Pre- and Post- Recession Input Allocation Decisions of Farm Credit System Lending Units

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Abstract

This paper applies the stochastic Translog input distance function and stochastic frontier analysis (SFA) method to evaluate the operational efficiency of lending units within the Farm Credit System (FCS). This study's model is applied as a comparative analytical frame work to analyze operating strategies and efficiencies of FCS banks versus credit associations (ACA) as well as among various size categories of FCS lending units. This study also adopts an intertemporal perspective by looking at comparative FCS efficiency before and after the most recent financial crisis. The study's analyses of changes in both technical efficiency (TE) and allocative efficiency (AE) will help FCS make operating adjustments to maximize total factor productivity.

Introduction

- As a government sponsored enterprise, FCS is a network of borrower owned financial institutions to provide credit and financial service to farmers, ranchers, producers or harvesters of aquatic products, and agricultural and aquatic cooperatives.
- In 2013, FCS has more than $260 billion assets and nearly 500,000 member borrowers.
- Unlike commercial banks, FCS lending units are not depository institutions and rely on the U.S. and international capital market to raise funds by issuing system-wide debt notes and bonds.
- As of January 2013, FCS is composed of four banks and 82 associations. The Banks of FCS provide loans to its affiliated associations, and those associations make short, intermediate, and long term loans to qualified borrowers.
- FCS provides more than $191 billion loans, which consist of more than one third of the credit needed by American people living and working in rural areas.
- The 2007-2008 global recession is considered by many economists as the most severe financial crisis since the 1930s Great Recession.
- The global recession reduced the demand for farm products, causing declining commodity prices. Although FCS banks and associations maintained capital ratios above the minimum regulation requirements, the turmoil in the U.S. and global markets during the recession limited the System's ability to raise third-party capital or issue term debt.

Objective

- In this analysis, we analyze the efficiencies of FCS lending units before and after the recession.
- A specific focus of the analysis is the input allocation decisions and strategies of FCS lending units during the study period.
- The lending units are analyzed and compared according to their types of operations (banks versus credit associations) as well as different size categories.

Data

- This study collected quarterly panel data from the Call Report Database from 2005 to 2011 published online by the Farm Credit Administration.
- The numbers from the original data are CPI adjusted with year 2005 as the baseline.
- There are a total of 5 banks and more than 100 associations with a total of 2,913 observations across 8 years. Lending institutions are classified as banks and associations. They are also classified into 5 groups based on total assets size.
- Lending institutions output data collected include Agricultural loans (y_1), Non-Agricultural loans (y_2), and other assets (y_3). Input data are labor (x1), physical capital (x2), and financial capital (x3).
- In addition, the loan quality index , measured by the ratio of non-performing loans to total loans (NPL), z1, and the financial risk index , measured by the equity capital to asset ratio (CAR), z2, are introduced to measure the loan quality and financial risks, respectively.

Methods

- The input distance function is first defined as follows (Shephard, 1953):

$$(1)\quad D^I(\mathbf{x},\mathbf{y}) = \sup\{\rho > 0 : (\mathbf{x}/\rho) \in L(\mathbf{y})\}$$

where the superscript I implies that it is the input distance function; the input set L(y) represents the set of all input vectors, x, that can produce the output vector, y; and ρ measures the possible proportion of the inputs that can be reduced to produce the quantity of outputs not less than y.

- This analysis applies the stochastic Translog distance functional form, which is considered to be a more flexible function form. It overcomes the shortcomings of the Cobb-Douglas function and puts few restrictions on production and substitution elasticities.
- The stochastic input distance function for each observation i can be estimated by:

$$\begin{aligned}\ln D_{it}^I = {} & \beta_0 + \sum_{k=1}^{M}\beta_{y_k}\ln y_{kit} + \frac{1}{2}\sum_{k=1}^{M}\sum_{l=1}^{M}\beta_{y_{kl}}\ln y_{kit}\ln y_{lit} + \sum_{j=1}^{N}\beta_{x_j}\ln x_{jit} + \frac{1}{2}\sum_{j=1}^{N}\sum_{n=1}^{N}\beta_{x_{jn}}\ln x_{jit}\ln x_{nit} \\ & + \sum_{k=1}^{M}\sum_{j=1}^{N}\beta_{a_{kj}}\ln x_{jit}\ln y_{kit} + \sum_{e=1}^{P}\beta_{z_e}\ln z_{eit} + \frac{1}{2}\sum_{e=1}^{P}\sum_{f=1}^{P}\beta_{z_{ef}}\ln z_{eit}\ln z_{fit} + \sum_{k=1}^{M}\sum_{e=1}^{P}\beta_{yz_{ke}}\ln y_{kit}\ln z_{eit} \\ & + \sum_{j=1}^{N}\sum_{e=1}^{P}\beta_{xz_{je}}\ln x_{jit}\ln z_{eit} + \sum_{k=1}^{M}\sigma_k(t\ln y_{kit}) + \sum_{j=1}^{N}\delta_j(t\ln x_{jit}) + \sum_{e=1}^{P}\theta_e(t\ln z_{eit}) + \lambda_t t + \frac{1}{2}\lambda_{tt}t^2 \\ & - \sum_{g=1}^{G-1}d_g dum_{git} - d_{st}dum_{sit} - d_{bt}dum_{bit}\end{aligned} \quad (2)$$

dum_{git} is the dummy variable for lending units in asset size group g; dum_{sit} is the dummy variable for banks; dum_{bit} is the dummy variable for time during or after the recession; k, l = 1, … M and M = 3 (number of outputs); j, h = 1, … N and N = 3 (number of inputs); d, f = 1, … P and P = 2 (number of indexes to measure financial risks and loan's quality), g = 1, …(G-1) and G = 5 (number of groups).

- Efficiency can be decomposed into two separate components: technical efficiency (TE) and allocative efficiency (AE).
- Technical efficiency (TE) is defined as

$$TE = 1/D^I(\mathbf{x},\mathbf{y}) \quad (3)$$

- In general, the allocative inefficiency for each observation i at time t can be measured by the relative input price correction indices:

$$k_{jh,it} = k_{j,it}/k_{h,it} = \frac{p_{j,it}^{*}/p_{j,it}}{p_{h,it}^{*}/p_{h,it}} = \frac{p_{j,it}^{*}}{p_{h,it}^{*}}\cdot\frac{p_{h,it}}{p_{j,it}} \quad (4)$$

where $k_{j,it} = p_{j,it}^{*}/p_{j,it}$ is the ratio of the shadow price, $p_{j,it}^{*}$, to the market price, $p_{j,it}$, for input j of firm i at time t. If $k_{jh,it} = 1$, allocative efficiency is achieved. If $k_{jh,it} > 1$, input j is being underutilized relative to input h. If $k_{jh,it} < 1$, input j is being over-utilized relative to input h.

Results

- The estimates of the components of the input distance function (defined in equation 2) are summarized in Table 1. The hypothesis that all coefficients of the distance function are equal to zero is rejected at 0.01 level by an LM test (p-value<.0001). The hypothesis that the function takes on Cobb-Douglas form, which requires that all parameters except for y_k and x_j in equation (2) equals to 0, is rejected at 1% level by the LM test. This result indicates that the flexible Translog function form is more applicable in this study.

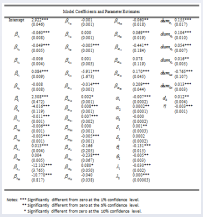

Table 1. Estimation Results for the Input Distance Function

- The coefficient of the dummy variable, dum_{sit}, that captures the effect of lender type is significantly different from 0 at 1% level. This indicates that differences in operating structure between FCS banks and associations can influence the cost structure of these lenders.
- The time dummy, dum_{bit}, that separates the time period into the pre-efficiency and post-efficiency phases is also significant level at 1%, thereby suggesting a notable change in efficiency levels before and after the recession.
- Figure 1 indicates that the overall TE levels of both FCS banks and associations (ACA) are below 0.50, thereby suggesting that these lenders in general have been operating below efficiency during the sample period. The associations have a higher TE than the banks.

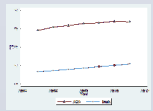

Figure 1. Trends in Technical Efficiency, By Institution Type, 2005-2011

- Figure 2 indicates among these size categories, the smaller lenders tend to have relatively higher TE levels than the larger lenders.

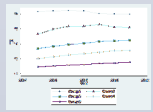

Figure 2. Trends in Technical Efficiency, by Group, 2005-2011

- Figure 3 provides a comparison of the plots of input allocation ratios (k_{jh}) of FCS banks and associations (ACA). Inputs are most efficiently used if the ratio is equal or closer to one.

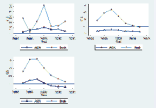

Figure 3: Input Allocation Ratios (k_{jh}) by Agency Category, 2005-2011

- Both the FCS banks and associations' k_{12} ratio (labor vs. physical assets) lie above the critical boundary (=1). These results indicate that FCS lending units over utilized their physical assets while underutilizing their. labor inputs.
- For k_{13} (labor vs. financial assets), banks' ratio lie above and associations' lie below the critical boundary (=1). These results indicate that banks over utilized their financial inputs and associations over utilized their labor.
- For k_{23} (physical assets vs. financial assets), banks' ratio lie above the critical boundary (=1). The associations' k_{23} lie above 1 during the recession and lie below 1 after the recession. These results indicate that banks over utilized their financial inputs. Associations over utilized financial inputs during the recession and over utilized physical assets after the recession.
- There are spikes of the k_{12} and k_{23} ratios for FCS banks during the recession. Banks raise capital for associations through domestic and global money market. It was hard to get capital during the recession and banks had to over utilize their existing financial assets. The ratios went down significantly after the recession, suggesting improving capital market conditions.

Conclusions

- The overall TE level of both FCS banks and associations (ACA) are below efficiency. Associations are more efficient than banks.
- Small lenders tend to have relatively higher TE than larger lenders.
- For input allocative ratio k_{12} (labor vs. physical assets), banks and associations over utilized physical assets compared to labor. For ratio k_{13} (labor vs. financial assets), banks over utilized financial inputs and associations over utilized labor. For k_{23} (physical assets vs. financial assets), banks over utilized their financial inputs and associations over utilized financial inputs during the recession and over utilized physical assets after the recession.
- FCS lending units do not have deposits as a source of capital and rely on banks to raise funds in the money market. Banks over utilized existing financial assets during the recessions, as they were hard to get capital from the market.

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