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Spanish saving banks (2000-2009): efficiency and productivity analysis

MARTÍN- Isabel*†

UNED.Spain.

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The important role played by the savings banks in the Spanish financial system explains the matter of their performance and development levels during 2000-2009. This paper aims to analyse the efficiency and productivity levels of this sector prior to its current restructuring. The methodology used is the nonparametric approach to efficiency frontiers of Data Envelopment Analysis by estimating the Malmquist productivity index. This methodology is used by many researchers to investigate how to measure the enterprises performance. The results show that the sector reaches its optimal performance level with no change in efficiency, but a positive productive deviation due to the technological change. In conclusion, the Spanish saving banks will have to increase their level of productivity focusing their efforts on boosting the efficiency level in order to step up their competitiveness.

Savings banks, efficiency, productivity, Data Envelopment Analysis, Malmquist Index.

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*Correspondence to Author (email: imartin@cee.uned.es)
† Researcher contributing first author.

Introduction

The important role of savings banks in the Spanish financial system along with the impact of the crisis that the world economy has been suffering since 2008, justify the need to analyze their efficiency and productivity developments before the financial restructuring started in 2010, currently underway.

The Data Envelopment Analysis (DEA) is one of the tools used to measure the efficiency.

It was proposed by Charnes et al. (1978) to calculate the efficiency of a set of decision making units (DMU) based on observed best performances.

An advantage of DEA is that the results obtained can measure an entity's productivity between two periods of time, using the Malmquist productivity index. The index can be decomposed into two components: efficiency change and technological change.

The aim of this document is to measure the efficiency and productivity of the Spanish savings banks during the period 2000-2009, providing information on their evolution from two perspectives: static, through scores of efficiency and dynamic, provided by productivity change.

This document has been organized in the manner described below.

The second section explains the methodology, DEA and Malmquist productivity index models, used to measure the efficiency and productivity Spanish savings banks. The third section presents the main results.

Finally, the last section describes the main findings of the investigation.

Methodology

Efficiency estimation

The research that study the efficiency levels of Spanish banks, highlight hose of Pastor (1995), Maudos, Pastor and Pérez (2002), Tortosa-Ausina et al. (2008), Escobar and Guzmán (2010).

Normally, efficiency is used to explain the level of performance that an economic decision unit can achieve from its production possibility set in accordance with existing technology.

Organizations spend various factors of production (inputs) at the same time to produce different goods or services (outputs).

Different techniques are necessary to jointly assess the relationship between these groups of variables, as well as to obtain the optimal production level and check the highest performance from a DMU in its economic environment. In this sense, Farrell (1957) was a pioneer studying the technical efficiency.

He analyzed the highest level of output in relation to a particular composition of inputs, considering that there is a particular production technology.

It is considered two different methodologies to determine the performance of a DMU: (i) parametric models that determine the functional form of the production function.

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Using statistical techniques or mathematical programming to estimate the parameters according to the data given by the evaluated DMUs (Coelli et al., 2005) and, (ii) non-parametric models that take into account the properties that should satisfy all production possibilities, considering a boundary formed by the efficient DMUs, not necessary to assume, a priori, a functional form for the function production (Thanassoulis, 2001).

An important advantage of the non-parametric method compared with the parametric method is its high degree of flexibility to easily adapt to multiproduct environments not considering the price variable.

However, it also presents a disadvantage resulting from its deterministic nature, since any deviation from the efficient frontier can be attributed to inefficient behavior of the evaluated DMU.

Data Envelopment Analysis (DEA)

From the doctrinal work of Charnes et al. (1978), DEA has predominated when measuring the efficiency of economic units. In the financial sector, the research done by Berger and Humphrey (1992), Thanassoulis (1999) and Drake et al. (2009) applied the nonparametric estimation for determining bank efficiency.

Casu and Molyneux (2003) applied the DEA to compare bank efficiencies across countries and Barr et al. (1994) applied the DEA to study the prediction of failure of commercial banks.

The mathematical formulation of DEA is developed through a linear programming model under the assumption that all DMUs are operating at their optimal scale of operations with constant returns to scale (CCR[10] model), which allows for overall technical efficiency ($TCHEF_{CCR}$) without considering diseconomies of scale.

According to the objective of the research, to calculate the technical efficiency can take double orientation factors: input orientation which determines the maximum reduction of inputs to obtain a supported level of outputs, or guidance that specifies the maximum output created to a minimal level of inputs.

A way to measure the efficiency of Spanish savings banks, trying to get the best possible results, it is to use the orientation toward maximizing outputs.

According to Charnes et al. (1978) and assuming the existence of n DMUs that consume m inputs to produce s outputs, it can be mathematically formulated the output oriented DEA model under the assumption of constant returns to scale (CCR model) as follows:

$$TCHEF_{CCR} = Max\phi_o \tag{1}$$

Subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq x_{io} \quad i = 1,2,...,m \tag{2}$$

[10] Charnes, Cooper and Rhodes (1978)

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$$(\sum_{j=1}^{n}\lambda_j y_{rj}) \geq \phi_o y_{ro} \qquad r = 1,2,...,s \tag{3}$$

$$\lambda_j \geq 0 \qquad j = 1,2,...,n \tag{4}$$

In formulas (1) to (4), grouped vectors x_{ij} and y_{rj} grouped respectively the consumed quantities of inputs and outputs by DMU_j produced, respectively.

The values (x_{ij}, y_{rj}) represent the quantities by DMU_o consumed and produced. The variable (λ_j) indicates the weight of DMU_j to construct the virtual unit that can be obtained by linear combination of the other sample units from the unit DMU_o evaluated.

If we cannot get the virtual drive, DMU_o for which the problem is solved, it will be solved as efficient.

When solving the above formula (1) to (4), for each DMU it is obtained scalar value ϕ_o, which represents the major output oriented obtaining greater outputs per unit assessed (DMU_o).

Taking the unit value when the DMU is efficient and obtaining values bigger than unity for inefficient institutions, their level of technical efficiency is given by the inverse of the scalar value ϕ_o ($1/\phi_o$).

To overcome the difficulties in measuring the technical efficiency from inefficient scale technique, Banker et al. (1984) proposed an alternative model in which the restriction $\sum_{j=1}^{n}\lambda_j = 1$ added to CCR model (Charnes et al., 1978), assuming the hypothesis of variable returns to scale (BCC[11] model, Banker et al., 1984). This allows to calculate pure technical efficiency ($TCHEF_{BCC}$) considering the operations scale of organizations regarding the efficient DMU evaluated in each case.

Malmquist Productivity Index

This methodology was originally introduced in the field of consumption theory from doctrinal research by Malmquist (1953), applied by Caves et al. (1982), to measure productivity in the context of production functions and Färe et al., (1989) under the DEA nonparametric approach.

Grifell-Tatjé and Lovell (1995) reported in their work Malmquist index measures the change in productivity, noting advantages thereof the following: i) it does not need to assume profit maximization or cost minimization, ii) to be functions based on distance, there is no need to know the prices of inputs and outputs and, iii) allows decomposition in certain elements that explain the causes of productive change. The same authors note that this index does not measure accurately the changes in productivity in the context of non-constant returns to scale (Tortosa-Ausina et al., 2008), therefore, assume the hypothesis of constant returns to scale (CCR model) output oriented.

[11] Banker, Charnes and Cooper (1984)

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Expressing the Malmquist productivity index (M_O) using the following mathematical formula (Färe et al., 1994):

$$M_o(y_{t+1}, x_{t+1}, y_t, x_t) = \left[\frac{d_o^{t+1}(x_t, y_t)}{d_o^{t+1}(x_{t+1}, y_{t+1})} \cdot \frac{d_o^t(x_t, y_t)}{d_o^t(x_{t+1}, y_{t+1})} \right]^{1/2} \quad (5)$$

Where in (5),

$d_O^{t+1}(x_t, y_t)$, is the distance function that measures the maximum proportional increase in output vector y_t, given input vector x_t, so that the observation (x_t, y_t) period is feasible $t+1$.

$d_O^{t+1}(x_{t+1}, y_{t+1})$, is the distance function that measures the maximum proportional increase in output vector y_{t+1}, given input vector x_{t+1}, so that the observation (x_{t+1}, y_{t+1}) period is feasible $t+1$.

$d_O^t(x_t, y_t)$, is the output oriented distance function that measures the maximum proportional expansion of output vector y_t, given input vector x_t, so that the observation (x_t, y_t) is in the frontier of the period t.

$d_O^t(x_{t+1}, y_{t+1})$, is the distance function that measures the maximum proportional increase in output vector y_{t+1}, given input vector x_{t+1}, so that the observation (x_{t+1}, y_{t+1}) is in the frontier of the period t.

Rewriting the expression (5) it is possible to decompose the Malmquist productivity index (M_O) into two components of technical efficiency change and technological change according to the following formulation:

$$M_o(y_{t+1}, x_{t+1}, y_t, x_t) = \left[\frac{d_o^t(x_t, y_t)}{d_o^{t+1}(x_{t+1}, y_{t+1})} \right] \cdot \left[\frac{d_o^{t+1}(x_t, y_t)}{d_o^{t+1}(x_{t+1}, y_{t+1})} \cdot \frac{d_o^t(x_t, y_t)}{d_o^t(x_{t+1}, y_{t+1})} \right]^{1/2} \quad (6)$$

In expression (6), the first term refers to the technical efficiency change (close to the frontier) and its compare the technical efficiency relative change from period t to period $t+1$ for the DMU analyzed.

The second term accounts for the variation of the production frontier between the two periods referenced and reveals sector technological change (frontier shift). If both terms are greater than unity implies that there has been an approach to the border and technological progress.

Conversely, if lower than the unit it means that it has produced a greater distance from the technological frontier and return, if the value is equal to the unity produces no change (Thanassoulis, 2001).

Data description and parameter estimates

The data and the variables used in the empirical study were collected from the annual accounts of the Spanish savings banks published in "Anuarios Estadísticos".

Financial information is provided by the Confederación Española de Cajas de Ahorros (CECA) on the website http://www.cajasdeahorros.es/balance.htm.

The analysis has been performed for all the 45 Spanish savings banks at December 31, 2009.

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The work has been prepared under the intermediation model that estimated that the savings banks act as financial intermediaries, and its main business of lending funds to claimants bidders and considering the "customer deposits" as an input. This approach has applied nonparametric DEA output oriented.

It is also preferred by most of the research on financial institutions (Wheelock and Wilson, 1999; Portela and Thanassoulis, 2006), by requiring the minimization of costs to maximize profits and not only reduced production costs.

Criterion matching literature to include interest expense paid on deposits (Pastor et al., 1997; Ray and Dabs, 2009).

Table 1 shows the inputs and outputs used in the analysis.

Variables staff costs and administrative expenses constitute a single input to support the discriminatory power of the model.

It is recommended that the total number of units is evaluated approximately three times the number of inputs/outputs selected to measure efficiency (El-Maghary and Ladhelma, 1995).

Inputs	Outputs
- Customer deposits - Interest and fees paid - Staff and administration	- Loans to customers - Interest and fees received

Table 1

Results

Empirical results: Efficiency

The results were obtained using the program PIM-DEA 3.0, Data Envelopment Analysis Software, exposing in Figure 1, which we observe the trend of the three variables analyzed during the period.

The overall technical efficiency (CCR model) gets its lowest average score in 2006, although it presents no alteration between the first and last years.

The pure technical efficiency (BCC model) shows a decrease of 0.9% and, the scale efficiency shows a cumulative increase of 1%, revealing the influence on the variation of the operations scale.

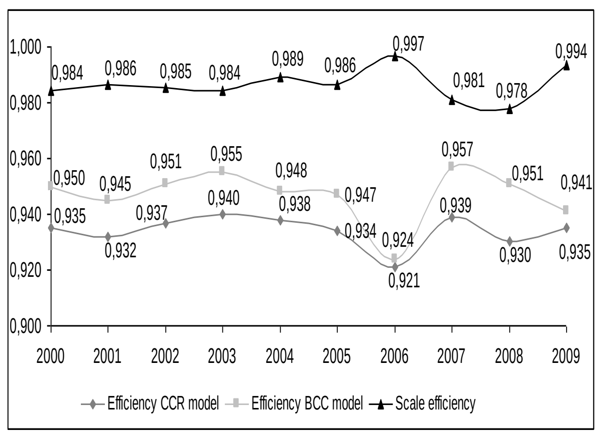

Figure 1

In terms of overall technical efficiency (CCR model) it gives an average performance level of 93.4% (see Table 2).

Indicating that Spanish savings banks should have increased their outputs (customer loans and interest income and commissions) by 6.6% to reach its optimum efficiency.

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They are situated at the frontier 22% of the studied saving banks, as seen in Figure 2.

CCR model	BCC model Efficiency	Scale
Period	Average Average	Average
2000-2009	0,934 0,987	0,947

Table 2

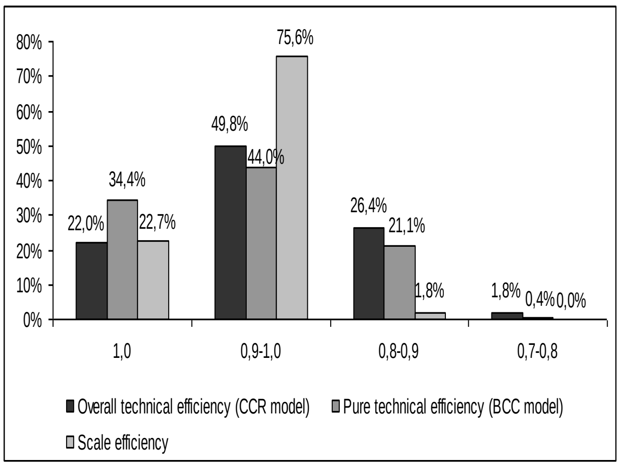

Figure 2

In terms of pure technical efficiency (BCC model), the average yield level is 94.7%, which suggests that Spanish savings banks have an index of inefficiency of 5.3%, with 34.4% of them located in the frontier.

The average level of performance in scale efficiency reaches 98.7%, showing that the entities are in a position close to its optimal scale operations, reaching 22.7% at the frontier. In average values, it is observed satisfactory levels for the period considered, since only 1.8% of the Spanish savings banks have efficiency ratings below 0.8 (see Figure 2).

Empirical results: Malmquist Productivity Index

In order to broaden the scope of the analysis, it is important to understand the dynamic that provides productivity change.

We have calculated the Malmquist productivity index (Malmquist, 1953), using the DEA by the criterion of constant returns to scale (Grifell-Tatjé and Lovell, 1995).

In the context of non-constant returns to scale, the index accurately measures productivity changes (Tortosa-Ausina et al., 2008).

Figure 3 shows the results of the decomposition of the Malmquist productivity index, on technological change (frontier shift) and efficiency change (closer to the frontier).

It shows an increase of 4% over the reporting period due to improved technological progress of 3.2% and a positive trend in efficiency of 0.8%.

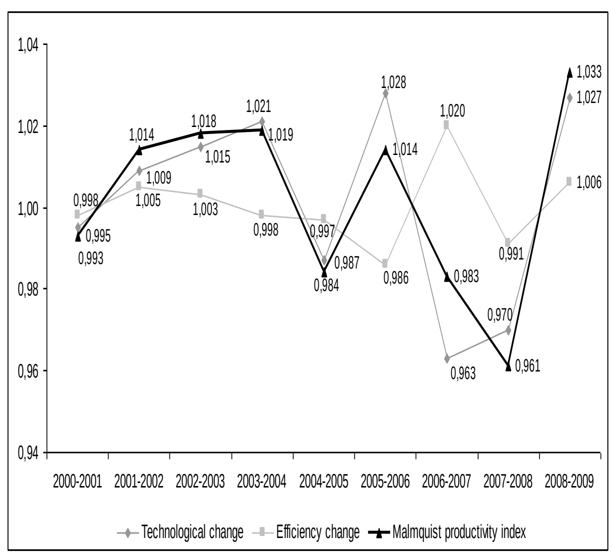

Figure 3

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It also shows the trend of the Malmquist productivity index, peaking in 2008-2009 and in 2007-2008 its minimum.

Table 3 presents the average result obtained in the decomposition of Malmquist productivity index over the period.

Period	EC	TC	TFP
2000-2009	1,000	1,002	1,002

Table 3

*EC: efficiency change; TC: technological change;TFP: total productivity change.

This result indicates that the Spanish savings banks have increased the level of productivity by 0.2%, achieving technological change by 0.2%, but they no change in efficiency as they have obtained a value of unity.

Conclusions

This paper analyzes the level of performance achieved by the Spanish savings banks, measured by efficiency and by changes in the level of productivity during the period 2000-2009, creating efficient frontiers.

For that objective, it has been considered intermediation model comprising a combination of three inputs and two outputs from the nonparametric technique DEA.

The conclusions drawn from the analysis of the results is that the Spanish savings banks have levels of performance close to optimal with respect scale efficiency.

In terms of productivity, it experiences an increase attributed to technological progress obtained by the sector, but it no change in efficiency.

Therefore, it is necessary that the Spanish savings banks must achieve efficiency gains to add value and increase their competitiveness.

The temporal evolution shows variations depending on the model performed.

If we accept the model under constant returns to scale, overall technical efficiency is unchanged.

If the model is admitted under variable returns to scale, pure technical efficiency decreases slightly.

Finally, it is planned to widen this research in the future analyzing the level of efficiency and productivity of Spanish savings banks from of year 2010, which was the origin of the largest and most important financial restructuring of the banking sector in Spain.

The work would be completed to develop a comparative analysis of the results of the other banks that make up the Spanish financial system (banks and credit unions).

Another line of research is the study from the point of view of methodology using stochastic frontiers, comparing and strengthen the conclusions reached in this nonparametric technique.

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