Title: **Examining Economies of Scale for Farmer Cooperatives in China's Shanxi Province**

by

1. Jing Liu
   College of Economics and Management
   Northwest Agriculture and Forestry University
   No. 3 Taicheng Road
   Yanling, Shaanxi 712100
   CHINA
   Telephone: 0086-15803403663
   Facsimile: 435.797.0402
   Email: darling_liujing@yahoo.com
   Ph. D. Candidate Northwest Agricultural and Forestry University; Yanling, China

2. **Corresponding Author**
   DeeVon Bailey
   Professor
   Department of Applied Economics
   Utah State University
   4835 Old Main Hill
   Logan, Utah 84322-4835
   Telephone: 435.797.2300
   Facsímile: 435.797.0402
   Email: deevon.bailey@usu.edu

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Abstract

China's new cooperatives law took effect in 2007 and resulted in rapid growth in the number of agricultural cooperatives. This study examines economies of scale for farmer cooperatives in Shanxi Province; the province with the fastest growth in cooperatives in China. The results indicate that all cooperatives considered grew rapidly in numbers of members and value of assets between 2008 and 2010. Large cooperatives have an advantage over small cooperatives in terms of economies of scale. The results indicate that when a strategy couples growth with specialization it tends to improve the competitive position of these cooperatives.

Key Words: *economies of scale, fruit and vegetable cooperatives, firm growth*

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Introduction

The concept of farmer cooperatives was introduced in China during the early part of the twentieth century. However due to recent legal reforms, there has been renewed and intense interest in using farmer cooperatives as a tool for rural economic development in China. For example, business liberalization and legal reform during the past decade facilitated by the new federal cooperatives law which went into effect on July 1, 2007 have led to the rapid development of new types of formal (legally-organized) farmer cooperatives (Central People's Government).

This law was passed during the 24th meeting of the Tenth National People's Congress and, among other things, allows for the legal establishment of agricultural cooperatives by 1) describing legal documents required submission to become a legally-recognized cooperative, 2) requiring that cooperatives have at least five members, and 3) requiring cooperatives to have a legal name. Cooperatives are also now required to establish a governing body including officers for the board of supervisors and the board of supervisors is permitted to hire managers and other employees.

The law directs both central and local governments to support the efforts of agricultural cooperatives by developing appropriate information, training, agricultural product quality standards and qualifications, agricultural infrastructure, marketing and promotional technologies, and other services. Agricultural cooperatives are also provided various methods under the new law to obtain capital from lending institutions and were granted tax preferences for many of their activities.

The new cooperatives law and the emerging market opportunities associated with China's rapid economic growth and economic liberalization, have led to rapid growth in the number agricultural cooperatives in China since 2007. According to statistics from China's Ministry of Agriculture, there are currently 150,000 agricultural cooperatives operating in China with member-farm households representing almost 35 million people. This number accounts for approximately 14% of all famers in China and the number of new cooperative members continues to grow rapidly. For example, new registrations of cooperative members in Shanxi Province during 2007 numbered 6,634 (the largest number of new registrants for any province in China), but in 2010 the number of new farm-households registering to be members of cooperatives in Shanxi Province had grown to 26,785.

The growth in cooperative membership in China has led to a range of economic and business questions about how these cooperatives should be best organized and operated. One important question relating to cooperative organization considering their rapid growth in number and size is the appropriate sizing of cooperatives for long-run economic viability. Achieving scale economies is an important economic consideration for China's farmer cooperatives because doing so will result in greater long-run economic viability for these cooperatives in terms of their core economic competitiveness (low per-unit costs of operation).

This paper presents results of an analysis using data from a survey of agricultural cooperatives in Shanxi Province. The analysis examined the cost structure of these cooperatives based on their scale of operations and other characteristics. Shanxi Province is located in north-central China, occupies an area equal to 60,000 square miles, and has a population of approximately 32 million. While Shanxi is not a major agricultural-producing province relative to China as a whole, agricultural production is an important component of the local economy.

The rate of growth rate in the number of agricultural cooperatives in Shanxi was also the largest in China between 2008 and 2010 making the Province an excellent candidate as a location to study the growth of agricultural cooperatives.

An econometric model of the cost function for the cooperatives included in the survey was estimated yielding a measure of economies of scale for the individual cooperatives and additional analysis was done using these estimates. The specific objectives of the study were to 1) describe the presence of economies of scale in fruit and vegetable cooperatives in Shanxi Province based on the economic characteristics of the cooperatives such as size, level of specialization, growth rate, and types of operations, and 2) to provide insights about the consequences of growth in terms of economies of scale and how different incentives for growth may have affected economies of scale for these cooperatives between 2008 and 2010.

The results suggest, perhaps not surprisingly, that larger cooperatives have costs that are decreasing with output (economies of scale) while smaller cooperatives, on the average, have diseconomies. This implies that incentives likely exist for larger cooperatives to continue to lower costs through mergers, acquisitions, or other types of growth in their operations. However, the results suggest that coupling growth with increasing specialization is a better strategy than simply growing the volume of sales.

Procedures and Survey

Cooperatives in China engage in a wide range of economic activities on behalf of cooperative members and non-members. For this study, cooperative members are considered to be the main objective of services provided by the agricultural cooperatives in the sample in Shanxi Province regardless of whether the service provided is purchasing agricultural inputs; pursuing multi-product sales; providing agricultural processing; providing transportation and

storage of agricultural production; or providing technology and other information relating to agricultural production, marketing and operations. The focus of this study is on fruit and vegetable cooperatives and is appropriate given that much of the growth in the number of cooperatives in Shanxi Province has involved fruit and vegetable cooperatives.

Farmer cooperatives in China typically negotiate with input manufacturers for inputs such as seed, fertilizers, chemicals, and crop covers. The goal of these negotiations is to provide these inputs to members at a net price lower than they would have paid to other input suppliers. Typically, farmers belonging to fruit and vegetable cooperatives in Shanxi Province also provide their crops to their cooperatives for marketing. Revenues from the sale of the members' crops is shared (pooled) among the members while the cooperative keeps a portion of the sales revenue to both cover operational costs and to provide for new investment in the cooperative. Assuming the goal of these cooperatives is to maximize net returns to cooperative members, operating at low cost per unit of output is an important competitive strategy for these cooperatives, and they are expected to attempt to keep per-unit costs low by achieving economies of scale if possible.

The approach used in this study is to estimate economies of scale in Shanxi Province for fruit and vegetable cooperatives[1] based on their stated costs of operations. A survey was used to obtain cost and other types of data to examine economies of scale for these cooperatives. Due to the nature of the analysis, individual cost information was required for each cooperatives and this information was not available from public sources.

Factors Affecting Firm Size and Economies of Scale

Competing theories about phenomena that influence firm size dominate the literature rather than well-defined rules about optimum firm sizing in terms of economies of scale. One incentive

[1] The primary products produced by these cooperative include apples, pears, cherries, strawberries, jujubes, and hawthorns.

for firm growth postulated by transaction costs economists is that costs are reduced by integrating the operations of the firm to reduce transaction costs rather than as an incentive to reduce production costs (economies of scale) (Coase; Williamson 1985 and 1993).[2] However, Riordan and Williamson also attempted to explain the connection between scale economies and transactions costs in sizing the firm through the concept of asset specificity.[3] Riordan and Williamson argue that in the presence of transaction costs and large-scale production technology, highly-specific production assets used by a supplier to produce a good or service for a buyer can be more easily replicated within the buyer-firm than non-specific assets can (p.369).[4] Thus, if production requires highly specific assets and average per-unit costs of production are decreasing with volume, the firm will tend to become increasingly specialized as it grows.[5] Conversely, diseconomies are expected according to Riordan and Williamson if asset specificity is low and suppliers can produce with their large-scale production to the needs of many buyers. Thus, in the presence of low asset specificity and transaction costs firms will not tend to replicate these assets and firms will tend to be smaller and less specialized as a result. Recognizing this as a potentially important explanation for firm growth, this study provides a preliminary examination of the connection between the growth in the size of cooperatives in Shanxi Province and their degree of specialization.

A large literature exists analyzing the influence of national financial policies on economic development and firm growth (e.g. Beck et al.; Pagano and Volpin; and Petersen and Rajan).

[2] Williamson and other transaction cost economists have theorized that other transaction cost-based incentives for integration include uncertainty, bounded rationality, reduced ability to communicate corporate action and goals (atmosphere consequences), the incentives for low-level employees in large firms to maximize personal rather than firm benefit (bureaucratic insularity), the tendency of large firms to base incentives on tenure and position (incentive limits), and the inability of single managers to understand all of the complexities of the firm leading to layers of communication and distortions in communications (communication distortion) (Canbäck).
[3] Asset specificity refers to the "physical, human, site, or dedicated assets" controlled by a firm (Canbäck).
[4] This argues that incentives exist to grow and specialize if asset specificity exists. See discussion in Canbäck.
[5] While recognizing the difference between economies of scale and returns to scale, Weaver supports the notion that returns to scale lead to specialization.

China's recent adoption of its new cooperative law should foster growth in cooperative numbers and size given that the new law provided legal status to cooperatives as well as allowing cooperatives to borrow money.

Joaquin and Khanna suggest that the level of competition in a market and market prices can cause firms of different size to time investment decisions differently.[6] They conclude that the effect of potential competition is to favor initial investment by small firms relative to large firms because the market-exit costs in the case of a mistake are less for small firms than for large firms. Consequently, the rates of growth (investment) and the timing of these investments may be different for these cooperatives based on their initial sizes. In this case, one would expect that small cooperatives would tend to invest earlier and at a higher rate than large cooperatives.

The size of the firm is also related to its efficiency and the production possibilities frontier. Firms should minimize the costs of inputs required to produce a given output. Otherwise, the firms, including cooperatives, may be incorrectly sized or, in other words, could be producing more output with the same expenditures on inputs (e.g., Porter and Scully; Akridge). Efficiency is not directly measured for the cooperatives in the sample because output units across the sample were not obtained due to different types of fruits and vegetables being marketed by the different cooperatives. Sales (Y) then became the measure of output in the models used in the analysis.

Economies of scope, also called inter-product complementarity, can contribute to overall scale economies if the joint production of two or more outputs results in lower per-unit costs of product for both than if each were produced separately (Deller, Chicoine, and Walzer). While economies of scope are not estimated directly for this study, the degree of specialization is

[6] Joaquin and Khanna indicate a theoretical basis for this finding is found in the real options literature al a Pindyck and also Dixit.

considered through measures of a product-mix index to provide an approximation of how focusing on a single product for revenue (sales) is related to economies of scale for cooperatives in Shanxi Province. The study also considers accounting measures related to firm performance to determine connections between accounting performance (in this case sales per cooperative member) and economies of size (Jerris and Pearson; Parliament, Lerman, and Fulton).

Because the literature indicates that different factors will result in different actions and strategies for firms relating to growth depending on their size, level of asset specificity, efficiency, and level of specialization we examine the relationship of some of these factors to the estimated economies of scale for the cooperatives in the sample. While not all of these potential influences on the size and investment decisions of firms are directly measureable in this study, some basic measures are used to ascertain connections between these factors and scale economies for the agricultural cooperatives studied.

Survey

The survey was administered during 2011 to a total of 70 fruit and vegetable cooperative managers in Shanxi Province. The cooperative managers were asked about costs of operation for their cooperative during each of the previous three years (2008, 2009, and 2010) as well as revenues and their cooperative's scope of operations during those three years. Clark indicates that financial statements are an acceptable source of such data, and although actual financial statements were not available, the managers' statements about costs were considered the best available approximation for costs and the other information provided. Among the 70 surveys completed, there were 44 surveys (cooperatives) with survey data complete enough to be included in an empirical statistical analysis using panel data to identify the individual cooperative's economies of scale.

The data for the 44 cooperatives used in the analysis were divided equally into two groups of 22 cooperatives for the purpose of comparing the scale economies of larger and smaller cooperatives. This was important because a large range of sizes exists for cooperatives in the Province and there is interest in understanding appropriate growth strategies for cooperatives based on size. An average value for physical assets of two million Yuan[7] during the three-year period of 2008 to 2010, inclusive, provided a natural dividing line to separate the cooperatives into two groups. Table 1 reports mean values and standard deviations for some basic characteristics of the 44 cooperatives used in the statistical analysis based on three years of data they provided (2008-2010).

Model

Duality theory argues the cost function of a cost-minimizing firm may be used to estimate economies of scale for the firm (see Green pp. 125-126 and Hertel). Translog cost functions (TCF) have frequently been used in studies estimating economies of scale (e.g., Caves, Christensen, and Tretheway; Kim; Cowing and Holtman; Deller, Chicoine, and Walzer) and a TCF was used in this study to estimate scale economies for the 44 cooperatives in the sample from Shanxi Province.

Separate analyses were conducted for the smaller cooperatives (average assets of less than two million Yuan) and larger cooperative (average assets of more than two million Yuan) as a method to compare economies of scale for cooperatives in these two size categories. This was done given that firm size is often used as an explanation for the existence or absence of economies of scale (e.g., Mankiw (p. 283)). A comparison of results between smaller and larger cooperatives was a test of that hypothesis for agricultural cooperatives in Shanxi Province.

[7] On April 6, 2012 xe.com reports an exchange rate of approximately 6.3 Yuan per $1 USD indicating that two million Yuan would equate to about $317,000.

Consequently, the analysis provided empirical results decision makers in cooperatives in Shanxi Province might be able to use when considering sizing their cooperatives relative to economies of scale. To our knowledge, no other study has completed this type of empirical analysis for agricultural cooperatives in China. Fruit and vegetable cooperatives were selected for the analysis for other reasons besides just their prominence in Shanxi Province. First, the level of technology adoption is approximately equal across the cooperatives in the sample and second, the method of operation for the cooperatives in the sample is approximately equal.

An econometric model using seemingly unrelated regression techniques and panel data was used to estimate the parameters of a TCF using panel data for the 44 cooperatives between 2008 and 2010, inclusive. The TCF was defined as:

$$(1)\ \ln C = \alpha_0 + \alpha_Y \ln Y + \beta_L \ln W_1 + \beta_K \ln W2 + \delta_T T + \frac{1}{2}\alpha_{YY}(\ln Y)^2 + \frac{1}{2}\beta_{LL}(\ln W_1)^2 +$$

$$\frac{1}{2}\beta_{KK}(\ln W_2)^2 + \frac{1}{2}\delta_{TT}(T)^2 + \phi_{YL}\ln Y \ln W_1 + \phi_{YK}\ln Y \ln W_2 + \phi_{TY} T \ln Y + \beta_{LK}\ln W_1 \ln W_2 + \phi_{TL} T \ln W_1 + \phi_{TK} T \ln W_2 \ ; \text{with}$$

$$(2)\ \frac{\partial \ln C}{\partial \ln W_1} = S_L = \beta_L + \beta_{LL}\ln W_1 + \phi_{YL}\ln_Y + \beta_{LK}\ln W_2 + \phi_{TL} T$$

$$(3)\ \frac{\partial \ln C}{\partial \ln W_2} = S_K = \beta_K + \beta_{KK}\ln W_2 + \phi_{YK}\ln Y + \beta_{LK}\ln W1 + \phi_{TK} T$$

The TCF must be linearly homogeneous in input prices. This requires the following parameter restrictions:

$$(4)\ \beta_L + \beta_K = 1;\ \ \beta_{LL} + \beta_{LK} = 0;\ \ \beta_{KK} + \beta_{LK} = 0;\ \ \phi_{YL} + \phi_{YK} = 0;\ \ \phi_{TL} + \phi_{TK} = 0$$

Y was defined as the sum of all outputs (*Total Sales* in Table 1) to solve for the condition that a specific output is zero, which avoids a negative value in the logarithm conversion condition.[8] Other variables represented in the TCF here were defined as the cooperative's stated annual total costs (*C*)[9] given outputs (*Y*), input prices (*W*), the price of labor and the price of capital are W_1 and W_2, respectively. W_1 was total wages of employees divided by the number of employees; W_2 is annual fixed assets divided by the annual net value of fixed assets (depreciation). *T* represented dummy variables corresponding to the years 2008, 2009, and 2010. *C* is the total cost for business expenses, administrative expenses and assets expenditures.

The degree of economies of scale (*SE*) was defined where,

$$(5)\ SE = \frac{\partial \ln C}{\partial \ln Y} = \alpha_Y + \alpha_{YY} \ln Y + \phi_{YK} \ln W_1 + \phi_{YK} \ln W_2 + \phi_{TY} T$$

If *SE* was less than one then economies of scale were said to exist (per-unit costs were declining as output increased) or if *SE* was equal to one then constant returns to scale existed, or if *SE* was more than one then diseconomies of size existed. It was anticipated that heteroscedasticity would exist in the data because of different sizes in *Y* for the various cooperatives. The method used to deal with this was to estimate the model separately for large and small cooperatives. If this had not solved the potential problems with heteroscedasticity, other methods, such as the White estimator would have been used to correct the problem.

Finally, describing the relationship between the estimated economies of scale (*SE)* for these cooperatives and factors suggested as contributing to firm growth and investment may

[8] Also see Table 1 for definitions of variables.

[9] Total costs were calculated as the sum of the manager's stated production (variable) costs, rental expenses, and depreciation (fixed costs). In cases where depreciation costs were not provided, depreciation was estimated using straight-line depreciation methods by dividing intermediate asset values by seven and long-term assets such as buildings by 20.

provide some insights to cooperative managers as they consider the best strategies for sizing their firms to be cost competitive. Consequently, a panel data estimator (Greene) was used to consider the relationship between economies of scale and some of the factors potentially affecting economies of size as mentioned in the literature. This took the following functional form:

(6) $SE_{it} = \propto_0 + \ \Sigma_{j=1}^{7} \ \propto_j X_{itj} + \ \varepsilon_{it}$

where X_{itj} was the j^{th} potential factor (j = GR*OWTH RATE*, *SPECIALIZE*, *SALESMEM*, *SMALL*, *TREND*, *ROGTR*, *ROGSPECIAL*) theorized, based on the previous research that has been cited, to be related to growth and investment of firms and, hence, potentially the economies of scale for the i^{th} agricultural cooperative in the sample (i = 1, 2, 3, . . ., 44) in the t^{th} was the time period (t = 2008, 2009, 2010). $\propto_0$ was an estimated intercept, $\propto_j$ are the parameter estimates for the effects of the j^{th} cooperative characteristic on the cooperative's economies of scale, and ε was the error term. Because a smaller value for *SE* indicated a tendency toward economies of scale (economies of scale existed if *SE* was less than 1), a negative estimated parameter ($\propto_j$ s) indicated a positive relationship between that characteristic, *X*, and the cooperative's economies of scale. Conversely, a positive estimated parameter indicated that the characteristic, *X*, had a negative relationship to the cooperative's economies of scale.

The factors (*X*) included in equation (6) were selected to represent different potential incentives for firm growth and investment that might affect the degree of economies of scale for the cooperatives in the sample (see Table 1). For example, theory suggested that growth is a principal consideration in the economics of firm size (Williamson). *GROWTH RATE* was the year-over-year growth in the cooperative's assets. Consequently, *GROWTH RATE* could be calculated for 2009 and 2010 but not the base year 2008 resulting in the observations for 2008

needing to be dropped from the regression and leaving 88 (44 cooperatives for two years) observations remaining.

SPECIALIZE was a variable describing the degree of specialization found in the cooperative and was calculated in a Herfindahl-like index as the sum of the squared proportions of total sales for each of the five categories of sales (commodity sales, seed sales, pesticide sales, chemical sales, and crop cover sales). A value of 1 for *SPECAILIZE* would have indicated that the cooperatives revenues (sales) were obtained exclusively from crop sales because every cooperative in the sample sold commodities. A value for *SPECIALIZE* approaching 0 indicated a low level of specialization for the cooperative.[10] Transaction cost economics suggested that as firms grew they would tend to specialize thus contributing to economies of size (Riordan and Williamson).

SALESMEM represented an accounting performance measure of sales volume per cooperative member or that a cooperative would be considered more efficient in the accounting sense if it were handling more volume of sales per each member than a cooperative with lower sales volume per member. *SMALL* was a binary variable accounting for the different size categories for the cooperatives in the sample and was equal to 1 if the cooperative had fewer than two million Yuan in assets and was 0 for cooperatives with over two million Yuan in assets. The parameter estimate for *SMALL* is expected to be positive and, if so, would confirm the hypothesis that small firms are more prone to diseconomies of scale than large firms.

TREND was a linear trend used to correct for systematic changes in the other variables over the study period (*TREND* =1 for 2008, 2 for 2009, and 3 for 2010). *TREND* was also an important consideration when considering the timing of investment and growth of the firm (e.g.

[10] The overall (including both large and small cooperatives) maximum value for *SPECIALIZE* in the sample was 1.00 and the overall minimum value was 0.399. Theoretically, a value of 0 would require a large number of different activities in the cooperative each contributing a very small (close to zero) proportion of total sales.

Joaquin and Khanna). Consequently, a variable, *ROGTR*, was created as the three-way interaction of growth, trend, and size of the cooperative (G*ROWTH RATE * TREND * SMALL*). According to Joaquin and Khanna, smaller firms (cooperatives in this case) were expected to expand investments[11] more rapidly than larger cooperatives leading to an expectation of a positive parameter being estimated for *ROGTR*.

Riordan and Williamson postulated that specialization and growth tend to occur simultaneously in the presence of transaction costs. The relationship of simultaneous growth and specialization was examined through the interaction variable, *ROGSPECIAL*, which was calculated as the product of *SPECIALIZATION* and *GROWTH RATE*. A negative parameter estimate for *ROGSPECIAL*, would support the notion that the cooperatives in the sample that have combined growth with specialization have tended to improve their scale economies.

The following section reports the parameter estimates for equation (1) as well as the estimates for *SE* (equation (5) for the different cooperatives. The results for the analysis examining the relationship between different factors expected to influence firm (cooperative) growth and investment and, hence, potentially economies of scale for these cooperatives (equation (6)) were reported together with a discussion of the implications of those results.

Results

Descriptive statistics for the sample indicated that these cooperatives have been growing rapidly in 1) the number of members in each cooperative (*MEMBERS*) and 2) the size of their operations measured both by *Y* and *ASSETS* (see Table 1). Given this result; economic incentives must have existed to encourage this growth. In fact, every cooperative in the sample had more members in 2010 than in 2008, and both the absolute and relative rates of growth in membership for these cooperatives are impressive. For example, the cooperatives in the small-

[11] Measured here as investment in physical assets.

size category saw membership grow by an average of over 1125% between 2008 and 2010 while the average number of members in the small-size cooperatives grew by over 149 during that same period.[12] Large cooperatives in the sample saw their member numbers grow an average of about 933% between 2008 and 2010 which translated into an average of 240 more members per large cooperative in 2010 than in 2008.

This suggests that the new cooperative law has had a large impact on fostering cooperative development in Shanxi Province and likely throughout China. This finding supports the premise that government policy, especially financial policy, plays an important role in investment decisions (Pagano and Volpin; Petersen and Rajan).[13]

The parameters for equation (1) for the cooperatives in the two size categories were estimated using SUR estimation techniques and are provided in Table 2. The results of the estimates for scale economies (equation (5)) based on size category are presented in Table 3. Table 4 provides individual average estimates for *SE* for each cooperative in the sample as well as information on per capita land size and average number of members for the cooperative during the three-year study period.

The results indicated that the smaller cooperatives in this sample may have been "over shooting" their optimum growth between 2008 and 2010 in terms of economies of scale. This conclusion was based on the average estimated *SE* for the group of smaller cooperatives increasing from approximately 0.82 (scale economies existed, on the average) in 2008 to over 1.16 in 2010 (scale economies did not exist, on the average) (Table 3). This suggested that by 2010 fruit and vegetable cooperatives in the large category tended to be experiencing economies

[12] Recall that formal cooperatives may be formed under China's new cooperative law with only five members. For the small cooperative group, the average number of members in 2008 was slightly over 31 and seven of the 22 smaller cooperatives had 10 members or less in 2008.

[13] The new cooperatives law established legal recognition of agricultural cooperatives and avenues and encouragements for borrowing capital.

of scale, on the average, while the cooperatives in the small category were not. This was based on the fact that only one of the 22 cooperatives in the large-size category had an estimated average *SE* between 2008 and 2010 that was greater than one (Tables 3 and 4) while 12 of the 22 cooperatives in the small-size category (about 55%) had an estimated average *SE* for the same time period greater than 1 (Table 4). This was not surprising though given that scale economies are typically thought of as being associated with larger volumes of product (sales) than with smaller volumes (Clark).

Questions about the relationship factors affecting firm growth and economies of scale may provide some insight into how such factors could be considered in future growth and investment decisions by these cooperatives. This was important considering that many of the cooperatives in the sample were experiencing diseconomies of size by 2010 (Table 3).[14] The presence of diseconomies suggests that while these cooperatives were growing, they may not have grown in an optimal manner to achieve better economies of scale. In fact, only nine of the 44 cooperatives in the sample saw their estimated value for *SE* decline during the three-year period.

Table 5 reports the estimated parameters for equation (6). Equation (6) used a panel data estimator to examine the relationship between some of the influences past researchers have postulated influence growth and economies of size. Unfortunately, a fixed effects model could not be estimated for a specification that includes individual-specific variables due to a perfect colinearity problem. Consequently, the analysis was unable to perform the standard Hausman test to compare the appropriateness of fixed versus random effects for the parameter estimation.

[14] The estimated average *SE* for larger cooperatives also increased between 2008 and 2010 but by a much smaller amount than did the smaller cooperatives (see Table 3).

Therefore, the random effects model was used as the best alternative for estimating the parameters of equation (6).

The growth rate in assets for the cooperative (*GROWTH RATE*) was not found to have a significant relationship by itself to economies of scale for these cooperatives (insignificant parameter estimate for *GROWTH RATE*). However, the timing of growth in investment by small cooperatives (*ROGTR*) was found to have a small but significant association with diseconomies of scale (positive parameter estimate for *ROGTR* reported in Table 5). However, further examination reveals that these results support those of Joaquin and Khanna who suggested that small firms in competitive markets tend to increase investment earlier than larger firms. The small cooperatives in the sample increased investment an average of 109.4% between 2008 and 2009 and 22.9% between 2009 and 2010. Conversely, the large cooperatives increased average investment by 22.9% between 2008 and 2009 and only 7.6% between 2009 and 2010. This was consistent with the notion that large firms tend to invest at a slower rate than small firms. But, this finding raises questions about the connection between economies of scale and the timing of investment because it suggests that early investment may not necessarily improve economies of scale.

The degree of specialization in the cooperatives in the sample (*SPECIALIZE*) appeared to have a positive relationship with lower values of *SE* (see Table 5). That is, on the average, cooperatives with a larger percentage of their total sales being commodities sales tended to have larger values for *SE* than cooperatives with lower degrees of specialization. However, when growth and specialization were considered together (*ROGSPECIAL*) there was a clear relationship with lower values for *SE* (contributes to economies of scale). This result could occur when investment is tied to specialized equipment and other assets that support a

specialized function such as handling and/or processing of fruit and vegetables. It also supported the notion that growth and specialization (e.g., Riordan and Williamson) is a viable method to reduce per-unit costs.

SALESMEM was associated with high values for *SE* suggesting that measures of accounting efficiency do not necessarily coincide with economies of scale. This was perhaps not surprising considering that the measure has not direct connection to the cost of sales. Consequently, accounting types of measure not connected to per-unit costs are not necessarily good predictors of economies of scale.

SMALL had a positive and significant association with diseconomies of scale as expected given the average values for *SE* for the small and large cooperatives in the sample (Table 3). This suggests incentives existed for the larger cooperatives to continue to grow during the study period but that small cooperatives became less competitive (per-unit costs will go up) as they continued to grow. This difference in incentives for large and small cooperatives may be indicative of differences in the types and quality of assets different cooperatives have made. For example, large cooperatives may have made investments in larger trucks or more sophisticated and expensive equipment than smaller cooperatives. As a result large cooperatives have lower and flatter average cost curves compared to small cooperatives in the sample. Whatever the reason, the results suggested that incentives likely exist for future merger and acquisition activity among the fruit and vegetable cooperatives in Shanxi Province.

A positive and significant estimated parameter for *TREND* simply confirmed that the values for *SE* for this sample increased, on the average, during the study period. While growth rates slowed between 2009 and 2010 compared to growth rates between 2008 and 2009, overall growth in these cooperatives was stunning by almost any measure and, again, supported the

notion that the new cooperative law has succeeded in driving a substantial amount of economic activity related to cooperatives since 2007.

The analysis has yielded results indicating that larger fruit and vegetable cooperatives in Shanxi Province tended to have economies of scale compared to smaller fruit and vegetable cooperatives which tended to have diseconomies of scale. Considering long-term profitability, one would tend to say that large fruit and vegetable cooperatives in this sample were more economically sustainable than the smaller cooperatives in the sample. This suggested that over time one would expect significant amounts of merger and acquisition activity among these cooperative with the larger cooperatives tending to incorporate smaller cooperatives. This type of "shake out" is not unusual in fledgling industries that have experienced such rapid growth like fruit and vegetable cooperatives in Shanxi Province have. The results suggested that a strategy coupling growth with increasing specialization has been a viable for cooperatives in the sample (see results for Table 5).

Conclusions

Growth in farmer cooperatives in China is impressive, especially in Shanxi Province. However, understanding the best strategies for growth is a question of vital importance to China's emerging cooperatives. The analysis presented in this paper provides some insight into how these strategies might be developed for fruit and vegetable cooperatives. The results indicated clearly that large fruit and vegetable cooperatives were in a better position to continue to expand operations in Shanxi Province than were small fruit and vegetable cooperatives. The results also suggested that coupling growth and specialization was a viable strategy for improving competitive position for these cooperatives between 2008 and 2010 and that one would expect increasing specialization on the part of these cooperatives in the future.

Educational programs and research designed to help cooperative managers and members understand economies of scale and other economic considerations related to growth strategies are needed to help these cooperatives make decisions in this highly dynamic environment. Financial planning and capital availability will also be needed as this industry approaches a likely consolidation phase in the near future.

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Table 1. Descriptive Statistics for Agricultural Cooperatives in Shanxi Province Included in the Sample by Size Category.[ab]

Variable	Assets < Two Million Yuan		Assets > Two Million Yuan	
	Mean	Std Dev	Mean	Std Dev
Total Costs (*C*)	105.821	54.355	1085.151	1223.726
Total Sales (*Y*)	118.817	71.235	1370.007	1484.134
Commodity Sales (*Y1*)	97.175	57.019	1099.041	1193.152
Seed Sales (*Y2*)	2.624	3.640	52.867	57.785
Pesticide Sales (*Y3*)	4.050	2.724	45.660	51.550
Fertilizer Sales (*Y4*)	9.854	6.943	106.203	115.979
Crop Cover Sales (*Y5*)	5.113	5.342	66.233	69.755
Labor Costs/Hour (W_1)	2.340E-04	2.760E-05	4.110E-04	1.830E-04
Depreciation (W_2)	0.140	0.006	0.139	0.006
# of Members (*MEMBERS*)	97.439	91.867	176.046	115.498
ASSETS	134.736	55.131	364.947	183.653
GROWTH RATE[c]	1.661	1.163	1.092	0.108
SPECIALIZE	0.700	0.121	0.652	0.038
SALESMEM	1.153	1.618	12.504	15.986

[a] All values are in average millions of Yuan for the three years from 2008 to 2010, inclusive, with the except of # of *Members* which is the average number of members during 2008 to 2010, inclusive. Consequently, 66 observations exist for each size category, i.e., 22 cooperatives in each category times three years.

[b] Category names are followed by the designation name in italics for that variable used in the equations describing the econometric model used in the analysis.

[c] Current year's assets divided by previous years, e.g., 2009 assets/2008 assets.

Table 2. Parameter Estimates for Equation (1) for Cooperatives with Average Annual Assets Under Two Million Yuan and Cooperatives with Average Annual Assets Exceeding Two Million Yuan for Shanxi Province Sample, 2008 to 2010, Inclusive.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Asset Less Than Two Million Yuan Group				
α_0	12.786	3.452	3.704	0.0007
α_Y	-2.446	0.627	-3.904	0.0004
β_K	3.390	1.232	2.914	0.0062
δ_T	0.300	0.146	2.052	0.0478
α_{YY}	0.339	0.036	9.463	0.0000
δ_{TT}	0.061	0.023	2.649	0.0120
ϕ_{YK}	-0.655	0.266	-2.462	0.0169
ϕ_{TY}	0.006	0.063	0.932	0.2262
β_{LK}	0.169	0.325	0.721	0.4058
ϕ_{TK}	0.125	0.172	0.723	0.4745
Assets Exceeding Two Million Yuan Group				
α_0	11.107	3.749	3.963	0.0055
α_Y	-1.099	0.567	-1.939	0.0606
β_K	1.431	1.315	1.088	0.2840
δ_T	0.113	0.099	1.142	0.2611
α_{YY}	0.229	0.037	6.264	0.0000
δ_{TT}	0.019	0.010	1.937	0.0609
ϕ_{YK}	-0.041	0.211	-0.934	0.2477
ϕ_{TY}	-0.025	0.024	-1.028	0.3109
β_{LK}	-0.008	0.064	-0.823	0.3027
ϕ_{TK}	-0.002	0.016	-0.936	0.226

Table 3. Estimated Average Economies of Scale by Size Category for Agricultural Cooperatives in the Shanxi Province Sample by Year (equation (5).

Year	Under Two Million Yuan Group		Over Two Million Yuan Group	
	SE	**Std. Error**	***SE***	**Std. Error**
2008	0.8249	0.3601	0.5079	0.2306
2009	1.0197	0.2627	0.5438	0.2326
2010	1.1671	0.2452	0.5485	0.2344

Table 4. Average Estimated Economies of Scale for Individual Cooperatives in Both Groups Included in the Sample from Shanxi Province, 1008-2010, Inclusive.

Number	Under Two Million Yuan Group				Over Two Million Yuan Group			
	SE	Std. Error	Per Capita Land	Members	*SE*	Std. Error	Per Capita Land	Members
1	1.1141	0.2676	3.9000	78	0.3529	0.0823	6.0000	220
2	0.6852	0.1893	4.0000	49	0.4906	0.0061	6.3333	151
3	1.1195	0.2107	4.0449	53	0.4005	0.0349	5.4286	100
4	0.7949	0.1476	4.8584	95	0.0967	0.0329	5.0769	122
5	0.4504	0.1285	5.7500	68	0.2567	0.0177	8.9109	154
6	0.8912	0.0612	3.0714	78	0.3635	0.0246	3.5000	110
7	0.5159	0.4363	5.0000	80	0.4259	0.0317	5.0000	145
8	1.1578	0.1484	5.0000	57	0.4281	0.0331	11.0000	154
9	0.5803	0.3950	6.4348	83	0.3405	0.0089	10.0000	117
10	0.8378	0.3540	6.5050	52	0.3677	0.0186	9.5146	138
11	0.9028	0.0880	6.1714	41	0.4129	0.0446	8.3774	180
12	1.0751	0.2030	8.3333	37	1.0181	0.0082	12.4779	230
13	1.4541	0.1621	3.6667	179	0.7460	0.0476	3.2800	300
14	1.2234	0.1303	6.5000	175	0.3493	0.0004	5.8560	207
15	0.9479	0.3395	4.8182	95	0.8895	0.0169	5.8065	167
16	1.1140	0.1569	5.5000	105	0.7392	0.0148	5.8594	148
17	1.2128	0.1971	4.3796	63	0.7078	0.0684	7.6087	200
18	0.9818	0.0768	5.0000	38	0.7200	0.1001	9.6154	213
19	1.3984	0.0825	6.8431	183	0.8265	0.0510	5.5556	189
20	1.1744	0.0805	5.0833	192	0.5440	0.0148	5.4286	210
21	1.2589	0.1047	6.2308	230	0.5399	0.0021	7.5922	198
22	1.1951	0.1447	5.4369	113	0.7186	0.0360	8.5078	220
Mean	1.0039	0.1866	5.2967	100	0.5334	0.0121	7.1241	176
Std. Error	0.2735	0.1077	1.2363	60.3655	0.2308	0.0128	2.4169	47.9706

Table 5. Panel Data Parameter Estimates for Model Describing Relationships Between Factors Affecting Firm Growth and Economies of Scale for Cooperative in Shanxi Province , 2008 - 2010.

Variable	Parameter Estimate	Std. Error	t-Statistic	Prob.
INTERCEPT	-0.203	0.265	-0.763	0.4455
GROWTH RATE	0.113	0.078	1.453	0.1464
SPECIALIZE	0.922	0.359	2.569	0.0102
SALESMEM	0.020	0.004	4.368	0.0000
SMALL	0.493	0.094	5.221	0.0000
TREND	0.067	0.022	3.089	0.0020
ROGTR	0.061	0.023	2.674	0.0075
ROGSPECIAL	-0.370	0.098	-3.775	0.0002

$R^2 = 0.713$
N = 88