The Relative Cost Efficiencies of Commercial Banks, Rural Financial Institutions, and Microfinance Institutions in China

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China has substantially boosted lending to farmers and agribusiness in recent years. Policymakers have encouraged rural financial institutions to channel more capital to the agricultural sector as part of its general policy aimed at raising rural incomes and improving farm productivity. From 2001 to 2005, the aggregate loan exposure to farmers has been doubled. Although China is trying to remold rural banks and credit cooperatives into financial intermediaries to allow them to operate more like commercial banks, rural financial institutions are still subjected to certain governmental restrictions that regulate the lenders' activities and decisions, such that the lending practice remains largely policy-driven. As such, these institutions' lending decisions often reflect the government's policy initiatives and development strategies (Gale and Collender, 2006).

Currently, the Agricultural Bank of China (ABC) and the Agricultural Development Bank of China (ADBC) are the major sources of loans to agricultural enterprises, rural cooperatives, and village organizations in China. Moreover, Rural Credit Cooperatives (RCCs), which had been the core of the rural financial system since their initiation in1950s, are currently the major source of formal loans to rural households. RCCs were managed by the Agricultural Bank of China prior to 1996, and reconstructed as a separate set of independent institutions afterwards. A microloan scheme was introduced in this reform, with some provisions for support on agricultural lending from the central bank, People's Bank of China (PBC). Although this reform improved access of rural households to RCC loans, the system was riddled with some problems, including the high demand for microloans and subsequent accumulation of financial losses (Dong and Featherstone, 2004).

Microfinance was introduced in China in the early 1990s. The development of the microfinance industry in China has undergone three phases. During the 1st Phase (early 1994 to October 1996), funding mainly came from international donation and soft loans without inclusion of governmental capital At this time, the focus was to explore the feasibility of establishing a Bangladesh “Grameen Bank” style in China. In the 2nd Phase (October 1996 to 2000), the government became actively involved in providing capital, manpower and organization, and attempted to pursue the target of poverty alleviation using microfinance as the financial tool. During the current phase (3rd Phase since 2000 to the present), RCCs started to be involved in the microfinance industry and gradually are becoming the main providers of micro loans to rural households.

At the micro level, cost inefficiency was frequently cited as the major reason for bank failures. As a result, efficiency analysis has been widely applied in banking industry since the 1990s. There have been some empirical studies that analyzed the efficiency and performance of Chinese banks and financial institutions. Heffernan and Fu (2008) suggested that economic value added and the net interest margin are the best dependent variables, as against the conventional measures of profitability, return on average assets (ROAA) and return on average equity (ROAE). They also found that two main indicators of reform (bank listing and foreign equity investment) have no significant influence on performance. Utilizing the information provided by China Rural Finance Almanac, Dong and Featherston (2004) evaluated pure technical efficiency, overall technical efficiency, and scale efficiency for RCCs using nonparametric techniques.

Objective

This study is designed to evaluate the comparative efficiency performance of selected commercial banks, rural financial institutions, and microfinance institutions in China. We employed nonparametric methods in this study to derive the efficiency measurements. Specifically, data envelopment analysis (DEA) is adopted to evaluate and compare the efficiency measurements between commercial banks and rural financial institutions (including RCCs), as well as between Rural Credit Cooperatives (RCCs) and microfinance institutions (MFIs).

This comparative analysis is expected to shed light on the effect of government restrictions and involvement on the cost efficiency of three sources of micro loans in China. Through the inclusion of commercial banking units, this analysis will also address the issue of whether the concentration of micro and agricultural loans in lending portfolios will favorably enhance the cost efficiencies of these lending institutions.

Methodology

The efficiency problem can be analyzed using any of three general approaches: parametric approach, semi-nonparametric approach, and nonparametric approach. The parametric approach assumes the most strictly specific functional form, a restriction that is relaxed in the semi-nonparametric approach. Particularly, the minimal *a priori* assumptions would have to be imposed to guarantee unbiased estimates (Gallant, 1982). However, the need to assume a functional form of the underlying technology and distribution for the inefficiency term makes the parametric and semi-nonparametric methods less flexible. In contrast, the nonparametric approach does not require the specification of an explicit functional form.

There are drawbacks in using the nonparametric technique. First, it only focuses on the technological optimization but neglects economic optimization. Second, it assumes a deterministic procedure instead of a stochastic procedure. Thus, there is no way to derive inferences of the estimated parameters or conduct the statistical hypothesis tests. However, some recent studies are exploring some simulation methods to overcome the drawback of the deterministic approach (Ray, 2004).

In this study, we will focus on evaluating and comparing efficiency measurements derived from nonparametric method, which is often referred to as data envelopment analysis (DEA). DEA is often used to measure technical efficiency of firms, which are called Decision-Making Units (DMUs). DEA constructs a best-performance benchmark from the observed input-output bundles of the firms in the sample. The constructed relative efficiency frontiers are non-statistical in the sense that they are constructed through the envelopment of the DMUs, with the best practice DMUs forming the frontier (Drake and Hall, 2003).

Farrell (1957) established that the efficiency of a firm can be decomposed into allocative efficiency (AE) and technical efficiency (TE). Allocative efficiency measures the ability of a firm to use the inputs in optimal proportions and quantities to achieve the minimum costs, given their respective prices and production technology. Technical efficiency measures the ability of a firm to obtain optimal outputs from a given set of inputs (Drake and Hall, 2003). In summary,

$$\textit{Productive Efficiency (PE)} = \textit{Allocative Efficiency (AE)} \times \textit{Technical Efficiency(TE)}$$

Unfortunately, accurate data on all input prices of Chinese banks and financial institutions are not available for the sample period; therefore, this study will not be able to consider the measurement of allocative efficiency.

Technical efficiency is comprised of two components: Pure technical efficiency (PTE) and Scale efficiency (SE). Pure technical efficiency measures how far off a DMU is from the production frontier. It indicates the potential reduction in inputs a DMU could achieve by adopting the best production practice of the best performance DMU. Scale efficiency measures the proportional reduction in input usage that is achieved by a DMU that is operating at constant return to scale (Dong and Featherstone, 2004). In other words,

$$\textit{Technical Efficiency(TE)} = \textit{Pure Technical Efficiency(PTE)} \times \textit{Scale Efficiency(SE)}$$

A DMU’s efficiency is a relative measure. It compares a DMU’s performance to the best performance benchmark from the observed data on input-output combinations. If many of the DMUs producing multiple outputs from multiple inputs, the bench mark will be made up of more than one DMU unless the DMU has the best performance in producing all outputs. Usually, a single DMU does not have the best performance in producing all outputs. So the best-performance benchmark of a DMU may include a number of DMUs that have the best performance in producing one or more outputs (Dong and Featherstone, 2004).

Consider the case where there are k DMUs in the sample, each producing m outputs [$Y_1, Y_2, ..., Y_k$] by using n input [$X_1, X_2, ..., X_k$], where Y_i ($i = 1, ..., k$) is the (m×1) vector of outputs and X_i ($i = 1, ..., k$) is the (n×1) vector of inputs. The outputs and inputs are represented by the k-column matrices: X and Y. The input requirement set can be represented by the free disposal convex hull of the observations. The smallest convex set contains the observations with the least input requirement set for the certain level of outputs.

The pure technical efficiency is obtained by solving the following DEA model:

$$
\begin{aligned}
&\min \ \theta_i \\
&\text{subject to:} \\
&z_1 y_{11} + z_2 y_{12} + ... + z_k y_{1k} \geq y_{1i} \\
&z_1 y_{21} + z_2 y_{22} + ... + z_k y_{2k} \geq y_{2i} \\
&\qquad \cdots\cdots \\
&z_1 y_{m1} + z_2 y_{m2} + ... + z_k y_{mk} \geq y_{mi} \\
&\theta_i x_{1i} - z_1 x_{11} - z_2 x_{12} - ... - z_k x_{1k} \geq 0 \\
&\theta_i x_{2i} - z_1 x_{21} - z_2 x_{22} - ... - z_k x_{2k} \geq 0 \\
&\qquad \cdots\cdots \\
&\theta_i x_{ni} - z_1 x_{n1} - z_2 x_{n2} - ... - z_k x_{nk} \geq 0 \\
&z_i > 0, \ (i = 1, 2, ..., k) \\
&z_1 + z_2 + ... + z_k = 0
\end{aligned}
\tag{1}
$$

where x_{ij} (i=1, …, n; j=1, …, k) is the ith input used by the jth DMU; and y_{ij} (i=1, …, m; j=1, …, k) is the ith output produced by the jth DMU. θ_i (i=1, …, k) is the measure of pure technical efficiency for the ith DMU. The overall technical efficiency, denoted as λ_i, can be obtained by solving the DEA model in equation (1) without the constraint $\sum z_1 = 1$. The scale efficiency is the ratio of the overall technical efficiency and pure technical efficiency:

$$S_i = \frac{\lambda_i}{\theta_i} \qquad (2)$$

If S_i is equal to 1, then the DMU is scale efficient; if S_i is less than1, then the DMU is inefficient. The source of scale inefficiency can be identified by estimating the DEA model in equation (1) with the constraint $\sum z_1 \leq 1$ instead of $\sum z_1 = 1$; that is, the technology is non-increasing returns to scale (NIRS). If the objective function of the DEA model under NIRS (labeled γ_i) is equal to pure technical efficiency (θ_i), decreasing returns to scale exist; otherwise, increasing returns to scale exist (Färe, Grosskopf, and Lovell, 1985).

Later on, bootstrapping can be utilized to investigate sampling properties of DEA estimators and to perform inference for efficiency measures.

Data

There are 13 commercial banks included in this study. The rural financial institutions considered in this analysis are: Agricultural Bank of China, Agricultural Development Bank of China, and Rural Credit Cooperatives (RCCs). Four microfinance institutions included in this study are: China Fund for Poverty Alleviation (CFPA), Chifeng Zhaowuda Women's Sustainable Development Association (CZWSDA), PATRA Hunchun, and PATRA Yanbian.

The financial data for the commercial banks and rural financial institutions are obtained from Almanac of China’s Finance and Banking (various years). Information on the microfinance institutions are collected from MixMarket. The study period is from 2004 to 2007.

As discussed by Berger and Humphrey (1992), there are three alternative methods of defining bank inputs and outputs which are the asset, user cost, and value-added approaches. It is argued that the value-added approach is the best method for accurately estimating changes on bank technology and efficiency over time. However, Sealey Jr. and Lindley (1977) suggested that the researcher can adopt any measure of output for a financial firm as long as the measure is consistent with the researcher's goal.

Two pairwise comparisons conducted separately in this study are efficiency comparison between commercial banks and rural financial institutions (including RCCs), and efficiency comparison between Rural Credit Cooperatives (RCCs) and microfinance institutions (MFIs). Because of the different data forms, input and output definitions are slightly different for these two pairs.

Commercial Banks & Rural Financial Institutions

The output measures used are loans, investments, and claims on other banks. The inputs are deposits, fixed assets, and number of employee. This study includes thirteen commercial banks and three rural financial institutions covering the period from 2004 to 2007. There are a total of 64 observations. The summary statistics are provided in Table 1.

Table 1. Summary Statistics of commercial banks and Rural financial institutions, 2004-2007

Variable	Minimum	Maximum	Mean	Standard Deviation
Y1-Loan	46.23	39,575.42	10,680.62	11,408.88
Y2-Investment	10.03	25420.24	4533.53	6866.40
Y3-Claims on other financial banks	24.3	11717.52	2537.35	2879.03
X1-Deposit	53.14	68984.13	16146.74	19192.88
X2-Fixed asset	4.34	1197.84	266.81	331.13
X3-Number of Employee	256	651664	134178	192670
N-observation number	64			

Note: All values are in hundreds of millions Chinese Yuan (￥100,000,000).

RCCs & MFIs

The outputs are loans and other asset. The inputs are liabilities and number of employees. This study includes RCCS and four microfinance institutions (MFIs) in years ranging from 2004 to 2007. There are a total of 20 observations. The summary statistics are presented in Table 2.

Table 2. Summary Statistics of RCCs and MFIs, 2004-2007

Variable	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
Y1-Loan	0.0062	24121.61	4136.19	8542.47
Y2-Other Asset	0.0035	16974.13	2806.47	5825.68
X1-Liability	0.0116	41095.74	6942.60	14362.19
X2-Number of employee	3	651664	123097	253167
N-observation number	20			

Note: All values are in hundreds of millions Chinese Yuan (￥100,000,000).

Empirical Results

As outlined previously, the efficiency measures are calculated for two separate pairwise comparisons: (1) commercial banks and rural financial institutions (including RCCs), (2) Rural Credit Cooperatives (RCCs) and microfinance institutions (MFIs). The relative results are presented in table 3 to table 8.

Commercial Banks & Rural Financial Institutions

First, we calculated and compared the efficiency measures between commercial banks and rural financial institutions (including RCCs). The summary statistics for overall technical efficiency (TE), pure technical efficiency (PTE) and scale efficiency (SE) are provided in table 3, table 4 and table 5, respectively.

With respect to overall technical efficiency, commercial banks exhibit higher mean score than rural financial institutions through the study period (2004-2007). The mean scores of commercial banks are all above 0.9 with the highest 0.9631 in 2004 and the lowest 0.9007 in 2005. On the other hand, the mean scores of rural financial institutions are all less than 0.9 with the highest 0.8760 in 2004 and the lowest 0.6726 in 2005. This suggests that the rural financial institutions could make significant reductions in input utilization (given the output level) and achieve significant cost savings. Both commercial banks and rural financial institutions experienced the same trend through the study period: decreasing efficiency from the highest level achieved in 2004 and reaching the lowest efficiency level in 2005, then increasing steadily through the rest of the study period.

In regards to pure technical efficiency, there is no significant difference in the results obtained for commercial banks and rural financial institutions. The mean scores are all above 0.9 throughout the study period (2004-2007). For each year, the mean score of commercial banks is slightly higher than the mean score of rural financial institutions.

The scale efficiency comparison provides similar results as overall technical efficiency. Commercial banks exhibit higher mean score of scale efficiency than rural financial institutions through the study period (2004-2007). The mean scores of commercial banks are all above 0.9 with the highest 0.9802 in 2006 while the mean scores of rural financial institutions are all less than 0.9 with the lowest 0.6953 in 2005. Both commercial banks and rural financial institutions experienced their lowest scale efficiency levels in 2005 with mean scores of 0.9469 and 0.6953, respectively.

It is worth of noting that, for both commercial banks and rural financial institutions, the bulk of the overall technical inefficiency is attributed to scale inefficiency rather than pure technical inefficiency. The mean DEA scores of pure technical efficiency are all higher than the mean DEA score of scale efficiency. This contrasts with recent US evidence which typically finds that X-inefficiency (failure to minimize costs for a given level of output) is a much more serious problem than scale inefficiency (Berger and Humphrey, 1997).

Table 3, Overall Technical Efficiency Results, 2004-2007

	2004	2005	2006	2007
Commercial Banks				
mean	0.9631	0.9007	0.9414	0.9570
Standard deviation	0.0708	0.1001	0.1007	0.0761
minimum	0.8133	0.7608	0.6384	0.7433
maximum	1	1	1	1
Rural Financial Institutions				
mean	0.8760	0.6726	0.7846	0.7643
Standard deviation	0.1429	0.3796	0.2244	0.2733
minimum	0.7198	0.2565	0.5522	0.4648
maximum	1	1	1	1

Table 4, Pure Technical Efficiency Results, 2004-2007

	2004	2005	2006	2007
Commercial Banks				
mean	0.9904	0.9509	0.9608	0.9936
Standard deviation	0.0347	0.0700	0.0993	0.231
minimum	0.8750	0.8260	0.6456	0.9167
maximum	1	1	1	1
Rural Financial Institutions				
mean	0.9711	0.9301	0.9554	0.9566
Standard deviation	0.0501	0.1211	0.0772	0.0752
minimum	0.9133	0.7902	0.8662	0.8697
maximum	1	1	1	1

Table 5, Scale Efficiency Results, 2004-2007

	2004	2005	2006	2007
Commercial Banks				
mean	0.9726	0.9469	0.9802	0.9634
Standard deviation	0.0639	0.0724	0.0359	0.0753
minimum	0.8113	0.8188	0.9002	0.7433
maximum	1	1	1	1
Rural Financial Institutions				
mean	0.8988	0.6953	0.8131	0.7876
Standard deviation	0.1063	0.3425	0.1815	0.2354
minimum	0.7881	0.3246	0.6375	0.5345
maximum	1	1	1	1

RCCs & MFIs

Now we focus on the efficiency measures of Rural Credit Cooperatives (RCCs) and microfinance institutions (MFIs). The summary statistics for overall technical efficiency (TE), pure technical efficiency (PTE) and scale efficiency (SE) are provided in table 6, table 7 and table 8, respectively. It is clear that RCCs and CFPA are the most efficient institutions, with efficiency scores of 1 through the study period (2004-2007).

For CZWSDA, the overall technical inefficiency is mostly attributed to scale inefficiency rather than pure technical efficiency. The only exception is year 2005 when the pure technical efficiency score is 0.6296, which is much lower than its scale efficiency score 0.9968. Pure technical inefficiency contributed most of the bulk of CZWSDA's overall technical inefficiency in 2005.

The pure technical efficiency scores are all 1 throughout the study period (2004-2007) for PATRA Hunchun. Since scale efficiency is the ratio of the overall technical efficiency and pure technical efficiency, PATRA Hunchun's overall technical efficiency and scale efficiency scores are the same for each year. Both of the efficiencies experienced decreasing trend from 2004 to 2007.

The pure technical efficiency scores are all 1 though the study period (2004-2007) for PATRA Yanbian. Again, since scale efficiency is the ratio of the overall technical efficiency and pure technical efficiency, PATRA Yanbian's overall technical efficiency and scale efficiency scores are the same for each year. Both of the efficiencies experienced V shape trend, decreasing from 2004 to 2006 and then increasing from 2006 to 2007.

Table 6, Overall Technical Efficiency Results, 2004-2007

	2004	2005	2006	2007
RCC	1	1	1	1
CFPA	1	1	1	1
CZWSDA	0.9281	0.6276	0.8298	0.9107
PATRA Hunchun	1	1	0.6286	0.5255
PATRA Yanbian	0.7380	0.5983	0.5771	0.7369

Table 7, Pure Technical Efficiency Results, 2004-2007

	2004	2005	2006	2007
RCC	1	1	1	1
CFPA	1	1	1	1
CZWSDA	0.9844	0.6296	1	1
PATRA Hunchun	1	1	1	1
PATRA Yanbian	1	1	1	1

Table 8, Scale Efficiency Results, 2004-2007

	2004	2005	2006	2007
RCC	1	1	1	1
CFPA	1	1	1	1
CZWSDA	0.9427	0.9968	0.8298	0.9107
PATRA Hunchun	1	1	0.6286	0.5255
PATRA Yanbian	0.7380	0.5983	0.5771	0.7369

Conclusions

Throughout the study period (2004-2007), commercial banks achieved higher level of overall technical efficiency, pure technical efficiency and scale efficiency than rural financial institutions (including RCCs). The source of the overall technical inefficiency is attributed to the scale inefficiency rather than pure technical inefficiency for both commercial banks and rural financial institutions.

RCCs and one of the selected MFIs are the most efficient institutions with all efficiency scores equal to 1 while other MFIs experienced some overall technical inefficiency and scale inefficiency through the study period (2004-2007).

Since the inputs and outputs are defined slightly different between the two pairwise comparisons, the calculated efficiency scores are not directly comparable across these two pairs. The direct comparison of efficiency scores across three categories (commercial banks, rural financial institutions and microfinance institutions) will be more meaningful and insightful if the necessary financial information for defining output and input variables are available.

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