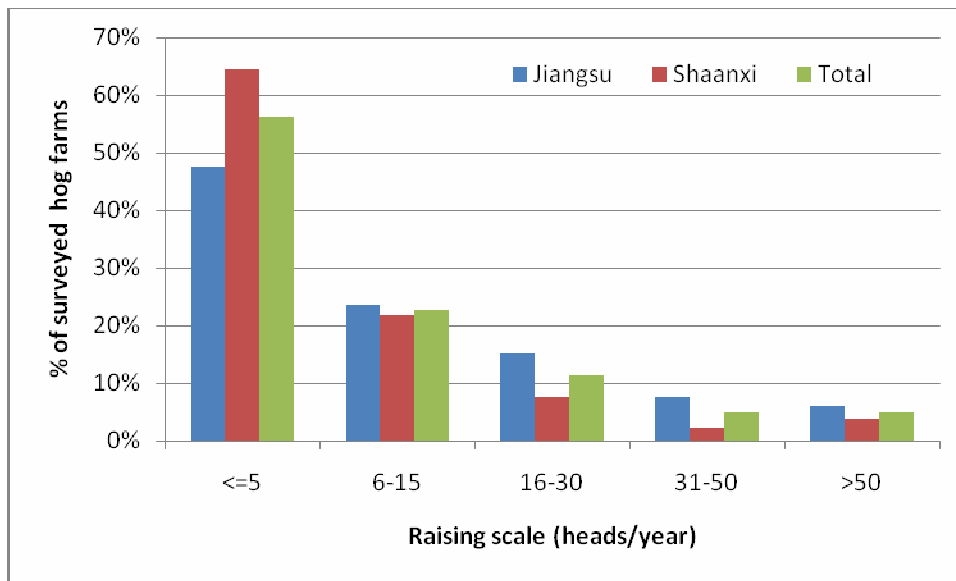
	<b>Jiangsu</b> (2,044)	<b>Shaanxi</b> (1,265)	<b>Total</b> (3,309)
(Total household samples)			
<b>Family members</b> (# of persons)			
Total	4.2	4.5	4.3
Adult	3.3	3.5	3.4
Senior	0.5	0.6	0.6
<b>Highest education level</b>			
Less than primary school	2.2%	1.4%	1.9%
Primary school	6.2%	6.2%	6.2%
Middle school	27.6%	32.6%	29.5%
High school	37.0%	35.6%	36.5%
College or higher	27.0%	24.2%	25.9%
<b>Cultivation land</b> (acre)	5.20	7.92	6.24
<b>Cultivation</b>			
Staple	84.4%	90.6%	86.7%
Economic products	15.6%	9.4%	13.3%
<b>Nonfarm job</b>	86.0%	55.7%	74.4%
<b>New farmers</b>	58.0%	27.5%	46.3%
<b>Vehicles</b>			
Motorcycle	73.7%	67.9%	71.5%
Auto	11.9%	11.9%	11.9%
Agricultural vehicles	36.3%	37.0%	36.6%

The sample households in Jiangsu Province have less cultivated land than the households in Shaanxi Province. On average, each household has 5.20 acres of land in Jiangsu and 7.92 acres of land in Shaanxi. A large portion of sample households, 84.4% in Jiangsu and 90.6% in Shaanxi, mainly cultivate staple products like rice, wheat, and corn.

Nonfarm jobs, such as in government or business, are popular in surveyed areas. In Jiangsu Province, 86.0% of sample households have at least one family member with a nonfarm job. The proportion is 55.7% in Shaanxi Province. In addition, 58.0% of sample households in Jiangsu and 27.5% of sample households in Shaanxi earn more than half of their household income from nonfarm jobs. Motorized bicycles and vehicles are common in the survey areas.

In our total household samples, 49.68% of respondents replied that they currently raise or did raise hogs in the past three years (2007, 2008, and 2009). The proportion is 39.92% in Jiangsu and 65.45% in Shaanxi, respectively. The analyses in this section are based on the household samples that are hog farms.

The number of hogs each hog farm sold in 2007, 2008, and 2009 were collected in the survey. Figure 6 shows the hog farms distribution by the average number of hogs sold in one year. It indicates that small-scale hog farms are the primary format in the surveyed areas. These small-scale hog farms, which raise 5 hogs or fewer per year, account for 47.67% of hog farms in Jiangsu and 64.49% of hog farms in Shaanxi. Comparatively, the proportions of hog farms that raise 16 hogs or more per year are bigger in Jiangsu Province than in Shaanxi Province.

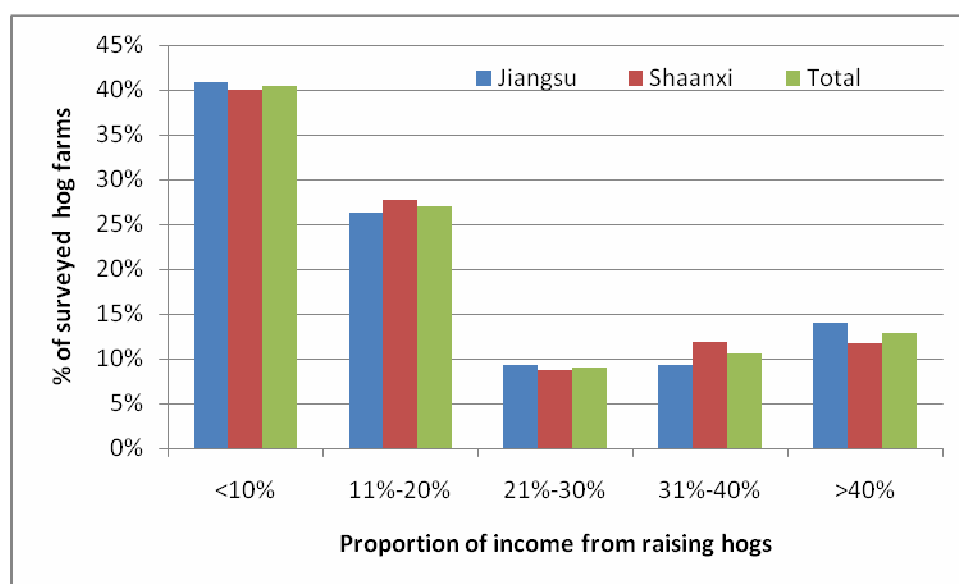


**Figure 6. Sample hog farms distribution by hog raising scale**

From the perspective of household income, raising hogs is a minor economic activity for most of the hog farms. Hog farmers were asked the question, “How much of your household income comes from raising hogs?” Figure 7 summarizes the sample hog farms distribution by the proportion of income from raising hogs. It shows that about 67.5% of total hog farms replied that

the income from raising hogs accounted for 20% or less of their total household income, in both provinces.

The other hog production information is summarized in Table 3. More than 96% of hog farmers replied that they independently participate the hog production, and do not contract with hog companies or cooperate with other hog farmers. Specialized piggeries are the major place to raise hogs in Jiangsu; 51.9% of Jiangsu’s hog farmers use or did use them to raise hogs. Shaanxi’s hog farmers still mainly use the traditional piggeries, which are part of courtyard, to raise hogs; 71.3% of Shaanxi’s hog farmers use traditional piggeries in their current houses or in unused houses to raise hogs. Grains are the main feed for hogs, accounting for more than 50% of total feed in both provinces.



**Figure 7. Sample hog farms distribution by the share of income from hog production**

Hog traders are the major path for hog farmers to sell hogs; 58.7% of Jiangsu’s hog farmers and 43.9% of Shaanxi’s hog farmers mainly depend on hog traders to sell hogs. Traders are an important player in China’s food market, working as a bridge that connects millions of diverse consumers and small farms. Hog traders purchase hogs from farmers, transport the hogs, and then sell the hogs to a slaughterhouse or in the market. Hog traders facilitate the hog transaction, and farmers benefit from the traders’ knowledge and information about the hog market. From the perspective of hog farmers, hog traders are the preferred path to sell hogs because traders can purchase hogs at the gate of the farm.

When the hog farmers were asked the question “Where do you get hog production and market information?” personal experiences were reported to be the primary source: 73.0% of Jiangsu’s hog farmers and 65.3% of Shaanxi’s hog farmers indicated it as their information resource. The second and third resources are farmers’ friends and hog traders. Among the media, television is the main information resource.

**Table 3. Hog production information**

	<b>Jiangsu</b>	<b>Shaanxi</b>	<b>Total</b>
<b>Production model</b>			
Independent	96.0%	96.6%	96.3%
Contract or cooperation	4.0%	3.4%	3.7%
<b>Piggery</b>			
Backyard	26.3%	48.4%	37.4%
Unused house	20.7%	22.9%	21.8%
Specialized piggery	51.9%	26.7%	39.2%
Free-range	1.1%	1.9%	1.5%
<b>Feedings</b>			
Compound feed	31.4%	25.9%	28.7%
Grain	53.8%	58.1%	56.0%
Others	14.7%	16.1%	15.4%
<b>Selling path</b>			
To hog traders	58.7%	43.9%	51.3%
To hog market	13.4%	10.2%	11.8%
To slaughter house	12.4%	33.4%	23.0%
Slaughter by themselves	11.9%	11.5%	11.7%
To contractor	2.6%	0.5%	1.5%
To coop. organization	0.9%	0.5%	0.7%
<b>Information*</b>			
Personal experiences	73.0%	65.3%	69.2%
Friends	35.8%	32.9%	34.3%
Hog traders	28.7%	31.0%	29.9%
TV	18.1%	26.2%	22.2%
Specialized raising farmers	17.8%	23.3%	20.6%
Newspapers/magazines	9.7%	9.8%	9.7%
Internet	6.0%	4.2%	5.1%
Cooperation organization	4.5%	1.8%	3.2%
Gov. tech services	4.8%	2.7%	3.7%
Hog companies	1.6%	1.7%	1.6%
<b>Loan</b>			
Got the loan	10.8%	10.0%	10.4%
Applied but did not get	5.0%	5.7%	5.4%
Did not apply	84.2%	84.3%	84.2%
<b>Cooperation organization</b>			
Attended	7.4%	6.1%	6.8%
Knew about them but did not attend	19.9%	15.4%	17.7%
Did not know about them	72.7%	78.4%	75.6%

Notes: \* The sum is not equal to 100%.

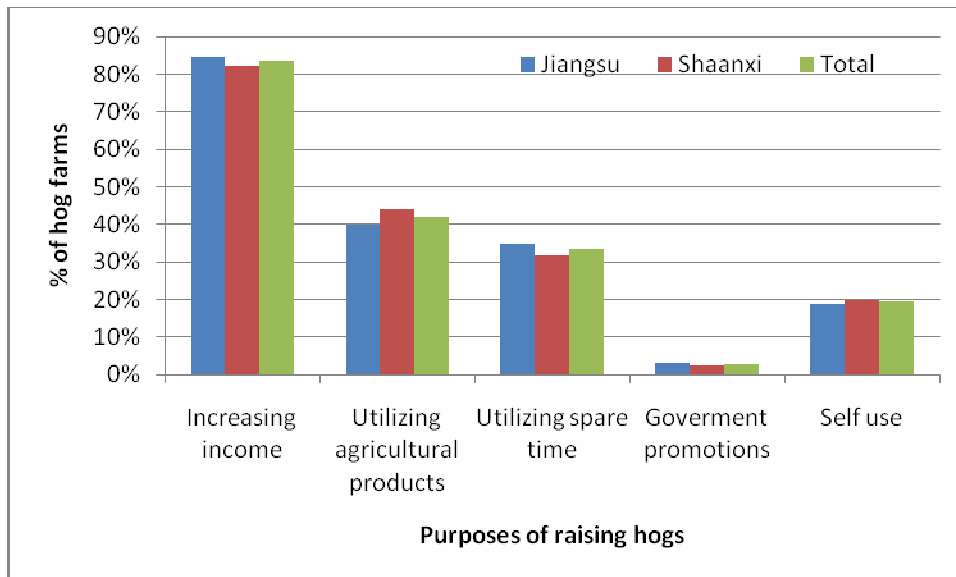


Hog farmers seldom borrow money from the bank or participate in cooperation organizations for hog production. The proportion of hog farmers who applied for and received a loan for hog production in the past three years is around 10% in both provinces. The proportion of hog farms that participate in any cooperation organization for hog production is even lower, 7.4% in Jiangsu and 6.1% in Shaanxi. A large proportion of hog farmers do not know that such organizations exist in the local areas.

In summary, raising hogs is still a sideline production in the surveyed areas. Hog farmers independently participate in the production with their own materials, funds, labor, and management. Hog traders play an important role in connecting hog farmers to the market.

To identify the reasons for raising hogs, the hog farmers were asked to choose reasons why they raise hogs. Figure 8 summarizes the results. The responses are consistent in both provinces. Increasing income is the most popular goal in raising hogs with more than 80% of hog farmers selecting this response in the survey. The next most popular purposes are utilizing agricultural products and utilizing spare time. Interestingly, there are more respondents than we expected who selected self use as their reason for raising hogs. One possible explanation is that farmers raise hogs as an alternative source of pork for consumption when pork prices increase. Significantly fewer farmers chose government promotions as their purpose for raising hogs.

Hog farmers were also asked about which factors influence their production plan. Figure 9 shows these results. All of the factors listed in the survey were selected by a significant portion of respondents, but the prices of hogs and feed are the two most influential factors. About 75% and 40% of the hog farmers selected them in the survey. Examples of other hog farmers' success and new pig breeds are the factors selected by the least number of respondents in the survey.



**Figure 8. Purpose for raising hogs**

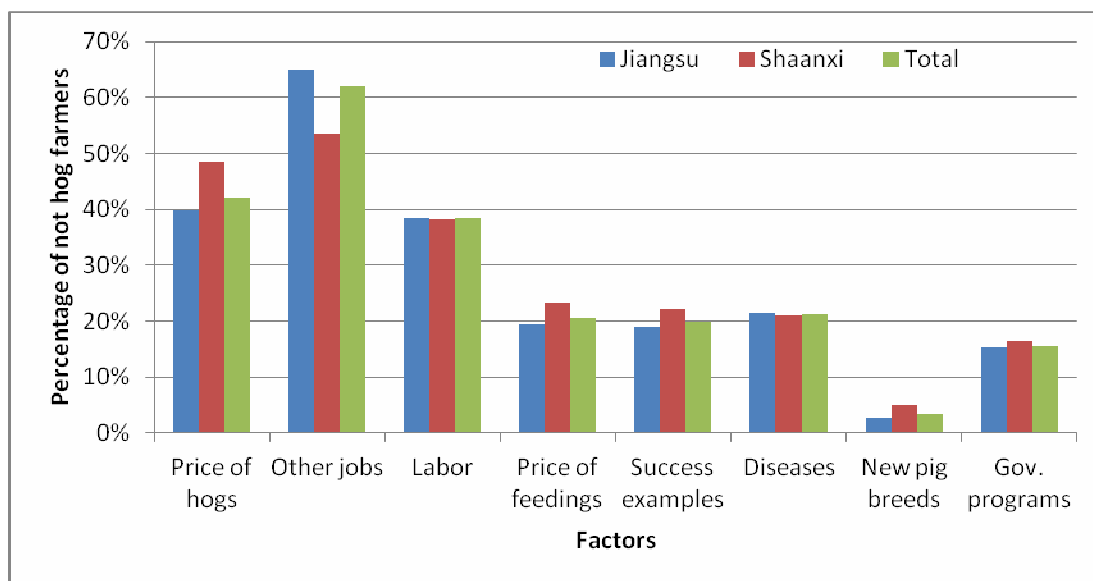
To provide insight into the reasons for not raising hogs, the farmers who did not raise hogs in 2007, 2008, and 2009 were asked to choose reasons why they did not raise hogs in those

three years. Figure 10 presents the results. Earning better income from other jobs is the most popular reason for not raising hogs; about half of non hog farmers selected it. Lack of labor and lack of a piggery are popular reasons in both provinces that prevent farmers from raising hogs. Comparatively, there are significantly more non hog farmers in Shaanxi than in Jiangsu who are prevented by money issues from raising hogs, and more non hog farmers in Jiangsu are concerned about hog disease.

## 5. Empirical results

The Heckman model is employed to investigate the factors that influence household farmers' decisions regarding both whether or not to raise hogs and the raising scale. Two dependent variables are needed to represent the farmers' two hog-production decisions. One dependent variable is the participation decision, represented by a dummy variable. It equals 1 for the sample households who raised hogs in the past three years and equals 0 for the sample households who did not. The other dependent variable is the hog production scale for the sample households who raised hogs in the past three years. It is represented by the average number of hogs each household raised per year.

The theoretical model revealed that farmers' participation and scale decisions about hog production are influenced by four sets of factors: household resources, opportunity cost, productivity of hog production, and hog market. In the end, 14 explanatory variables were selected to represent the four sets of factors. Table 4 summarizes the 14 variables.



**Figure 9. Influential factors for hog production plan**

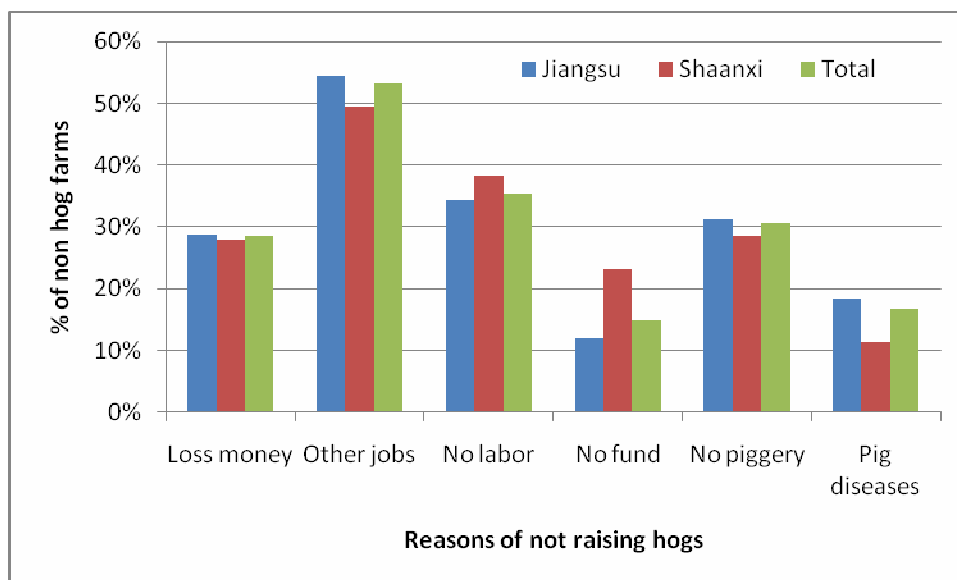


Figure 10. Reasons for not raising hogs

Table 4. Potential explanatory variables

Variables	Format	Explanation
<b>Household resources</b>		
Labor	Numeric	The number of adults aged 18–60
The elder	Numeric	The number of old people aged more than 60
Subsidy	Binary	Whether or not the local government provides subsidy for hog production
Loan	Ordinal	Is it easy to get a loan from a local bank?
<b>Opportunity cost</b>		
Cultivated land	Numeric	The area of cultivated land
New farmers	Binary	Get more than 50% of income from nonfarm activities
Proportion of migrant workers	Ordinal	Percentage of labor forces working in cities
<b>Productivity of hog production</b>		
Proportion of hog farmers	Numeric	Percentage of hog farmers in the village
Mid size hog farmers	Binary	Whether or not there are hog farmers who raise 16–100 hogs per year.
Big size hog farmers	Binary	Whether or not there are hog farmers who raise more than 100 hogs per year
Coop. organization	Binary	Whether or not there is a hog raising cooperation organization in local areas
<b>Hog market</b>		
Location	Nominal	Where is the village located?
Distance to market	Numeric	The kilometers from the village to the nearest market
Slaughterers	Binary	Whether or not there are slaughterers in the village

In addition to the 14 variables, 2 dummy variables are also included in the estimation. One is “Jiangsu,” which is added to both estimations for the purpose of catching the difference between Jiangsu and Shaanxi. It is equal to 1 for the sample households in Jiangsu and 0 for those in Shaanxi. Another one is “Big farmer,” which is equal to 1 for the hog farms who raised 100 hogs or more per year and 0 for others. The “Big farmer” variable is added to only the scale decision equations, to represent the unobserved factors that make these households decide to raise hogs on a big scale. In the end, there are 15 explanatory variables in the participation decision equation and 16 variables in the scale decision equation.

The estimation results of the Heckman model using a two-step method are summarized in Table 5. To make the comparison, the participation decision equation and scale decision equation in the model are also estimated with logistic regression and OLS, respectively. The estimation results of both procedures are similar.  $\rho$  estimated in the two-step method is equal to 0.130, which means the correlation between two error terms are slight and that the two-step estimation method is more suitable; only the estimation results of Heckman two-step methods are presented here.

### *Participation decision*

The estimation results on the participation decision suggest the following findings: First, all of the household resources factors except loans have significant, positive influences on farmers’ decisions about whether to raise hogs. Focusing on the availability of labor force, the more adult family members, including the elderly, the more likely the household is to raise hogs. With regard to financial factors, although subsidies will significantly increase the likelihood of raising hogs, the availability of bank loans has insignificant influence.

Second, among the opportunity cost factors, the amount of cultivated land and identification as a new farmer have significant, negative influences on farmers’ decisions to raise hogs. The scale of cultivated lands has a negative impact; that is, when farmers have more land, they are likely to give up hog production and concentrate on planting. New farmers, who already earn more than half of their income from nonfarm jobs, are less likely to raise hogs than traditional farmers. These results may suggest that when farmers have opportunities to earn income from nonfarm jobs, like working in government and doing part-time jobs, they would be less likely to raise hogs.

Third, with regard to the market factors, the location of the village has significant impacts on the likelihood of raising hogs for its households. Compared to those who live in the countryside, farmers who live in a township are less likely to raise hogs, while farmers who live near a city are more likely to raise hogs. The distance between the village and the local market also has significant influence. The closer the village is to the market, the more likely it is to have households that raise hogs.

Fourth, rural households in Jiangsu are less likely to raise hogs compared to similar households in Shaanxi.

**Table 5. Estimation results of the Heckman model**

	Participation		Scale	
	B	P-value	$\beta$	P-value
Household resources				
Labor	0.112	0.000	1.100	0.004
The elder	0.096	0.001		
Subsidy	0.195	0.000		
Loan			1.177	0.059
Opportunity cost				
Cultivated land	-0.006	0.031		
New farmers	-0.707	0.000	-6.171	0.002
Proportion of migrant workers			0.508	0.026
Productivity of hog production				
Proportion of hog farmers	0.646	0.000		
Mid size hog farmers			6.566	0.000
Big size hog farmers			7.872	0.000
Coop. organization	-0.250	0.000	-3.594	0.004
Hog market				
Location				
Town	-0.369	0.000		
City	0.292	0.006		
Distance to market				
Slaughter				
Jiangsu	-0.346	0.000	5.858	0.000
Big hog farmer			163.727	0.000
Constant	-0.207	0.107	-5.100	0.275
N		3287		
Wald Chi-square		4195.06		
Prob > Chi-square		<0.0001		
Rho		0.130		

Notes: Only the significant (0.100) variables are presented.

### *Scale decision*

Estimation on the production scale model suggest the following findings: First, among the household resources factors, only the number of adults aged 18 to 60 significantly contributes to the scale of hog production; the influence of the number of senior family members becomes insignificant. Different from participation decision, hog farmers' scale decision is significantly influenced by the availability of loans but has insignificant relation with the existence of subsidy.

Second, new farmers are not only less likely to raise hogs, they also have less raising scale even if they raise hogs. The percentage of migrant workers has positive influences on the production scale, which means that the more people from a particular village that work in the cities, the larger the hog production scale of the hog farms in that village.

Third, with regard to the village specialization effects, the existence of both middle-sized hog farms and large-size hog farms in a village tend to increase the size of small farms. On the other hand, the existence of cooperation organizations does not increase the production scale of local hog farms.

Fourth, no hog market variables show significant impacts on raising scale. That may be because Chinese hog farmers are still in the far end of supply chain and depend more on the middle trader to sell hogs. The average hog production scale is higher in Jiangsu than in Shaanxi.

## **6. Conclusions and implications**

Although the survey reveals that China's hog production is still dominated by small-scale household hog farms in the surveyed regions, the descriptive and empirical analyses indicate that China's hog production will likely become more concentrated. On one hand, the number of household hog farms may continue to decrease when people migrate into cities and have more opportunities to feed their family with nonfarm jobs. Our survey indicates three reasons. First, there has been a current of adult family members migrating from rural areas to cities and working in cities in China. The empirical analysis shows that the likelihood of raising hogs and the raising scale of hog farms are significantly influenced by the availability of labor force. When more and more labor forces migrate into cities, rural households will likely decrease or even give up raising hogs.

Second, our survey reveals that farmers' decisions about hog production are mainly determined by the comparative profitability of hog production. The empirical analysis supports that if the local farmers earn more income from other jobs, they are less likely to raise hogs. As nonfarm economy in China's rural areas continues to grow, more farmers may give up hog production and turn to nonfarm jobs.

Third, many hog farmers suffer high risk of hog disease and death. This risk may deter small hog farmers from raising hogs. The survey shows that hog production is usually a sideline production of small hog farms. If the perceived risk overwhelms the potential benefits, these farmers can and will easily quit hog production.

One the other hand, specialized hog farms with larger production scales and specialized hog villages are likely to increase for three reasons. (1) Specialization of agricultural production is a significant trend in China's rural areas, especially in coastal provinces like Jiangsu. In such situations, following the success of pioneers, multiple farmers in one village begin to specialize in a few agricultural products. Such may also be the case for hog productions. (2) Our empirical analysis shows that the existence of middle-size hog farms (16–100 heads) and big-size hog farms (more than 100 heads) significantly increases the production scale of other hog farms in

the same village. Public technology and information services are scarce in most of China's rural areas and personal experiences play a substantial role in conducting agricultural production. The existence of specialized hog farms may encourage and assist other hog farms in the same villages to expand their production scale. (3) The percentage of migrant workers positively influences the production scale, which means that the more people from one village work in the cities, the larger hog production scale the local hog farms have. This may be because when more villagers work in cities, local farmers are more likely to have access to capital, husbandry knowledge, and market information, so they are more likely to be able to raise more hogs.

China's pork consumption will very likely continue to increase. Most of the growing demand will be supplied by domestic producers. Chinese government has a strong inclination to remain self-sufficient in terms pork production. It has made great efforts to do so, providing subsidies to hog farmers and imposing a ban on imported pork to recover domestic pork production after the outbreak of "blue ear pig disease" in 2007 and 2008.

It is also very likely that China will increase pork imports. As discussed in the previous section, China's pork production will likely become more concentrated, with the decline of backyard hog farms and growth of specialized hog farms. This structure change may increase the cost of pork production in China. Specialized hog farms depend more on processed feed grains like corn and soybeans. China has limited land to produce such land-intensive but labor-extensive products. As Chinese consumers' demands for other livestock products like dairy increase simultaneously, the shortage in feed grain production will compel China to import more feed grain or pork. Pork may be preferred because of both the cost (Fuller, et al., 2002) and the increasing demand for high-quality pork (Ortega & Wang, 2009).

The United States is in a good position to capture the pork import market in China. First and foremost, the United States has a cost advantage over China's hog farms and its global competitors in pork production because of its low grain cost and economies of scale. For example, the production cost for one pound of pork is about \$0.35 in the United States, compared with \$0.60 in China and \$0.54 in Denmark (Amponsah, et al., 2003).

Second, U.S. food products have an international reputation for high quality (Peng, Marchant, & Qin, 2003). With increased income and doubts about domestic products, Chinese consumers are more likely to purchase imported pork if it is available. The U.S. pork may be preferred because Chinese consumers have a positive perception of U.S. pork (Ortega & Wang, 2009).

Third, Chinese consumers' preferences for pork are highly complementary to that of U.S. consumers. Whereas U.S. consumers mainly consume loins and tenderloins, Chinese consumers find these products unappetizing and lacking in taste. On the other hand, while Chinese consumers would be willing to pay high prices for variety meats like feet, stomach, and nape of neck, these products have limited market value in the United States and are priced much lower than loins. These complementary preferences are also represented in the trade as large proportion U.S. port exports to China are the variety meats. The exports of such pork products from the United States to China have benefited both sides (Hayes, 1997; Hayes & Clemens, 1997).

Fourth, the U.S. hog producers are able to cut the hog production cost further if they can export more pork variety meat to China. The example of poultry industry shows that new export markets for chicken legs and wing tips have actually reduced the cost of producing chicken breasts (Hayes, 1997). In 2009, 53.7% U.S. pork exports to China are pork variety meat. By exporting more pork variety meat to China, the U.S. pork industry can become more competitive and that will benefit the whole industry.

Finally, China's huge foreign reserves in U.S. dollars and its significant trade surplus with the United States are likely to encourage China to import more food products, including pork from the United States. In 2008, the United States exported \$12.1 billion in agricultural products to China but imported only \$3.5 billion in agricultural products from China (USDA/ERS, 2010).

China's pork market is not fully open to U.S. pork products yet. Some issues should be considered by U.S. pork exporters besides the negotiation between the two countries.

First, U.S. pork producers may need to make some changes, like revising feed recipes, to cater to the Chinese government and Chinese consumers. Ractopamine and other additives are common in U.S. pork production because of U.S. consumers' preference for leaner meat. Although ractopamine has been proved safe for human consumption in more than 30 countries, it is banned in China and has been used by China's government as a nontariff trade barrier to prevent imports of U.S. pork (Ortega & Wang, 2009). Chinese consumers, too, very possibly have strong negative feelings about pork with ractopamine because they have long suffered from domestic abuse of food additives. Additionally, Chinese consumers prefer fattier cuts of pork and discount lean "Western" cuts.

Second, U.S. pork exporters need to develop niche markets and customize products for that. For example, the majority of U.S. pork exported to China is frozen. Frozen meats have little space in the Chinese consumer market because Chinese consumers prefer freshly slaughtered pork. The more promising market for U.S. pork may be restaurants and food companies in China. With their increased incomes, Chinese consumers are increasing their food consumption outside the home, where they are less concerned about the freshness of the pork used in dishes.

Third, U.S. pork exporters should develop strategic partners to build distribution channels. U.S. pork is more likely to succeed in China's supermarkets rather than wet markets because consumers shopping in supermarkets pay more attention to quality, whereas consumers shopping in wet markets focus more on price. The cold supply chain used by supermarkets is also more easily connected with international transportation. However, supermarkets are usually operated by international or local retail companies. Without cooperation with these distributors, it would be difficult and costly to enter China's pork market.



## References:

- Amponsah, W. A., Qin, X., & Peng, X. (2003). China as a potential market for U.S. pork exports. *Review of Agricultural Economics*, 25(1), 259–269.
- Costales, A., Delgado, C. L., Catelo, M. A., Lapar, M. L., Tiongco, M. M., Ehui, S. K., & Bautista, A. Z. (2007). Scale and access issues affecting smallholder hog producers in an expanding peri-urban market: Southern Luzon, Philippines.
- Fuller, F., Tuan, F., & Wailes, E. (2002). Rising demand for meat: Who will feed China's hogs? *China's Food and Agriculture: Issues for the 21st Century*: USDA.
- Geissler, C. (1999). China: The soyabean-pork dilemma. *Proceedings of the Nutrition Society*, 58, 345–353.
- Hayes, D. (1997). *The Chinese market for U.S. pork exports*. Trade Research Center Policy Issues Paper No. 2. Montana State University, Department of Agricultural Economics and Economics.
- Hayes, D. J., & Clemens, R. (1997). *The Chinese market for U.S. pork exports*. Briefing Paper 97-BP 14. Iowa State University, Center for Agricultural and Rural Development. [www.card.iastate.edu](http://www.card.iastate.edu).
- Heckman, J. J. (1979). Sample selection bias as a specification error. *Econometrica*, 47(1), 9.
- Lohmar, B., & Gale, F. (2008). Who will China feed? *Amber Waves*, 6(3), 10–15.
- Lohmar, B., Gale, F., Tuan, F., & Hansen, J. (2009). China's Ongoing Agricultural Modernization. *US Department of Agriculture, Economic Research Service, Economic Information Bulletin*, 51.
- Mérey, G. v. (2006). *The Transformation Process of the Chinese Meat Production*. Institut für Agrarwirtschaft IAW, Zurich.
- National Bureau of Statistics of China (NBSC). China Statistical Yearbook, 1981–2010. China Statistics Press, Beijing. (In Chinese.)
- Ortega, D. L., & Wang, H. H. (2009). Opportunities for U.S. pork in China and implications for U.S. hog producers. From Purdue Extension <http://www.ces.purdue.edu/extmedia/EC/EC-758.pdf>.
- Ortega, D. L., Wang, H. H., & Wu, L. (2009). Consumer Preferences for U.S. Pork in Urban China. Agricultural and Applied Economics Association.
- Pan, C., & Kinsey, J. (2002). *The supply chain of pork: U.S. and China*. Working paper. University of Minnesota, The Food Industry Center.

- Peng, X., Marchant, M. A., & Qin, X. D. (2003). *Chinese consumers' preferences for livestock products*. Paper presented at the American Agricultural Economics Association Annual Meeting, Montreal, Canada.
- Somwaru, A., Zhang, X., & Tuan, F. (2003). *China's hog production structure and efficiency*. Paper presented at the American Agricultural Economics Association Annual Meeting, Montreal, Canada.
- United State Department of Agriculture/Economic Research Services (USDA/ERS). (2010). Top 15 U.S. agricultural import sources, by fiscal year, U.S. value. <http://www.ers.usda.gov/Data/FATUS/DATA/Mfytop15.xls>.
- U.S. Meat Export Federation (USMEF), (2010). Export Statistics. <http://www.usmef.org/news-statistics/statistics/>
- Wang, Q., Parsons, R., & Zhang, G. (2010). China's dairy markets: Trends, disparities, and implications for trade. *China Agricultural Economic Review*.
- Wodajo, T. (2008). A double-hurdle model of computer and internet use in American households. *Department of Economics, Western Michigan University*.