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ABSTRACT

The analysis of bank accounting ratios as indicators of competitiveness has been complemented and occasionally revised by the increasing use of more sophisticated indices of efficiency. In recent years, over a hundred studies have analysed the efficiency of financial institutions, concentrating mostly on costs. However, the few available studies that estimate profit frontier functions come up with efficiency levels that are much lower than cost efficiency levels, implying the existence of the most important inefficiencies on the revenue side. Also, few are the studies that run comparisons at an international level, and none of these deals with profit efficiency. This paper analyses, by means of alternative techniques, both cost and profit efficiency in a sample of 11 countries of the European Union for the period 1993-1996, again obtaining profit efficiency levels lower than cost efficiency levels, as well as compatible results in the different estimation procedures used.

Key words: Efficiency, European Banks

JEL: G21, G28

RESUMEN

El análisis de ratios contables como indicadores de competitividad ha sido completado y ocasionalmente revisado por la creciente utilización de indicadores más sofisticados de eficiencia. En los últimos años, más de un centenar de trabajos han analizado la eficiencia de las instituciones financieras, centrándose mayoritariamente en la vertiente de los costes. Sin embargo, los escasos estudios que estiman funciones frontera de beneficios obtienen niveles de eficiencia en beneficios mucho menores que en costes, lo que implica la existencia de importantes ineficiencias en la vertiente de los ingresos. Además, son pocos los estudios que realizan comparaciones a nivel internacional, y ninguno de ellos analiza la eficiencia en beneficios. Por ese motivo, este trabajo analiza la eficiencia en costes y beneficios en una muestra de 11 países de la Unión Europea en el periodo 1993-93 por medio de diversas técnicas frontera. Se obtienen niveles de eficiencia en beneficios inferiores que en costes, siendo este resultado robusto a las distintas técnicas utilizadas.

Palabras clave: Eficiencia, banca europea.

1. Introduction

For many years, the comparison of bank accounting ratios as well as banking sectors has shown the existence of remarkable differences in average costs. Also, wide ranges of ROA and ROE have been found, although these results are more difficult to evaluate due to their greater instability. Both types of evidence have supported the view that differences in the efficiency of banks are due to the existence of a low level of competitiveness. This view has been reconsidered as the liberalisation process brought about a clear intensification of competition. However, the dispersion of costs and profits continues to be notable among companies and among countries, which calls into question the suitability of accounting indicators in portraying the productive efficiency achieved.

On the cost side, the analysis of the differences in average costs has been oriented for many years towards the question of economies of scale and, to a lesser extent, to the study of scope economies (specialisation).

In recent years, the tendency has changed towards the analysis of the X-efficiency of banks, giving rise to a large number of studies. The existence for a group of banks of similar size of a greater dispersion of average costs than that for banks of different sizes has made X-efficiency a much more important potential source of cost reduction than the achievement of an optimum size of production for minimising average costs. Thus, the efficiency analysis has currently replaced economies of scale as the main objective of empirical research.

Many X-efficiency studies consider different output vectors, and so they are limited by the available information. Thus, they consider the impact of specialisation on costs, and this is one reason why X-inefficiencies do not generally present such a wide range as accounting ratios do.

However, the objective of maximising profits does not only require that goods and services be produced at the minimum cost. It also demands the maximum volume of revenues. In this sense, computing profit efficiency constitutes a more important source of information for bank management than the partial vision offered by the analysis of cost efficiency.

The scarce available evidence has shown greater profit inefficiency than cost inefficiency levels. This result could be an indication of the important inefficiencies on the revenue side, either due to the choice of the wrong composition of output, or to the establishment of an erroneous pricing policy.

Of the 130 studies reviewed in the extensive survey carried out by Berger and Humphrey (1997) on efficiency in financial institutions, only 9 studies analysed efficiency in profits¹. With the exception of the study by Miller and Noulas (1996), profit efficiency is found lower than cost efficiency, the former reaching an average value of 64% for the studies referring to the U.S. banking system. However, in only three of the studies (Berger and Mester, 1997; Lozano, 1997 and Rogers, 1998) are the results compared using a single sample, with profit inefficiency always shown to be the largest one².

Berger et al. (1993) is the first study that compares profit with cost efficiency. This paper breaks down profit inefficiency into two parts, one part attributable to technical causes and the other one associated with problems of allocation. The study finds inefficiency levels of 50%, most of them of the technical type. According to this result, inefficiency is explained better by an insufficient level of income than by an excess of costs. This outcome suggests that estimates based only on cost underestimate total inefficiency.

As in Berger et al. (1993), the studies by Akhavein et al. (1994), DeYoung and Nolle (1995) and Rogers (1998), referring to the U.S. banking sector found that the major part of inefficiency was due to insufficient income rather than to excessive costs. In a recent study by Berger and Mester (1997), the greater importance of profit inefficiency is shown. Using a panel of nearly 6,000 U.S. banks for each year (from 1990 to 1995) Berger and Mester estimate their preferred model, a Fourier-flexible specification estimated by the distribution free approach DFA method. They find a value of 46.3% for the alternative profit efficiency and of 54.9% for the standard profit efficiency³, in contrast to an average cost efficiency of 87%. Also, the standard deviation of profit inefficiency is nearly four times higher than that of cost inefficiency, which is indicative of the greater dispersion of the first type of inefficiencies.

Another interesting result of Berger and Mester's study is that, contrary to what could have initially been expected, profit efficiency is not positively correlated with cost efficiency⁴, suggesting the possibility that cost and revenue inefficiencies may be negatively correlated. This

¹ Two further papers should be added to their list, namely, Rogers (1998) and De Young and Hasan (1998).

² In Berger and Mester (1997) profit efficiency is approximately half of cost efficiency. In the case of the Spanish savings banks, using the thick frontier approach, Lozano (1997) obtains a profit efficiency level more than twice the size of that of cost efficiency. Finally, Rogers (1998) obtains an average profit efficiency of 69.2% and a cost efficiency of 75.6%, with a lower revenue efficiency of 43.7%.

³ Berger and Mester (1997) define *alternative* profit efficiency as when banks have market power to set prices and *standard* profit efficiency as when they behave as price takers.

⁴ This result is also achieved in Rogers (1998), although with a positive correlation between income and profit efficiency.

result indicates that a bank with higher costs may compensate this apparent inefficiency by achieving higher revenues than its competitors, either using a different composition of its vector of production or by benefiting from a greater market power in price setting derived from its specialisation. Thus, part of what we measure as cost inefficiency may be contaminated by the output composition, making possible that an output vector of more quality could be more costly but not necessarily inefficient. Alternatively, the estimation of a frontier profit function could capture productive specialisation, allowing the higher revenues received by banks that produce differentiated or higher quality outputs to compensate for the higher costs incurred.

Another issue insufficiently dealt with in the extensive literature on bank efficiency refers to international comparisons. The four studies reviewed by Berger and Humphrey (1997)⁵ find substantial differences of cost efficiency by countries, although none of them considers profit efficiency. As they are centered exclusively on the cost side, the results must be interpreted with caution. In fact, many factors can influence cost efficiency, like the different regulatory environments, the intensity of competition, the output specialisation, the input quality, etc. Consequently, the estimation of the alternative profit efficiency, which takes into account the different degree of competition as well as the effect of output quality on revenues, seems to be a more appropriate way of running international comparisons.

To sum up, there are two areas in which the available evidence on bank efficiency is very limited: a) estimation of profit efficiency and its comparison with cost efficiency; and b) international efficiency comparisons. The intersection of the two areas is an empty set. This is the domain in which this study is situated; the analysis of cost and profit efficiency in a sample of 11 countries, full members of the European Union during the period 1993-1996.

The establishment of a common currency area in most of the countries in the sample will strongly reinforce the mobility of financial flows, as well as cross-border banking activities. However, the current differences of cost and the wide variations of profitability among different banking systems (see figures 1 and 2) continue to raise questions about the future consequences of the gradual integration of banks in an effectively integrated European banking system. Thus,

⁵ Fecher and Pestiau (1993), Pastor et al. (1997), Ruthenberg and Elias (1996) and Allen and Rai (1996).

**Figure 1. Average costs in the European banking systems. 1995
(% Total assets)**

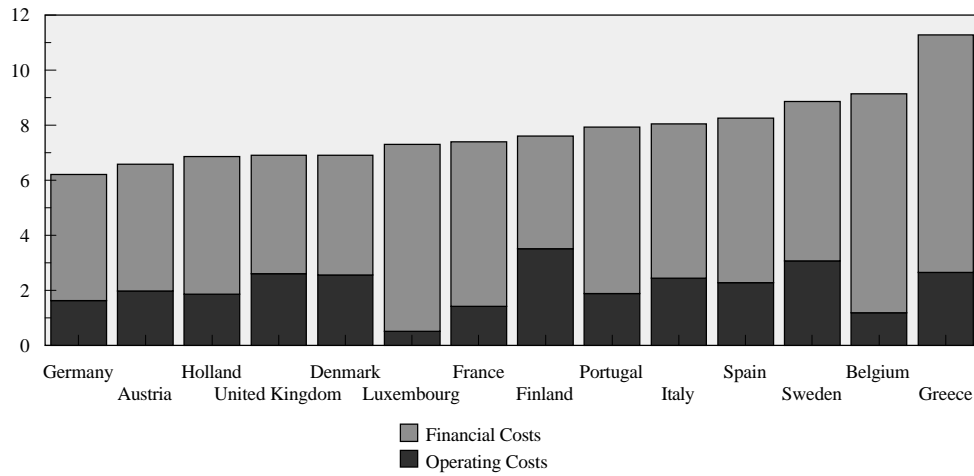
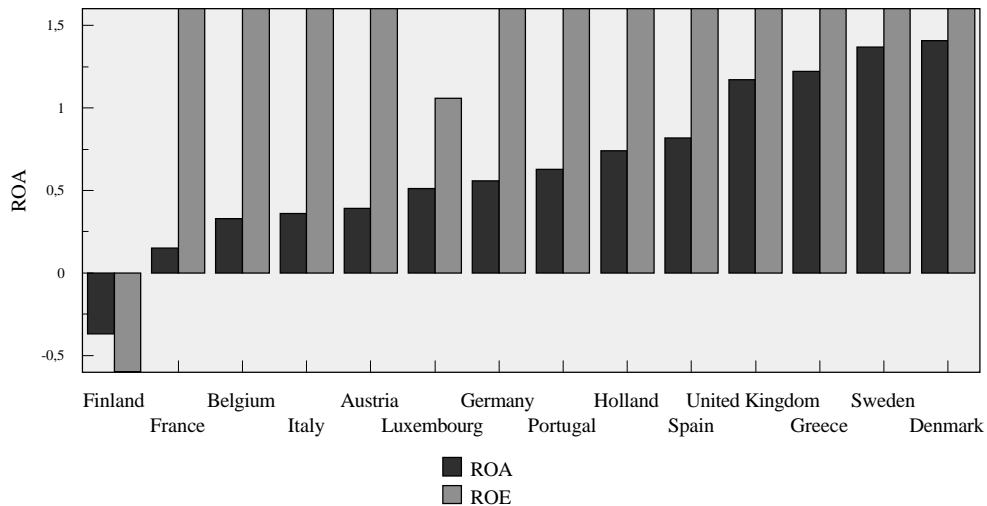


Figure 2. Profitability in the European banking systems. 1995



*Note: Ireland is not included in the "Bank Profitability" data base.
Source: Bank Profitability (OECD).*

the study of the different efficiencies among countries of the European Union will explain the competitive starting position of each country, which may condition its capacity to respond to the new scenario.

With this objective, the paper is structured as follows: Section 2 describes the concepts of cost and profit efficiency, specifying the frontier functions to be estimated; Section 3 comments briefly on the different approaches used for the estimation of efficiency and examines how the technique chosen influences the results; In section 4 the sample data are described and empirical results obtained; Section 5 draws conclusions.

2. Cost efficiency vs. profit efficiency

Cost and profit efficiency definitions correspond, respectively, to two important economic objectives: cost minimisation and profit maximisation. Cost efficiency is the ratio between the minimum cost at which it is possible to attain a given volume of production and the cost actually incurred. Thus, an efficiency value of E_c implies that it would be possible to produce the same vector of production, saving $(1-E_c) \cdot 100$ per cent of the costs. Efficiency ranges over the $(0,1]$ interval, and equals one for the best-practice bank in the sample.

The costs of a bank depend on the output vector (y), the price of inputs (w), the level of cost inefficiency (u) and a set of random factors (v) which incorporate the effect of errors in the measurement of variables, bad luck, etc. Thus, the cost function is expressed as:

$$C = C(y, w, u, v) \quad [1]$$

or in logarithmic terms, and assuming that the efficiency and random error terms are multiplicatively separable from the remaining arguments of the cost function,

$$\ln C = f(y, w) + \ln u + \ln v \quad [2]$$

On the basis of the estimation of a particular functional form f , cost efficiency (E_c) is measured as the ratio between the minimum costs (C^{\min}) necessary to produce the output vector and the costs actually incurred (C):

$$E_c = \frac{C^{\min}}{C} = \frac{\exp[f(y, w)] \exp[\ln v]}{\exp[f(y, w)] \exp[\ln u] \exp[\ln v]} = \exp[-\ln u] \quad [3]$$

Profit efficiency is a broader concept than cost efficiency since it takes into account the effects of the choice of a certain vector of production both on costs and on revenues. Two profit functions can be distinguished, depending on whether or not there is market power: the *standard* profit function and the *alternative* profit function.

The standard profit function assumes that markets for outputs and inputs are perfectly competitive. Given the input and output price vectors (p) and (w), the bank maximises profits by adjusting the amounts of inputs and outputs. Thus, the profit function can be expressed as:

$$\Pi = \Pi(w, p, v, u) \quad [4]$$

and in logarithmic terms:

$$\ln(\Pi + \theta) = f(w, p) + \ln v - \ln u \quad [5]$$

where θ is a constant added to the profits of each firm in order to attain positive values, thus able to take logarithms. Profit efficiency is defined as the ratio between the actual profit of a bank and the maximum level that could be achieved by the most efficient bank:

$$E_{\Pi} = \frac{\Pi}{\Pi^{\max}} = \frac{[\exp[f(w, p)] \exp[\ln v] \exp[-\ln u]] - \theta}{[\exp[f(w, p)] \exp[\ln v]] - \theta} \quad [6]$$

The exogenous nature of prices in the above concept of profit efficiency assumes the existence of no market power on the banks' side. If, instead of taking prices as given, we assume the possibility of imperfect competition, we would take as given the output vector, and not that of prices. In this way we define the alternative profit efficiency:

$$\Pi_a = \Pi_a(y, w, v, u) \quad [7]$$

an expression which is equivalent to that of the cost function only if costs are substituted by profits as the dependent variable. Notice that, in the alternative profit function, banks take as given the quantity of output (y) and the price of inputs (w) and maximise profits by adjusting the price of the output (p) and the quantity of inputs. As indicated by Berger and Mester (1997), the

alternative profit efficiency is a representation closer to reality whenever the assumption of perfect competition in pricing is questionable, or when there are differences of production quality among the banks in the sample.

To the extent that the sample includes a diverse group of countries with different levels of competition, the use for international comparisons of the alternative profit efficiency seems more appropriate than that of the standard profit. Also, the latter definition of efficiency requires information on output prices which is not available with the necessary degree of disaggregation. For both reasons, only alternative profit efficiency is estimated in this study.

Both the cost and profit functions are assumed to take the translogarithmic specification. To avoid negative values, we transform the profit variable by adding to all individual values a constant equal to the maximum loss experienced by any bank in the sample plus one. After this transformation, the bank experiencing the maximum loss will have a value of the transformed variable equal to one (or zero in logarithmic terms⁶).

3. The measurement of inefficiency

The main problem in measuring inefficiency is separating what is genuinely inefficient behaviour from random circumstances affecting costs or profits for other reasons. In the case of the banking sector, the four⁷ most commonly used approaches differ from each other in the assumptions they make. The *stochastic frontier* approach (SFA) proposes that the observed costs of a bank may deviate from the cost frontier either because of random fluctuations or because inefficiency. In order to separate the two components an asymmetrical probability distribution for the inefficiency term is assumed. The *thick frontier approach* (Berger and Humphrey, 1991) assumes that the differences in predicted costs within the quartile of banks with lowest average costs for a given size are due to random factors, while the differences in predicted costs between the quartiles with lowest and highest costs are due to inefficiency. *Data envelope analysis* (DEA), like any determinist technique, assumes that all deviations between observed costs and the minimum costs of the frontier are due to inefficient behaviour. Finally, the *distribution free approach* (DFA) by Berger (1993) is based on the hypothesis that efficiency is persistent over time, whereas random errors tend to cancel each other out in the course of time.

⁶ For more details see Berger and Mester (1997).

⁷ More general overviews regarding frontier approaches are to be found in Lovell (1993) and Greene (1993).

The availability of a panel of data enables the use of standard models of fixed and random effects without the need to make any distributional assumption for the inefficiency term (Schmidt and Sickles, 1984). However, they impose the assumption that efficiency is constant over time. In the context of the stochastic frontier approach, the availability of a panel of data permits consistent estimators of efficiency, whereas this estimation is inconsistent, though unbiased, with cross-section data⁸.

In the case of the fixed effects model (FEM) the inefficiency term is treated as a constant specific to each firm, the model being estimated by OLS (or by using intra-group transformation when the number of firms is very large). The assumption made is that the bank with the lowest fixed effect (if a cost function is being estimated) is the most efficient one in the sample. Then efficiency is measured as the distance between the fixed effect of each bank and that of the most efficient one:

$$E_i = \exp[-(\hat{\alpha}_i - \hat{\alpha}_i^{\min})] \quad [8]$$

where α_i are the fixed effects.

Contrary to the FEM, the random effects model (REM) explicitly takes into account the stochastic nature of efficiency (see Simar, 1992). However, its main disadvantage is that GLS estimators are not consistent if the regressors are correlated with the individual effects. In this model the inefficiency term forms part of the random term, and efficiency is computed in accordance with the following expression:

$$E_i = \exp[-(\ln \hat{\epsilon}_{i\cdot} - \ln \hat{\epsilon}_{i\cdot}^{\min})] \quad [9]$$

$$\ln \hat{\epsilon}_{i\cdot} = \frac{1}{T} \sum_{t=1}^T \ln \hat{\epsilon}_{it}$$

where $\ln \hat{\epsilon}_{it}$ are the residuals of the estimation of the random effects model by GLS.

The availability of a panel of data also allows the use of Berger's DFA technique, a variant of the estimation by GLS of the REM. Basically, this method is similar to REM, with the difference that in DFA the regression coefficients are permitted to vary over time in order to reflect changes in technology and in the environment. In this approach it is assumed that for each bank

⁸ See Battese and Coelli (1988).

there is a given efficiency level which is constant over time, while random errors cancel out. The cost or profit functions are estimated separately for each year of the sample, efficiency being estimated from the average of the residuals for each individual bank. However, since the extreme values of these averages may reflect different aspects of efficiency, truncations are established, assigning to the extreme observations the value of the variable corresponding to the point of truncation. Cost and profit efficiencies are computed respectively by the following expressions:

$$E_c = \frac{C^{\min}}{C} = \frac{\exp[f(y, w)] \exp[\ln \hat{u}^{\min}]}{\exp[f(y, w)] \exp[\ln \hat{u}]} = \frac{\hat{u}^{\min}}{\hat{u}} \quad [10]$$

$$E_{\Pi} = \frac{\Pi}{\Pi^{\max}} = \frac{\exp[f(y, w)] \exp[\ln \hat{u}] - \theta}{\exp[f(y, w)] \exp[\ln \hat{u}^{\max}] - \theta} \quad [11]$$

In this study we use the four parametric panel data approaches described above: the fixed effects model (FEM), the random effects model (REM), the stochastic approach with panel data (SFA) and the distribution free approach (DFA)⁹. However, no results are reported for SFA because neither the estimation for each separate year nor the estimation with a panel of data delivered results that were asymmetrically compatible with the cost and profit functions. As mentioned above, the distribution free approach is, *a priori*, the preferred method, as it allows technology to vary from year to year, without the need to impose distributional assumptions for the inefficiency term. However, it is necessary to test the robustness of its results with different points of truncation.

⁹ The recent study by Bauer et al. (1998) shows that DEA is the method that meets fewest conditions of consistency with very low levels of efficiency. The thick frontier approach does not provide estimates of efficiency at company level, and does not allow comparisons with the other methods.

4. Sample and results

All the necessary information for the estimation of efficiency, both in costs and in profits, is contained in the balance-sheets and income statements included in the IBCA data base¹⁰. Countries included are Austria, Belgium, Finland, France, Germany, Italy, Luxembourg, Holland, Portugal, Spain and the United Kingdom. Denmark, Greece, Ireland and Sweden were excluded for lack of complete information. Altogether, the sample contains 3516 observations corresponding to 879 banking firms over the period 1993-96. On the basis of the figures for 1996 (table 1), they represent 55% of the total assets of the countries considered. Luxembourg is the country with the lowest relative representation (19%) and Finland the country with the largest one (96%). Germany and France, followed by the United Kingdom and Italy, are the countries with the greatest weight in the sample, both in terms of total assets and number of banks.

Table 1: Significance of the European banking system in the sample (mill. \$US)

	(1) Total Asset	(2) % over the EU-11	(3) Sample Asset	(4)=(3)/(1) % Asset included	(5) Number of firms
Germany	5.144.367.487,0	28,05	3.239.424.448,9	63,0	468
Austria	421.911.198,6	2,30	110.514.415,0	26,2	14
Belgium	874.449.163,3	4,77	406.045.118,0	46,4	13
Spain	1.072.363.848,7	5,85	871.695.764,8	81,3	76
Finland	110.674.593,2	0,60	106.482.903,0	96,2	5
France	4.348.676.157,2	23,71	2.241.301.317,5	51,5	136
Holland	974.718.499,6	5,32	345.400.289,2	35,4	18
Italy	1.733.536.694,4	9,45	1.230.744.806,0	71,0	91
Luxembourg	468.002.245,0	2,55	90.160.754,3	19,3	18
Portugal	295.142.238,8	1,61	231.958.050,9	78,6	15
United Kingdom	2.894.818.941,7	15,79	1.176.020.880,6	40,6	25
EU-11	18.338.661.067,3	100,00	10.049.748.748,1	54,8	879

Source: IBCA

The first problem faced by any study on bank efficiency is the definition and measurement of output. This study adopts the intermediation approach, which considers balance sheet items as adequate indicators of output. With this perspective, and conditioned by the disaggregation of the balance and profit and loss account as provided by IBCA, the following three outputs were used¹¹:

1.- y_1 = Loans

¹⁰ London-based International Bank Credit Analysis LTD's 'Bankscope' database.

¹¹ The descriptive statistics of the variables appear in table 2.

2.- y_2 = Other earning assets

3.- y_3 = Deposits

Table 2: Descriptive statistics of the variables: 1993-96

	Average	Std.	Coef. Var.
TC = total costs (financial + operating)	2.870.167	8.377.943	2,919
P = operating profit (net income - provisions)	151.310	700.341	4,629
A = total assets	40.683.125	125.191.893	3,077
y_1 = loans	21.270.566	65.617.619	3,085
y_2 = other earning assests	16.744.739	61.940.836	3,699
y_3 = loanable funds	30.131.661	91.944.193	3,051
w_1 = price of loanable funds	0,214	0,072	0,336
w_2 = price of labor	0,044	0,027	0,614
w_3 = price of physical capital	5,981	11,496	1,922
TC/A	0,071	0,017	0,239
P/A	0,006	0,006	1,000

Note: TC, P, A, y_1 , y_2 in mill. of \$US.

Source: IBCA

The second type of variables appearing in the cost and profit function are the prices of productive factors. Three inputs were selected and, consequently, the following input prices were used:

1.- w_1 = Cost of loanable funds, computed by dividing financial costs by their corresponding liabilities.

2.- w_2 = Cost of labor. Since IBCA does not provide information on the number of employees for each bank, the price of labor has been calculated by dividing personnel costs by total assets¹².

3.- w_3 = Cost of physical capital, defined as the ratio between expenditures on plant and equipment and the book value of physical capital.

¹²This approximation is common in all studies using IBCA data. The variable used can be interpreted as labor cost per worker adjusted for differences in labor productivity, since $(PE/A)=(PE/L)(L/A)$ where PE=personnel expenses, A=total assets and L=labor.

The translog frontier cost function finally estimated is as follows:

$$\ln(C/w_3 a) = \alpha + \sum_{i=1}^3 \beta_i \ln(w_i/w_3) + \frac{1}{2} \sum_{i=1}^3 \sum_{j=1}^3 \beta_{ij} \ln(w_i/w_3) \ln(w_j/w_3) + \sum_{n=1}^3 \gamma_n \ln(y_n/a) + \frac{1}{2} \sum_{n=1}^3 \sum_{m=1}^3 \gamma_{nm} \ln(y_n/a) \ln(y_m/a) + \sum_{i=1}^3 \sum_{n=1}^3 \rho_{in} \ln(w_i/w_3) \ln(y_n/a) + \ln v + \ln u$$

[12]

where the restrictions of symmetry and linear homogeneity have been imposed on input prices. Notice, furthermore, that costs and outputs are expressed as the ratio to average total assets (a)¹³.

In the estimation of the cost function both financial and operating costs are included. In the case of the profit function, the variable to be explained is the operating profit¹⁴.

In the alternative profit function the dependent variable is $\ln[(\Pi/w_3 a) + |(\Pi/w_3 a)^{\min}| + 1]$, where we add the minimum value of profits plus one in order to ensure a positive value for the transformed variable. These transformations are considered later when the values of efficiency for each country are estimated¹⁵.

Table 3 shows average costs per unit of assets and the return on assets of the banking systems considered as an average for the period (1993-96). The coefficients of variation show greater dispersion for profit efficiency than for cost efficiency. Thus, sectors with ROA's over 0.7% (Spain and the U.K.) coexist with sectors with profit rates close to zero (Italy, France and Luxembourg).

¹³ The profit variable is also expressed as ratio to total assets in the translog frontier function. As indicated by Berger and Mester, there are three reasons for proceeding in this way: 1) it reduces possible problems of heteroskedasticity; 2) it reduces possible biases of scale; 3) the dependent variable used in the estimation of the frontier profit function is an indicator of profitability over assets (ROA), and therefore has a clear economic interpretation. Berger and Mester (1997) use equity instead of assets as the variable of normalisation. In this study the preferred scale variable was total assets, since institutional differences among different types of banks (savings banks vs. commercial banks) could affect the definition of equity.

¹⁴ The variable of profits used is what the IBCA calls *operating profit*, which is the net income minus provisions (provisions for loan losses and other provisions).

¹⁵ As in Berger and Mester (1997), although not required, we assume linear homogeneity in prices in the profit function, to keep it equivalent to the estimated cost function.

Table 3: Total cost and profit as a share of assets: mean values 1993-96 (%)

	TC/A	P/A
Germany	6,05	0,52
Austria	6,19	0,47
Belgium	6,46	0,03
Spain	8,38	0,70
Finland	6,11	0,03
France	7,25	0,00
Holland	7,04	0,56
Italy	8,86	-0,01
Luxembourg	6,70	0,01
Portugal	8,90	0,68
United Kingdom	6,56	0,89
EU-11	7,06	0,37
Std	0,02	0,01
Coef. Of Var.	0,24	1,06

Source: IBCA

One aspect to be considered is the low correlation between the rankings in terms of average costs and those in terms of profit rates. Furthermore, the value of the rank correlation coefficient between average costs and the margins on assets is positive (0.43). What this result suggests is that higher (lower) costs do not necessarily imply lower (higher) profits, which indicates the potential importance of the revenue side in the valuation of efficiency.

Tables 4 and 5 contain the average levels of efficiency in costs and profits, estimated by using the three methods, namely; distribution-free approach (DFA), fixed effects (FE) and random effects models (RE)¹⁶. Furthermore, to make convenient comparisons between the results obtained by using the three methods, different truncation points are reported.

¹⁶ Berger's DFA model allows the estimated parameters of the profit and cost function to vary over time in order to reflect possible changes in technology or in the environment. With the aim of making more appropriate comparisons with the standard data panel models, we have introduced time effects into the fixed and random effects models.

Table 4: Cost efficiency

	Distribution-free approach (DFA)				Fixed effects model (FEM)				Random effects model (REM)			
	DFA(0)	DFA(1)	DFA(5)	DFA(10)	FEM(0)	FEM(1)	FEM(5)	FEM(10)	REM(0)	REM(1)	REM(5)	REM(10)
Germany	0,505	0,817	0,873	0,891	0,403	0,777	0,870	0,889	0,428	0,783	0,865	0,886
Austria	0,518	0,839	0,899	0,919	0,410	0,791	0,888	0,910	0,438	0,800	0,887	0,909
Belgium	0,531	0,860	0,919	0,937	0,425	0,819	0,916	0,937	0,453	0,828	0,914	0,936
Spain	0,546	0,885	0,946	0,965	0,434	0,836	0,939	0,960	0,465	0,850	0,941	0,964
Finland	0,540	0,875	0,941	0,961	0,434	0,836	0,938	0,959	0,462	0,844	0,934	0,957
France	0,547	0,886	0,946	0,959	0,443	0,848	0,946	0,965	0,468	0,853	0,941	0,960
Holland	0,553	0,895	0,950	0,962	0,441	0,839	0,934	0,953	0,469	0,849	0,933	0,953
Italy	0,555	0,899	0,961	0,978	0,442	0,851	0,955	0,976	0,474	0,865	0,958	0,979
Luxembourg	0,527	0,853	0,911	0,929	0,441	0,850	0,953	0,971	0,459	0,838	0,927	0,947
Portugal	0,481	0,779	0,843	0,869	0,375	0,723	0,820	0,845	0,400	0,732	0,822	0,852
United Kingdom	0,433	0,726	0,850	0,879	0,336	0,698	0,826	0,857	0,363	0,694	0,836	0,869
EU-11	0,522	0,848	0,914	0,932	0,417	0,806	0,908	0,929	0,444	0,813	0,907	0,929
Std.	0,039	0,056	0,052	0,049	0,040	0,062	0,062	0,059	0,039	0,060	0,058	0,055
Coef. Of Var.	0,075	0,066	0,057	0,052	0,097	0,077	0,068	0,064	0,088	0,074	0,064	0,059

Table 5: Profit efficiency

	Distribution-free approach (DFA)				Fixed effects model (FEM)				Random effects model (REM)			
	DFA(0)	DFA(1)	DFA(5)	DFA(10)	FEM(0)	FEM(1)	FEM(5)	FEM(10)	REM(0)	REM(1)	REM(5)	REM(10)
Germany	0,458	0,715	0,868	0,905	0,546	0,770	0,827	0,855	0,465	0,763	0,865	0,899
Austria	0,446	0,697	0,846	0,884	0,515	0,726	0,779	0,804	0,447	0,734	0,832	0,866
Belgium	0,407	0,635	0,773	0,828	0,506	0,714	0,766	0,790	0,417	0,685	0,777	0,816
Spain	0,462	0,722	0,885	0,925	0,613	0,864	0,925	0,951	0,480	0,788	0,898	0,936
Finland	0,430	0,671	0,816	0,852	0,525	0,740	0,794	0,819	0,436	0,717	0,812	0,845
France	0,424	0,664	0,809	0,848	0,504	0,710	0,764	0,796	0,426	0,702	0,799	0,835
Holland	0,456	0,713	0,866	0,904	0,567	0,800	0,860	0,889	0,465	0,764	0,866	0,901
Italy	0,432	0,676	0,821	0,859	0,533	0,752	0,807	0,834	0,436	0,717	0,814	0,849
Luxembourg	0,425	0,665	0,819	0,861	0,471	0,664	0,722	0,765	0,428	0,705	0,814	0,855
Portugal	0,473	0,739	0,900	0,934	0,586	0,826	0,886	0,906	0,486	0,799	0,904	0,932
United Kingdom	0,496	0,771	0,900	0,928	0,585	0,822	0,878	0,897	0,495	0,808	0,888	0,915
EU-11	0,444	0,694	0,843	0,881	0,546	0,769	0,826	0,853	0,451	0,741	0,840	0,875
Std.	0,051	0,069	0,065	0,057	0,080	0,108	0,103	0,089	0,053	0,076	0,070	0,062
Coef. of Var.	0,116	0,100	0,077	0,065	0,147	0,141	0,125	0,105	0,118	0,102	0,083	0,071

Source: IBCA

The levels of cost efficiency depend greatly on the truncation point chosen. Thus, for example, in DFA the cost efficiency of the average of the countries considered changes from 52.2% to 84.8% when only 1% of the extreme values are replaced by the value of the truncation point. The efficiency increases up to 91.4% when using 5% truncation, but the increase tapers off after this point. What this result suggests is that even after using averages for several years, there is still a high relative weight of random factors, other than inefficiency, that do not cancel each other out in the course of time. This effect has to be alleviated by substituting the more extreme values with those of the points of truncation for a correct valuation and quantification of inefficiency levels. The fact that the change from 5% to 10% truncation does not substantially alter the levels of efficiency leads us to consider 5% a reasonable level of truncation for valuing the results¹⁷.

The results at 5% truncation show a level of cost efficiency of 91.4% for the average of the 11 countries of the European Union considered. According to this estimate it would be possible to reduce costs by about 8%-9%, simply by eliminating X-inefficiencies. Looking at particular countries we find Portugal and the United Kingdom to be the least efficient countries, with values near 15% of total costs, and Italy standing at the opposite extreme with an inefficiency level of 4%.

The levels of efficiency estimated, and the dispersion of the values, are fairly similar in the FE and RE models. Thus, again taking as reference a truncation of 5%, the average efficiency of the FE model is 90.8%, very similar to the 90.7% of the RE model. The identification of the most and least efficient banking sectors is independent of the frontier function used. In both FE and RE models, Italy and Portugal are, respectively, the most efficient and inefficient countries. Thus, both in terms of average values and in identifying the most and least efficient banking sectors, the results are robust to the technique used for estimation. These results are conditions of consistency *sine qua non* for ensuring the credibility and utility of indicators of efficiency¹⁸.

The results corresponding to alternative profit efficiency appear in table 5. Once more, the levels of efficiency vary considerably depending on the point of truncation chosen. Again, the change from 5% to 10% causes quite a small change in magnitude, so we will centre on the results corresponding to 5%.

¹⁷ This result corresponds with that obtained in Berger and Mester (1997) and Berger (1993).

¹⁸ See Bauer et al. (1998) for a full description of conditions of consistency.

The first result to note is the existence of lower levels of profit efficiency than of cost efficiency. These results are similar to those obtained in other studies (Berger and Mester (1997) and Rogers (1998) for the US banking system, and Lozano (1997) for the Spanish savings banks). Thus, and once again independently of the method used, profit efficiency is in the neighbourhood of around 82%-84%, 7-8 percentage points lower than the cost efficiency level¹⁹.

The information by countries shows a range of variation relatively similar to that obtained before in terms of cost efficiency. Thus, the difference between the least efficient sector (Belgium) and the most efficient (Portugal and the United Kingdom) is 12 percentage points. Except for Portugal and the United Kingdom, the profit efficiency of each country is always lower than cost efficiency, the extreme cases being the difference of about 12-14 percentage points in Belgium, Finland, France and Italy. On the other hand, in Germany the difference between cost efficiency and profit efficiency is only about 1 percentage point.

To test for the consistency of the rankings of efficiency, tables 6 and 7 contain the values of the rank correlation coefficients. Two results can be highlighted:

- 1.- For the same frontier technique, the ranking in efficiency is very similar independently of the level of truncation chosen, the value of the coefficient being 0.98-0.99 in all cases.
- 2.- The coefficients of correlation between efficiency rankings using different techniques are very high and statistically significant. A high correlation is also observed between the REM and DFA methods, a logical result if it is taken into account that in both methods inefficiency is estimated from the residues of the regression²⁰. The lowest values of the coefficients of correlation are observed in the case of the FE model, although the magnitude of the coefficient is high in all cases.

¹⁹ The higher volatility of ROA as compared to that of average costs could explain the lower profit efficiency level with respect to the cost efficiency level. To test for this possibility, the cost and profit functions were re-estimated using average values as opposed to annual observations. Very similar results were obtained by applying corrected minimum squares with different points of truncation.

²⁰ In both models the stochastic nature of the inefficiency term is taken into account, while in the fixed effects model inefficiency has a determinist character (see Simar, 19).

Table 6: Ranking correlation coefficients (Cost)

	DFA(0)																				
DFA(0)	1,000	DFA(1)																			
DFA(1)	1,000	1,000	DFA(5)																		
DFA(5)	1,000	1,000	1,000	DFA(10)																	
DFA(10)	0,998	0,998	0,998	1,000	FEM(0)																
FEM(0)	0,881	0,881	0,880	0,878	1,000	FEM(1)															
FEM(1)	0,881	0,881	0,880	0,878	1,000	1,000	FEM(5)														
FEM(5)	0,881	0,881	0,880	0,879	1,000	1,000	1,000	FEM(10)													
FEM(10)	0,878	0,878	0,878	0,878	0,998	0,998	0,998	1,000	REM(0)												
REM(0)	0,936	0,936	0,936	0,934	0,979	0,979	0,978	0,976	1,000	REM(1)											
REM(1)	0,936	0,936	0,936	0,934	0,979	0,979	0,978	0,976	1,000	1,000	REM(5)										
REM(5)	0,936	0,936	0,936	0,934	0,978	0,978	0,979	0,977	1,000	1,000	1,000	REM(10)									
REM(10)	0,934	0,934	0,934	0,934	0,976	0,976	0,977	0,977	0,998	0,998	0,998	1,000									

Note: all coefficients are statistically significant at 5%

Table 7: Ranking correlation coefficients (Profits)

	DFA(0)																		
DFA(0)	1,000	DFA(1)																	
DFA(1)	1,000	1,000	DFA(5)																
DFA(5)	1,000	1,000	1,000	DFA(10)															
DFA(10)	0,998	0,998	0,998	1,000	FEM(0)														
FEM(0)	0,742	0,742	0,742	0,742	1,000	FEM(1)													
FEM(1)	0,742	0,742	0,742	0,742	1,000	1,000	FEM(5)												
FEM(5)	0,742	0,742	0,742	0,742	1,000	1,000	1,000	FEM(10)											
FEM(10)	0,741	0,741	0,741	0,742	0,998	0,998	0,999	1,000	REM(0)										
REM(0)	0,959	0,959	0,959	0,957	0,839	0,839	0,838	0,838	1,000	REM(1)									
REM(1)	0,959	0,959	0,959	0,957	0,839	0,839	0,838	0,838	1,000	1,000	REM(5)								
REM(5)	0,959	0,959	0,959	0,957	0,838	0,838	0,838	0,838	1,000	1,000	1,000	REM(10)							
REM(10)	0,957	0,957	0,957	0,957	0,837	0,837	0,838	0,838	0,998	0,998	0,999	1,000							

Note: all coefficients are statistically significant at 5%

Using the values of efficiency at 5% truncation, the rank correlation coefficients of the cost and profit efficiencies in table 8 show completely different results. Thus, the coefficient of rank correlation among the two definitions of efficiency is negative and statistically significant, whatever the frontier technique used²¹. The explanation of this result, at first sight contradictory, is that cost efficiency may be negatively correlated to profit efficiency if the banks which incur the greatest cost inefficiencies compensate these with higher revenues. This finding can reflect the fact that banks with the highest revenues feel less pressure from competition to reduce their costs, or that banks compete in different market segments and provide different product qualities.

One of the indicators of consistency proposed by Bauer et al. (1998) is based on a comparison of the efficiency indicators and the well known accounting ratios. Table 8 also contains the rank correlation between cost and profit efficiency on the one hand, and two of the most frequently used accounting indicators: average costs per unit of assets (TC/A) and the return on assets (B/A). The most outstanding results are:

1.- The rank correlation of average costs and the estimated cost efficiency is positive and significant, regardless of the frontier approach used. Thus, paradoxically, the most cost-efficient banks have the highest average costs. This result may be due to the fact that the accounting ratios do not take into account the differences in the composition of output or the price of inputs. On the contrary, cost efficiency does take into consideration these variables because it estimates a cost function including the vector of production and input prices.

2.- In the case of profit efficiency and ROA, the results confirm the expected sign. There is a high positive correlation between the two indicators, so that those banks that achieve the highest levels of profit efficiency are the most profitable²².

²¹ The most paradoxical case is the United Kingdom, the second most inefficient country in costs and the most efficient one in profits.

²² At the aggregate level, there is an exact coincidence between the most profit efficient sector and the sector with the highest return on assets. Thus, the UK enjoys the highest profitability and the highest profit efficiency.

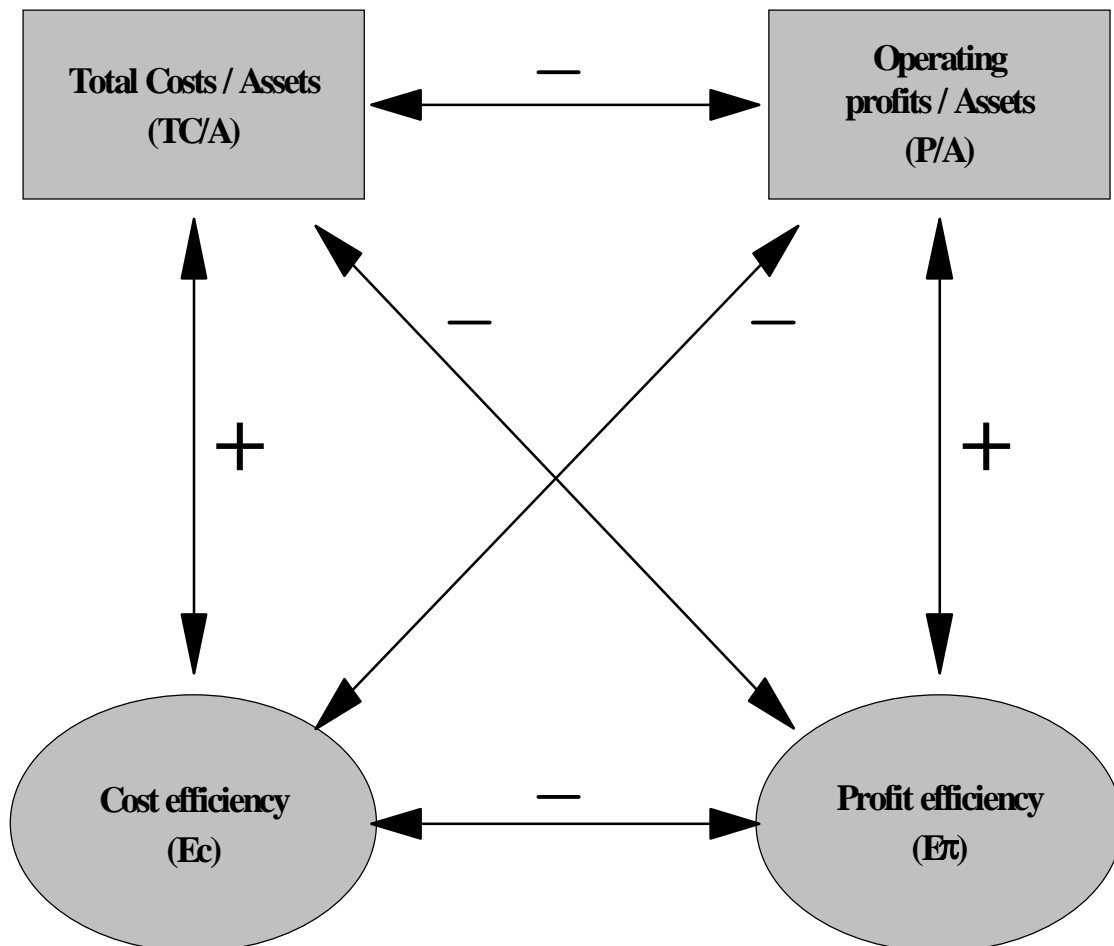
Table 8: Ranking correlation coefficients

	DFA(5)-C								
DFA(5)-C	1,000	FEM(5)-C							
FEM(5)-C	0,880	1,000	REM(5)-C						
REM(5)-C	0,936	0,979	1,000	DFA(5)-P					
DFA(5)-P	-0,367	-0,353	-0,365	1,000	FEM(5)-P				
FEM(5)-P	-0,287	-0,426	-0,359	0,742	1,000	REM(5)-P			
REM(5)-P	-0,368	-0,378	-0,381	0,959	0,838	1,000	TC/A		
TC/A	0,216	0,225	0,245	-0,259	-0,116	-0,256	1,000	P/A	
P/A	-0,334	-0,473	-0,435	0,779	0,757	0,794	-0,328	1,000	

Note: all coefficients are statistically significant at 5%

3.- The correlation between the two accounting ratios, average costs and ROA, is negative. Banks with higher average costs present lower profit rates. Thus, following the above line of causation, average costs are positively correlated with cost efficiency, cost efficiency is negatively correlated with profit efficiency, profit efficiency is positively correlated with the return on assets; so it follows that average costs should be negatively correlated with the return on assets. Also in this line of causation, negative correlations are found among cost efficiency and the return on assets, and, also, among profit efficiency and average costs. All these correlations are mutually consistent. (see figure 3).

Figure 3. Correlation between efficiency indicators and accounting ratios



Finally, table 9 gives the same rank correlations constructed on this occasion for the mean values of the 11 countries. As can be seen in the table, the signs of the correlations are maintained although, in this case, some of them are not statistically significant. The only difference lies in the zero correlation between average costs and the return on assets.

5. Conclusions

In recent years, studies on bank efficiency based on the use of accounting ratios and scale economies estimations have been completed with studies done on X-inefficiencies. These studies include more information on bank output composition and on input and output prices.

Most studies have paid attention to cost efficiency, disregarding possible inefficiencies on the revenue side. However, the studies that have analysed cost and profit efficiency by using frontier profit functions have shown the existence of higher levels of profit than of cost inefficiencies. According to this result, a proper evaluation of efficiency should not be restricted to cost efficiency because many times banks can have better returns from activities that are more costly, but that provide higher net returns.

Furthermore, not much evidence was available regarding international comparisons, and none of the studies included profit efficiency analysis.

In this context, the study analyses cost and profit bank efficiencies for 11 countries of the European Union, using IBCA information for the period 1993-96. Incomplete information and the possible existence of bank market power in setting prices advised the estimation of the *alternative profit efficiency*, the most adequate definition of efficiency to be used.

Using data panel frontier approaches, we find, in general, high levels of efficiency in costs and lower levels in profits, verifying the importance of inefficiencies on the income side of banking activity. Also, the absence of correlation between the rankings of cost and profit efficiency is indicative of the partial view provided by the cost efficiency analysis. Thus, although the banking sectors of the United Kingdom and Portugal are the least cost efficient ones, their position in the ranking changes completely in terms of profit efficiency, where they are the most efficient sectors.

Table 9: Ranking correlation coefficients (by Countries)

	DFA(5)-C								
DFA(5)-C	1,000 *	FEM(5)-C							
FEM(5)-C	0,800 *	1,000 *	REM(5)-C						
REM(5)-C	0,936 *	0,900 *	1,000 *	DFA(5)-B					
DFA(5)-B	-0,436	-0,582 ***	-0,473	1,000 *	FEM(5)-B				
FEM(5)-B	-0,109	-0,464	-0,182	0,864 *	1,000 *	REM(5)-B			
REM(5)-B	-0,309	-0,500	-0,364	0,982 *	0,891 *	1,000 *	TC/A		
TC/A	0,300	0,273	0,300	0,282	0,336	0,373	1,000 *	P/A	
P/A	-0,445	-0,709 **	-0,518	0,827 *	0,818 *	0,827 *	-0,009	1,000*	

* Significant at 1 %

** Significant at 5 %

*** Significant at 10 %

The analysis allows us to conclude that average cost levels are not illustrative of cost efficiency (in fact the rank correlation coefficient is positive) but that they do have the expected negative effect on profit efficiency. Furthermore, the high levels of average costs affect the accounting indicator of profit (ROA) negatively. Finally, the correlation of ranks between ROA and profit efficiency is positive, as was to be expected, and, in this case, with no paradoxical effect. Consequently, it is possible that the effects of specialisation on costs may be greater than that on profits.

In view of these results, it can be concluded that the differences of efficiency among the banks and among the banking sectors considered are not as great as accounting indicators would indicate. Nor are they as small as suggested by the indices of cost efficiency. There is a notably wide range of variation in profit efficiency. Actually, it is greater if we take into account that, although we have worked with individual data, we are presenting average results for countries. Consequently, it would be interesting to analyse, in coming years, the changes that may occur in this range of relative efficiencies, as the forces of competition in the new European scenario take full effect.

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