ESTUDIOS DE ECONOMÍA APLICADA VOL. 33-2 2015 PÁGS. 633 – 648

Financial and Operative Cost Efficiency: Spanish Savings Banks in Pre-Crisis Period

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ABSTRACT

With the aim of knowing if a relationship exists between cost inefficiency and instability of financial entities before the 2008 financial crisis, a stochastic frontier approach is applied to Spanish savings banks in the period (2002-2007). Moreover, translog financial and operative cost functions are estimated by Maximum-Likelihood to determine the influence of each field of cost efficiency on financial instability. The results show that biggest inefficiencies are associated with operative cost, so management policies should be specially oriented to reduction of physical capital. On the other hand, the financial covariates show that the most effective strategies in this field consist of looking for advantages in deposits market and increases in resources and in quality of assets through provisions.

Keywords: Stochastic Frontier Approach, Cost efficiency, Savings Banks.

Eficiencia en costes financieros y operativos: Las cajas de ahorros españolas en el periodo pre-crisis

RESUMEN

Este estudio aplica la aproximación de frontera estocástica a una muestra de cajas de ahorros españolas en el periodo pre-crisis (2002-2007) con el objetivo de analizar la relación entre la ineficiencia en costes y la inestabilidad financiera. Además, se estiman por Máxima Verosimilitud dos funciones translog de costes, financieros y operativos, para determinar la influencia del nivel de eficiencia en cada dimensión del coste. Los resultados asocian las mayores ineficiencias a los costes operativos, por lo que las políticas de gestión deberían orientarse a la reducción del capital físico. Por otra parte, las covariables financieras localizan las estrategias más efectivas en la búsqueda de ventajas en los mercados de depósitos y el incremento en recursos y la calidad de los activos mediante provisiones.

Palabras clave: Aproximación de Frontera Estocástica, Eficiencia en costes, Cajas de ahorros.

JEL Classification: C10, G21

Artículo recibido en diciembre de 2014 y aceptado en marzo de 2015
Artículo disponible en versión electrónica en la página www.revista-eea.net, ref. ə-33206

ISSN 1697-5731 (online) – ISSN 1133-3197 (print)

1. INTRODUCTION

Bank's performance measurement and assessment are one of the most important agendas in today's business world. Failure to do some satisfactory performance may damage the bank's reputation, leading to customer defections and breakdowns with other key stakeholders, such as deterioration or loss of investor confidence in management. Thus, banks not only need to be profitable, but also efficient; otherwise, it may create instability and impede in the process of development in any economy.

To understand the evolution of Spanish banking system it is essential to consider the key role played by savings banks. These entities, which are legally established as foundations of a private nature, are specialized in channeling people´s savings (40% of banking sector assets) and financing of households and SMEs. Crespí *et al*., 2004 study the particularities of the governance mechanisms in savings banks, especially after the deregulation process in the late 1980s and early 1990s. The savings banks efficiency has been drastically influenced by their incentive and the corporate governance problems, which were widely visible during the recent financial crisis. In addition, efficiency measure of savings banks is important for at least two reasons. First, efficiency measures are indicators of success, by which the performance of individual banks, and the industry as a whole, can be gauged. The second reason to investigate the efficiency of savings banks is the potential impact of government policies on efficiency.

Banking efficiency has long been a subject of many studies (Casu and Girardone, 2004; Fitzpatrick and McQuinn, 2005; Altunbas *et al*., 2007 and Chortareas *et al*., 2013) and analyzing savings banks efficiency is a contemporary fact (Tortosa-Ausina *et al*., 2008; Han *et al*., 2012 and Nguyen, 2012).

In banking efficiency literature, two major methods for empirical estimation are often used: parametric and nonparametric approaches. The methods used in parametric approach are Stochastic Frontier Approach (SFA) (Aigner *et al.,* 1977; Meeusen and van den Broeck, 1977; Gómez-Gallego *et al*., 2012), Thick Frontier Approach (TFA) (Berger and Humphrey, 1991; Weill, 2004) and Distribution Free Approach (DFA) (Berger, 1993; Carbó *et al*., 2004). On the other hand, the nonparametric researches use Data Envelopment Analysis (DEA) (Charnes *et al*., 1978; Maudos and Pastor, 2003), Malmquist Index, Tornqvist Index and Distance Functions to measure bank efficiency. In the parametric studies, SFA is often used but it was not applied to banking until the authors of Sherman and Gold, 1985 started their own. They applied the frontier approach to banking industry by focusing on the operating efficiency of branches of savings bank. Since then, many studies had been carried out using frontier approaches to measure banking efficiency.

The majority of studies are focused on the estimation of total cost efficiency, for example Mester, 1997. However, in contrast to the majority of earlier studies, this paper has as main objective, following Carbó *et al.*, 2004, to show an analysis that distinguishes between financial and operative cost efficiency in order to specify the influence of each field of total cost efficiency on financial instability. To this effect, a stochastic frontier approach is applied to total, financial and operative translogarithmic cost functions. The sample of data consists of Spanish savings banks along the period 2002-2007. The selected entities have disappeared nowadays due to financial problems during the period selected, so it is interesting to go in depth in efficiency and financial situation.

The rest of the paper is organized as follows: methodology and variables are explained in section 2, section 3 shows the results and section 4 summarizes the conclusions.

2. METHODOLOGY AND VARIABLES

Pioneer studies on estimation of stochastic frontier production functions are Aigner *et al.*, 1977 and Meeusen and van den Broeck, 1977. Pitt and Lee, 1981 and Schmidt and Sickles, 1984 extend this model to panel data, supposing that technical efficiency of each individual unit is invariant along the period. Subsequently, Cornwell *et al.*, 1990 and Battese and Coelli, 1992, 1995 propose an advanced model that allows variable efficiency results and includes covariates that explain differences among the results achieved by each unit, respectively.

Unlike the majority of studies about banking efficiency, this paper proposes three stochastic cost functions: the first one is related to total costs, the second one to financial costs, while the third one to operative costs. A standardisation has been imposed in order to guarantee linear homogeneity in inputs' prices of cost function Berger and Mester, 1997:

$$ln\left(\frac{TC_{it}}{w_{itn}}\right)=\alpha_0+\sum_p^r\beta_p\,ln\,y_{itp}+\sum_m^s\delta_m\,ln\left(\frac{w_{itm}}{w_{itn}}\right)+\varepsilon_{it} \quad (1)$$

$$ln\left(\frac{FC_{it}}{w_{itn}}\right)=\alpha_0+\sum_p^r\beta_p\,ln\,y_{itp}+\sum_m^s\delta_m\,ln\left(\frac{w_{itm}}{w_{itn}}\right)+\sum_j\tau_j\,covariate_{jt}+\varepsilon_{it} \quad (2)$$

$$ln\left(\frac{OC_{it}}{w_{itn}}\right)=\alpha_0+\sum_p^r\beta_p\,ln\,y_{itp}+\sum_m^s\delta_m\,ln\left(\frac{w_{itm}}{w_{itn}}\right)+\varepsilon_{it} \quad (3)$$

$$i=1,2,...,I;t=1,2,...,T.$$

where TC_{it}, FC_{it}, OC_{it} represent total, financial and operative costs, respectively, $\ln y_{it}$ are outputs logarithm, w_{it} are prices of inputs and the covariates are variables that explain differences in efficiency. The error term, ε_{it}, is composed by u_{it}, that are distributed as a half normal $N^{+}(0,\sigma_u^2)$ and interpreted as effects of cost inefficiency, and v_{it}, distributed as a normal $N(0,\sigma_v^2)$ and interpreted as effects of the random errors of the decision making unit (DMU).

Total and operative cost frontiers are estimated following Battese and Coelli, 1992. However, financial cost frontier is estimated using Battese and Coelli, 1995, where parameters of the stochastic cost function and the inefficiency model are estimated simultaneously. To do so, u_{it} are the non-negative inefficiency effects, which are assumed to be independently (but not identically) distributed as a truncation at zero of $N(m_{it},\sigma_u^2)$. The mean is $m_{it} = z_{it}\omega$, with a vector of covariates z_{it}.

The estimation of the parameters can be realized by Maximum-Likelihood (ML), Corrected Ordinary Least-Squares (COLS) (Richmond, 1974) or Bayesian estimation (Van den Broek *et al.,* 1994 and Ortega and Gavilán, 2014). Greene, 1980 analyzes the properties of ML estimator in stochastic frontier models and concludes that, if the assumptions and conditions of regularity enumerated in his study are accepted, ML estimation is consistent and asymptotically efficient and normal. Coelli, 1995 investigates the properties of the half normal frontier model with finite samples through a Monte Carlo experiment and concludes that ML estimator is significantly better than COLS estimator when the contribution of the technical inefficiency effects to the total variance term is large. Specifically, ML estimator is asymptotically more efficient than COLS estimator. On the basis of this, Coelli *et al.*, 1998 recommend to use ML estimator instead of COLS estimator whenever possible.

Once the estimates of the parameters have been obtained, the perturbation can be estimated as the difference between the observed and estimated values. Regard to the estimation of inefficiency, this study follows Jondrow *et al.*, 1982 and estimates inefficiency through the mean of the conditional distribution of inefficiency given the error term.

Regarding the validation of the model, it requires testing the assumptions of temporal variability of the inefficiency effects, functional form of the frontier and inefficiency term distribution. Previously, the existence of inefficiency effects must be tested in order for the model to make sense. As has been argued in Coelli, 1995, if a frontier model considers the assumption of a half normal distribution for inefficiency term, testing the existence of inefficiency presents the null hypothesis $\sigma_u^2 = 0$ versus the alternative, $\sigma_u^2 > 0$. One of the most commonly used statistics is Wald test, $W = \hat{\lambda}_{MV} / S_{\hat{\lambda}_{MV}}$, that is asymptotically normal distributed. The test of $\lambda = 0$ versus $\lambda > 0$, where $\lambda = \sigma_u^2 / \left(\sigma_u^2 + \sigma_v^2\right)$, is defined by the critical region $\left| \hat{\lambda}_{MV} / S_{\hat{\lambda}_{MV}} \right| > z_{\alpha/2}$.

Hereafter, one-sided generalized likelihood ratio (LR) tests are enumerated to check different aspects in the specification of the stochastic frontier model (Zajc, 2006). These statistics are asymptotically distributed as a chi-square random variable with a number of degrees of freedom equal to the number of restrictions and are calculated as:

$$LR = -2\left\{ln\left[L(H_0)\right] - ln\left[L(H_1)\right]\right\} \tag{4}$$

where $L(H_0)$ and $L(H_1)$ are the values of the loglikelihood function under the null and alternative hypothesis, respectively. The critical region of the test with size α is defined by $LR_{\exp} > \chi^2_{restrictions;\alpha}$.

Battese and Coelli, 1992 expand the stochastic frontier model allowing effects of inefficiency to vary over the time:

$$u_{it} = \left\{exp\left[-\eta(t-T)\right]\right\}u_i \qquad i = 1,2,...,N \qquad t = 1,2,...,T \tag{5}$$

where u_{it} are assumed to be an exponential function of time, η is the only unknown parameter and u_i are assumed to be i.i.d. generalized truncated normal random variables. The null hypothesis of inefficiency effects with non-significant variation along the time, $H_0 : \eta = 0$ is tested versus the alternative hypothesis, $H_1 : \eta \neq 0$. The critical region is defined by $LR_{\exp} > \chi^2_{1;\alpha}$ from equation (4).

In order to prove if the most appropriate functional form to impose on the cost frontier is the Cobb-Douglas or the translogarithmic one, the null hypothesis $H_0 : Cobb - Douglas$ is tested versus the alternative $H_1 : trans\log$ through the whole significance of translog parameters that do not appear in the Cobb-Douglas. The critical region is defined by $LR_{\exp} > \chi^2_{10;\alpha}$.

As it is assumed $u_i \approx N^+\left(\mu, \sigma_u^2\right)$, it is interesting to test $H_0 : \mu = 0$, the distribution is a half normal, versus $H_1 : \mu \neq 0$, a truncated normal. The critical region is determined by $LR_{\exp} > \chi^2_{1;\alpha}$.

The proposed method is applied to a sample of 46 Spanish savings banks for the period 2002-2007 with the software FRONTIER 4.1 (Coelli, 1996). Data were obtained from the Spanish Confederation of Savings Banks (CECA).

Concerning the identification of variables as ouputs or inputs of banking activity, the intermediation approach is adopted (Table 1), like Weill, 2004, 2009; Bos and Schmiedel, 2007; Bonin *et al*., 2005; Pasiouras, 2008 and Lozano-Vivas and Pasiouras, 2010.

Table 1
Variables definition

Variable	Name	Definition
y_1	Credit to clients	Sum of outstanding balance of credits of clients
y_2	Securities portfolio	Fixed and variable interest investments
x_1	Loanable Funds	Sum of the balance of deposits of clients in the entity
x_2	Physical Capital	Value of tangible fixed assets of the entity
x_3	Employees	Number of employees of the entity
w_1	Price of L. Funds	Interests / Total liability
w_2	Price of P. Capital	Recovery and maintenance / Physical Capital
w_3	Price of Labour	Personal expenses / Employees
FC	Financial Cost	Interests
OC	Operative Cost	Recovery and maintenance + Personal expenses
TC	Total Cost	FC+OC

Source: Own elaboration.

In the case of financial cost frontier, some financial indicators, at least partially exogenous, are included in the model proposed by Battese and Coelli, 1995 to explain some of the differences in the results (Table 2) (Dios *et al.,* 2006; Bos *et al*., 2009).

Table 2
Covariates definitions

Liquidity (L)	Solvency (S)	Tendency (T)	Quality (Q)	Profitability (P)	Management (M)
Current liability / Current asset	Equity / Requirable liability	Credits / Total asset	Provision / Net margin	Net profit / Equity	Net margin / Total asset
	Equity / Total asset	Depostis-Credits / Total assets	Provision / Total asset		

Source: Own elaboration.

3. RESULTS

Averages for each year from 2002 to 2007 are reported along with the mean and standard deviation in the whole period of costs, outputs, input prices (Table 3) and covariates (Table 4).

The inputs and outputs selection in Table 3 is based on positive correlations. Outputs show high growth rates, even three hundred percentage points in securities portfolio. As regards to inputs, only price of physical capital shows a negative trend due to the increase of employees, mainly. Costs have development a positive trend (total cost have increased more than one hundred percentage points and financial cost more than two hundred). In Table 4, the most relevant fact is an important negative trend of solvency and quality in Spanish savings banks.

Table 3
Variables statistics

	Mín	Máx	Mean	StDev	Averages					
					2002	2003	2004	2005	2006	2007
y_1^*	150	162215	12212	20655	7021	8183	9889	12712	16370	19143
y_2^*	0.4	22161	1554	2902	647	691	671	2151	2159	3002
w_1	0.01	0.06	0.02	0.01	0.03	0.02	0.02	0.02	0.02	0.04
w_2	0.02	0.40	0.07	0.03	0.09	0.08	0.08	0.05	0.05	0.06
w_3	38.73	76.94	53.44	7.72	49.61	51.09	52.34	54.38	55.89	57.29
TC^*	7.5	8310.8	506.3	923.4	376.1	354.2	355.9	426.5	601.0	924.1
FC^*	3.9	6240.3	334.6	654.8	230.0	200.4	195.9	250.7	413.2	717.4
OC^*	3.3	2193.3	171.7	303.7	146.1	153.8	160.0	175.8	187.8	206.7

Min, max, mean and standard deviation in 258 observations of 43 savings banks in 2002-2007.
** Variables expressed in millions of euros.*
Source: Own elaboration.

Table 4
Covariates statistics

	Min	Max	Mean	Std.Dev.	Averages					
					2002	2003	2004	2005	2006	2007
L1	0.000	2.960	0.422	0.353	0.404	0.403	0.421	0.393	0.433	0.482
S1	0.040	0.230	0.083	0.031	0.085	0.085	0.078	0.089	0.082	0.078
S2	0.030	0.160	0.0672	0.024	0.069	0.069	0.064	0.072	0.067	0.063
T1	0.410	0.930	0.760	0.090	0.678	0.705	0.730	0.803	0.828	0.815
T2	0.950	1.760	1.498	0.139	1.469	1.496	1.517	1.502	1.508	1.493
Q1	-0.220	0.620	0.165	0.156	0.302	0.272	0.281	0.048	0.062	0.027
Q2	-0.002	0.010	0.001	0.002	0.003	0.004	0.001	0.000	0.001	0.000
P	0.040	0.320	0.110	0.031	0.115	0.112	0.113	0.096	0.105	0.117
M	0.000	0.040	0.012	0.004	0.011	0.013	0.011	0.011	0.011	0.012

Min, max, mean and standard deviation in 258 observations of 43 savings banks in 2002-2007.
Source: Own elaboration.

Table 5 includes the results of tests and allows achieving the following conclusions:

On checking if the effects of inefficiency vary over time, the hypothesis of nullity of η is rejected with a p-value of 0.000 for the three cases. So, total, financial and operative cost efficiencies are variable over the time.

Table 5
Testing the stochastic frontier model

Test	Total cost		Operative cost		Financial cost	
	LR	d.f.	LR	d.f.	LR	d.f.
Temporal variability	54.8454	1	49.8862	1	52.6723	1
Functional form	182.9662	10	42.2500	6	62.8866	6
Inefficiency distribution	12.0346	1	6.0590	1	160.7516	1

$\chi^2_{1;0,001} = 10{,}8274; \chi^2_{6;0,001} = 22{,}4575; \chi^2_{10;0,001} = 29{,}5879$

Source: Own elaboration.

In the test for the mean of the distribution of inefficiency, the hypothesis of nullity of the mean μ, is rejected for total and financial cost with a p-value of 0.000. So, the most appropriate distribution of inefficiency in total and financial cost is truncated normal, while in the case of operative cost is half normal.

The null hypothesis that established a Cobb-Douglas functional form is rejected with a p-value of 0.000 for the three functions. Therefore, the most appropriate functional form is the translogarithmic one.

Observed costs and prices of inputs must be normalized by any input's price before have taken logarithm. These specifications guarantee that a proportional increase of inputs' prices increases cost in the same proportion. This study uses price of labour to normalize and subscript t is omitted to simplify notation. Finally, the expressions of cost functions for each frontier are:

$$ln\left(\frac{TC_i}{w_{i3}}\right) = \alpha_0 + \sum_{p=1}^{2}\beta_p\, ln\, y_p + \sum_{m=1}^{2}\delta_m\, ln\left(\frac{w_{im}}{w_{i3}}\right) + \frac{1}{2}\sum_{p=1}^{2}\sum_{q=1}^{2}\beta_{pq}\, ln\, y_{ip}\, ln\, y_{iq} + \\ + \frac{1}{2}\sum_{m=1}^{2}\sum_{n=1}^{2}\delta_{mn}\, ln\frac{w_{im}}{w_{i3}}\, ln\frac{w_{in}}{w_{i3}} + \sum_{p=1}^{2}\sum_{m=1}^{2}\gamma_{pm}\, ln\, y_{ip}\, ln\frac{w_{im}}{w_{i3}} + u_i + v_i \quad (6)$$

$$ln\left(\frac{FC_i}{w_{i3}}\right) = \alpha_0 + \sum_{p=1}^{2}\beta_p\, ln\, y_{ip} + \delta_1\, ln\left(\frac{w_{i2}}{w_{i3}}\right) + \frac{1}{2}\sum_{p=1}^{2}\sum_{q=1}^{2}\beta_{pq}\, ln\, y_{ip}\, ln\, y_{iq} + \frac{1}{2}\delta_{11}\, ln^2\left(\frac{w_{i2}}{w_{i3}}\right) + \\ + \sum_{p=1}^{2}\gamma_{p1}\, ln\, y_{ip}\, ln\frac{w_{i2}}{w_{i3}} + \sum_{r=1}^{9}\tau_r\, covariate_{ir} + u_i + v_i \quad (7)$$

$$ln\left(OC_i\right) = \alpha_0 + \sum_{p=1}^{2}\beta_p\, ln\, y_{ip} + \delta_1\, ln\left(w_{i1}\right) + \frac{1}{2}\sum_{p=1}^{2}\sum_{q=1}^{2}\beta_{pq}\, ln\, y_{ip}\, ln\, y_{iq} + \frac{1}{2}\delta_{11}\, ln^2\left(w_{i1}\right) + \\ + \sum_{p=1}^{2}\gamma_{p1}\, ln\, y_{ip}\, ln\, w_{i1} + u_i + v_i \quad (8)$$

Total and operative cost frontiers, equations (6) and (8), are estimated following Battese and Coelli, 1992. However, financial cost frontier, equation (7), is estimated using Battese and Coelli, 1995 in order to include the estimation of covariables.

As far as the existence of inefficiency effects is concerned, it is demonstrated in the model by the high significance of the parameter λ in Tables 6 and 7. The highly significant negative coefficient of the first output indicates the existence of percentage decreases in the three costs due to improvements of credits *(ceteris paribus)*.

Table 6
Estimation results of total and operative cost

	Total cost			Operative cost		
	Coefficient	**Std.Dev.**	**t-ratio**	**Coefficient**	**Std.Dev.**	**t-ratio**
α_0	3.313***	7.968E-01	4.158	3.335***	8.816E-01	3.783
β_1	-7.230E-10***	4.472E-11	-1.616E+01	-1.216E-09***	1.743E-10	-6.974
β_2	4.035E-02	7.130E-02	5.659E-01	1.864E-01**	9.738E-02	1.914
δ_1	6.215E-10	6.464E-10	9.615E-01	1.399E-09	9.144E-10	1.530
δ_2	6.988E-02	4.962E-02	1.708	—	—	—
β_{11}	-2.258E-10	1.707E-10	-1.723	-6.984E-02**	3.202E-02	-2.180
β_{22}	1.896E-02	6.862E-02	2.763E-01	-2.898E-10	2.180E-10	-1.729
δ_{11}	-1.189E-11	6.469E-11	-1.837E-01	-2.229E-02	5.507E-02	-4.047E-01
δ_{22}	8.646E-02**	3.798E-02	2.276	—	—	—
β_{12}	-6.048E-11	6.163E-11	-9.813E-01	2.291E-11	6.126E-11	3.740E-01
δ_{12}	2.527E-02***	2.316E-03	1.091E+01	—	—	—
γ_{11}	-1.933E-10	5.184E-09	-3.728E-02	2.041E-02***	3.175E-03	6.426
γ_{12}	-2.151E-03	2.032E-03	-1.058	—	—	—
γ_{21}	6.845E-11	1.294E-09	5.288E-02	-1.281E-09	2.586E-09	-4.955E-01
γ_{22}	-3.449E-02***	5.268E-03	-6.548	—	—	—
σ^2	4.434E-02***	6.578E-03	6.741	1.009E-01***	1.712E-02	5.897
λ	3.327E-01***	7.850E-02	4.238	4.836E-01***	7.667E-02	6.308
μ	2.429E-01***	6.573E-02	3.695	4.420E-01***	1.234E-01	3.581
η	1.243E-01***	3.110E-02	3.997	1.064E-01***	2.487E-02	4.280

*t-ratio: ***critical value of 2.57 at significance level of 1%, ** 1.96 of 5% and * 1.64 of 10%.*
Source: Own elaboration.

Table 6 shows that the increase of total cost presents a growing rate due to improvements of the ratio price of physical capital over price of employees. In terms of operative cost, credits keeps showing a highly significant negative for both linear and quadratic effect, while securities portfolio shows a positive one. There is a significant decreasing rate due to increases of the ratio price of loanable funds over price of employees in financial cost function.

About financial cost, the behavior of significant covariates explains the development of its efficiency along the period. The frontier includes a set of variables detailed in Table 2, measuring the most important aspects of the activity developed by savings banks, their trend in banking process and the diversification of their activity.

Table 7
Estimation results of financial cost

Financial Cost							
	Coefficient	Std.Dev.	t-ratio		Coefficient	Std.Dev.	t-ratio
α_0	5.449E-01	1.093	4.986E-01	Const	-9.721E-01	6.541E-01	-1.486
β_1	-8.199E-10***	7.809E-11	-1.050E+01	τ_1 (L)	-1.638E-02	1.583E-02	-1.034
β_2	1.900E-01	1.200E-01	1.582	τ_2 (S1)	-1.109E-09	4.569E-09	-2.427E-01
δ_1	2.258E-09*	1.168E-09	1.9334	τ_3 (S2)	1.326E-01***	3.705E-02	-3.581
β_{11}	6.718E-02	6.005E-02	1.118	τ_4 (T1)	-9.691E-10	8.044E-10	-1.204
β_{22}	-8.535E-11	2.497E-10	-3.417E-01	τ_5 (T2)	-1.307E-02	1.950E-02	-6.704E-01
δ_{11}	2.625E-01***	8.768E-02	2.993	τ_6 (Q1)	1.403E-08**	5.711E-09	-2.458
β_{12}	-1.807E-10*	1.005E-10	-1.797	τ_7 (Q2)	-4.471E-02	3.717E-02	-1.202
γ_{11}	1.887E-02***	5.257E-03	3.589	τ_8 (P)	2.793E-11	1.264E-09	2.210E-02
γ_{21}	-4.781E-09	7.294E-09	-6.555E-01	τ_9 (M)	-9.569E-02***	2.931E-02	-3.264
	—	—	—	σ^2	1.152E-01***	1.108E-02	1.039E+01
	—	—	—	λ	3.518E-01***	1.290E-01	2.725

*t-ratio: ***critical value of 2.57 at significance level of 1%, ** 1.96 of 5% and * 1.64 of 10%.*
Source: Own elaboration.

In Table 7, a decrease of total assets implies a better management of surplus towards more productive investments. If this change presents an increase in resources, it will show higher levels of solvency (S2), which increase efficiency. However, this ratio has presented a decreasing trend since 2005 (Table 4), so its influence on financial cost efficiency has been negative since then. Grigorian and Manole, 2002 explain that well capitalized banks are better positioned to attract deposits. In this sense, Mester, 1993 argues that executives of banks close to bankruptcy (low capital ratios) tend to focus on its benefits. The positive relationship between the share of capital and cost efficiency is a conclusion that was reached in other studies about bank efficiency, like Nikiel and Opiela, 2002; Hasan and Marton , 2003; Casu and Girardone, 2004; Carvallo and Kasman, 2005; Chang and Chiu, 2006; Zajc, 2006 and Yildirim *et al.*, 2007.

Quality ratio (Q1) has had a sharp decrease from 2004 (Table 4), when the change comes into effect in regulation under circular 4/2004 of the BE. Its positive coefficient for financial cost efficiency shows the importance of maintaining a level of allocations to provide for bad debts (net) over net margin to guarantee the quality of assets.

The current evolution of management ratio (M) will be a decrease because of legal pressure to reduce margin and improve total assets. However, this ratio shows an improvement from 2005 (Table 4), so there is no advance towards efficiency in net terms.

Estimated efficiencies in total, operative and financial cost are presented in Tables 8, 9 and 10, respectively.

Table 8
Statistics of total costs efficiency scores

Period	Median	Mean	Std.Dev	Mean C.I. (95%)	Min.	Max.
2002	61.05	62.73	12.18	58.98;66.48	42.68	92.98
2003	64.70	66.15	11.30	62.67;69.63	47.16	93.79
2004	68.10	69.34	10.44	66.13;72.55	51.51	94.51
2005	71.25	72.30	9.59	69.36;75.26	55.68	95.14
2006	75.05	74.14	8.77	72.35;77.75	59.63	95.70
2007	77.57	76.79	7.99	75.11;80.03	63.36	96.20

Source: Own elaboration.

The average of total cost efficiency for the period is 0.705, indicating that a DMU has costs a 29.5% above the potential minimum cost of the best practice DMU, producing the same output mix under same conditions. This result is very close to the average efficiency of 0.75-0.80 found by the 130 studies on the banking sector of 21 countries analyzed by Berger and Humphrey, 1997. Others authors like Maudos and Pastor, 2003 and Lozano-Vivas and Pasiouras, 2010 show higher results: 0.90 in banks and 0.80 in savings banks during 1985-1996 and 0.86 in banks of 87 countries during 1999-2006, respectively. In Spanish banking system, the closest result is 0.77 in savings banks during 1989-1996, found by Carbó *et al.*, 2002. Concerning the development of total cost efficiency it shows a slowdown of growth in the second half of the period (Table 8). Following Carbó *et al.,* 2004, DFA total cost efficiency has been obtained and the mean in the period is 0.51. In spite of the results are lower than SFA ones, the temporal trend increase in both estimations and correlation coefficient results 0.997.

Table 9
Statistics of operative costs efficiency scores

Period	Median	Mean	Std.Dev	Mean C.I. (95%)	Min.	Max.
2002	47.66	47.86	15.07	43.22;52.49	18.21	80.40
2003	51.40	51.35	14.60	46.86;55.85	21.64	82.24
2004	55.0	54.76	14.06	50.43;59.08	25.27	83.91
2005	58.44	58.04	13.46	53.90;62.18	29.05	85.44
2006	61.72	61.19	12.81	57.24;65.13	32.92	86.83
2007	64.82	64.19	12.13	60.45;67.92	36.84	88.10

Source: Own elaboration.

Table 9 shows the lowest results of cost efficiency. The average operative cost about 0.562 can be explained by an oversizing of physical capital. Although the trend of operative cost efficiency is positive in the period, the important difference with the best level indicates that exist capability to maneuver in operative field.

Table 10

Statistics of financial costs efficiency scores

Period	Median	Mean	Std.Dev	Mean C.I. (95%)	Min.	Max.
2002	59.22	61.49	13.33	57.39;65.60	39.93	97.20
2003	63.66	65.45	12.12	61.72;69.18	41.04	94.95
2004	67.62	67.14	12.59	63.27;71.02	45.40	97.61
2005	62.27	63.70	11.70	60.10;67.30	44.03	92.36
2006	55.47	56.56	12.59	52.69;60.44	34.23	94.33
2007	47.05	49.53	12.23	45.76;53.29	35.30	89.80

Source: Own elaboration.

The average financial cost efficiency shows a growing trend in the period 2002-2004, from the level 0.615 to 0.671. From 2005, the results describe a decrease of 22 percentage points in just three years, reaching 0.495 in the last year of the study. This change of behaviour in efficiency of financial cost was a prediction of the complicated situation in the majority of Spanish savings banks at present. This problem is worsening because of limits of savings banks to get advantages in the deposits market, given official interest rates.

Financial cost efficiency shows a significant positive correlation with total cost efficiency (0.684; p-value: 0.000), so improvements in financial net presents an important influence in total cost efficiency scores. However, there is a significant negative correlation (-0.713; p-value: 0.112) between averages of financial and operative efficiencies. It is relevant to explain the inverse significant correlation between the size of savings banks, approached by total assets, and the average of operative cost efficiency (-0.215; p-value: 0.167). To sum up, biggest entities used to show lowest operative cost efficiencies, but highest financial and total cost efficiency results.

If these results are compared with those obtained in Spanish banking during 1992-2001 by Carbó *et al.*, 2004, averages about 0.988 in financial cost and 0.880 in operative cost, a worsening in both types of cost efficiency can be observed. As a result, the negative trend of cost efficiency shows the need of changes in management techniques in the sector and it could be an indicator of future financial instability.

About future investigations, it is interesting to apply an alternative model where covariables explain the inefficiency term allowing to analyzing their influence on efficiency in a more explicit way. Besides, data would include banks institutions in order to compare efficiency scores and to obtain conclusions for the whole banking system.

4. CONCLUSIONS

Total, financial and operative estimated cost efficiencies in pre-crisis period have presented lower results than the reported in literature for previous periods. Therefore, low estimated cost efficiency could be due to the financial instability in Spanish savings banks. In order to know specific management strategies to get better efficiency levels, specific operative and financial cost functions have been estimated. In this sense, highest total and financial cost efficiencies are related to lowest operative cost efficiencies scores and it used to happen in biggest savings banks.

Biggest inefficiencies are associated with operative cost, so management policies should be specially oriented to reduction of physical capital. Specifically, changes in the employees' conditions or in the net of entities through mergers to decrease market power and spatial diversification.

On the other hand, estimated financial cost efficiency show a slowdown of growth since the second half of the period. However, the ability of savings banks to maneuver in this field is low due to the existence of official interest rates. Hence, some significant covariates in financial cost function indicate that the most effective strategies to improve efficiency consist of looking for advantages in deposits market and increases in resources and in quality of assets through provisions.

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