COST AND PROFIT EFFICIENCY IN EUROPEAN BANKS(*)

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Abstract

In recent years, over a hundred studies have analysed the efficiency of financial institutions, mostly centering on costs. However, the few available studies that estimate profit frontier functions report efficiency levels that are much lower than cost efficiency levels, implying that the most important inefficiencies are on the revenue side. There are also few 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 10 countries of the European Union for the period 1993-1996, again obtaining profit efficiency levels lower than cost efficiency levels. The paper also examines several possible sources of the differences in measured efficiency, including differences in size, specialisation, other bank characteristics, and market characteristics.

Key words: Efficiency, European Banks

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1. Introduction

For many years, a comparison of accounting ratios in the banking sector has shown the existence of remarkable differences in average costs. Wide ranges of ROA and ROE are found, although these results are more difficult to evaluate due to their greater instability. Both types of evidence support the view that differences in the efficiency of banks are due to the existence of a low level of competitiveness. This view can no longer be supported as the liberalisation process brings about a clear intensification of competition. The dispersion of costs and profits among companies and among countries continues to be notable, calling into question the suitability of accounting indicators to determine the productive efficiency of banks.

On the cost side, differences in average costs have been examined for many years by estimating economies of scale and, to a lesser extent, of scope. In recent years, the focus has changed, with a large number of studies analysing the X-efficiency of banks. A group of banks of similar size that show greater dispersion of average costs than banks of different sizes has made X-efficiency a much more important potential source of cost reduction than achieving an optimum size of production to minimise average costs. Thus, the analysis of efficiency has currently replaced economies of scale as the main tool for empirical research.

However, the objective of maximising profits does not only require that goods and services be produced at a minimum cost. It also demands the maximising of revenues. Computing profit efficiency therefore constitutes a more important source of information for bank management than the partial vision offered by analysing cost efficiency. In fact, the limited evidence available now shows that there are higher levels of profit inefficiency than of cost inefficiency[1]. This result supports the importance of inefficiencies on the revenue side, either due to the wrong choice of output or to the mispricing of output.

The study by Berger and Mester (1997) shows that, contrary to initial expectations, profit efficiency is not positively correlated with cost efficiency[2], suggesting the possibility that cost and revenue inefficiencies may be negatively correlated. This 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 greater market power in pricing derived from its specialisation. Thus, a measurement of cost inefficiency may be contaminated by the composition of output, so that an output vector of higher quality could be more costly but not necessarily inefficient. The estimation of a frontier profit function instead can 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)[3] find substantial differences of cost efficiency among countries, although none of them considers profit efficiency. As they are centred exclusively on the cost side, the results must be interpreted with caution. Indeed, many factors can influence cost efficiency, such as different regulatory environments, the intensity of competition, specialisation, input quality, macroeconomic variables, etc. Consequently, the estimation of 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 method for making international comparisons.

To sum up, there are two areas where the available evidence on bank efficiency is very limited: a) estimation of profit efficiency and its comparison to cost efficiency; and b) international efficiency comparisons. The intersection of the two areas is an empty set. This study fills this void by analysing cost and profit efficiency from a sample of 10 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 average costs and the wide variations of profitability among different banking systems continue to raise questions about the future consequences of the gradual integration of banks in an effectively integrated European banking system.

The study of the differences in efficiency among countries of the European Union will also explain the competitive starting position of each country, which may also shed light on capacity to respond to the new changing environment. The "Bank Profitability" data supplied by the OECD for the countries of the European Union referring to the last year analysed in the study (figure 1) show that there are substantial differences both in average costs per unit of assets and in profitability (ROA and ROE).

Finally, it is important to identify the possible factors explaining the observed differences of efficiency between countries. For this reason, an analysis is made of the possible explanatory variables of the observed differences of efficiency including factors such as size, specialisation, other specific characteristics of the firm, and of the markets in which the banks operate.

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 is devoted to analysing the potential correlates of efficiency; Section 6 draws conclusions.

2. Cost efficiency vs. profit efficiency

The definitions of cost efficiency and profit efficiency 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 realized cost. 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, as defined below, are a function of 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:

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

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

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

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

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

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

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

and in logarithmic terms:

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

where θ is a constant added to the profits of each bank in order to attain positive values, enabling them to be treated logarithmically. 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:

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

The exogenous nature of prices in this concept of profit efficiency assumes that there is 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 only the output vector, and not that of prices. Thus we define the alternative profit function:

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

an expression which is equivalent to that of the cost function only if costs are replaced by profits as the dependent variable. Note 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), alternative profit efficiency is 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.

As the sample includes a diverse group of countries with different levels of competition, it seems more appropriate to use alternative profit efficiency than standard profit efficiency for international comparisons. 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 cost and profit functions are assumed to take the translog 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 variable corresponding to the bank with the maximum loss will have a value of one (or zero in logarithmic terms[4]).

3. The measurement of inefficiency

The main problem in measuring inefficiency is to separate genuinely inefficient behaviour from other random factors affecting costs or profits. In the case of the banking sector, the four[5] 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 of inefficiency. To separate these two components, an asymmetrical probability distribution is assumed for the inefficiency term. 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.

The availability of a data panel enables standard models of fixed and random effects to be of without needing to make any distribution 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 data panel permits consistent estimators of efficiency, whereas this estimation is inconsistent, though unbiased, with cross-section data[6].

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. Efficiency is then 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:

$$E_i = \exp[-(\ln \hat{\varepsilon}_{i\cdot} - \ln \hat{\varepsilon}_{i\cdot}^{\min})]$$
$$\ln \hat{\varepsilon}_{i\cdot} = \frac{1}{T}\sum_{t=1}^{T} \ln \hat{\varepsilon}_{it} \qquad [9]$$

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

The availability of a data panel 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 there is a given efficiency level which is constant over time, while random errors cancel each other 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 at the truncation point. Cost and profit efficiencies are computed respectively by the following expressions:

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

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

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)[7]. However, no results are reported for SFA because neither the estimation for each separate year nor the estimation with a data panel delivered results that were asymmetrically compatible with the cost and profit functions. As mentioned above, the distribution free approach (DFA) is *a priori* the preferred method, as it allows technology to vary from year to year, without needing to impose distributional assumptions for the inefficiency term. However, the robustness of its results have to be tested with different points of truncation.

4. Sample and results

All the information necessary for estimating both cost and profit efficiency is contained in the balance-sheets and income statements in the IBCA data base[8]. The countries included are Austria, Belgium, Finland, France, Germany, Italy, Luxembourg, Portugal, Spain and the United Kingdom. Denmark, Greece, Holland, Ireland and Sweden were excluded for lack of complete information. Altogether, the sample contains 3,328 observations corresponding to 832 banks over the period 1993-96. All the banks have over $1,000 million in assets, and were in continuous operation over the entire period (balanced panel). On the basis of the figures for 1996 (table 1), they represent 67.9% of the total assets of the countries considered. The United Kingdom is the country with the lowest relative representation (3.3%) and Belgium the country with the highest (85.8%). Germany and France, followed by Italy, are the countries with the greatest weight in the sample, in terms of both total assets and number of banks.

34.7% of the firms in the sample are commercial banks, 36.2% savings banks, 14.2% co-operative banks and 14.9% of other specialisations[9]. This aggregate composition differs from one country to another. Finland and Luxembourg stand out, with high percentages of commercial banks, and Germany and Spain with a high representation of savings banks.

The first problem faced by any study of bank efficiency is the definition and measurement of output. This study adopts the intermediation approach, considering balance sheet items to be 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 used (the descriptive statistics of the variables appear in table 2):

1. y_1 = Loans
2. y_2 = Other earning assets
3. y_3 = Deposits

The second type of variables in the cost and profit function are the prices of productive factors. Three input prices were used:

1. w_1= Cost of loanable funds, computed by dividing financial costs (interest paid) by their corresponding liabilities (deposits, money market funding and other funding).

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 assets[10].

3. w_3= Cost of physical capital, defined as the ratio between expenditures on plant and equipment (other non interest expenses) and the book value of physical capital (fixed assests).

The concept of efficiency is based on the comparison between optimum costs or profits and those realized. It is assumed that any deviation from the optimum can only be due to inefficiency. These traditional measures of efficiency are normally a good instrument for analysing the management of banks, but it is sometimes necessary to consider other factors. In the case of banks, one of the most important is the risk of insolvency, as a bank should not only be efficient, but also prudent and solvent[11]. This is not exclusive to the banking sector, but it does have a greater impact than in other sectors, given the potential economic repercussions of bank failures[12]. A bank's insolvency risk depends on the composition of its assets and on the financial capital available to absorb any failed investments. This risk of insolvency affects (a) the prices of inputs, and therefore costs, through the risk premium that banks must pay to depositors; and (b) the prices of outputs, and therefore revenue and profits, through the higher return offered by the more risky investments. For this reason, Berger and Mester (1997) advise that a variable capturing banks' insolvency risk should be introduced into the estimation of the cost and profit functions; they therefore include financial capital.

The inclusion in the cost and profit functions of financial capital, as well as risk, offers additional advantages. Firstly, capital affects costs, either because it is a source of funds other than deposits that does not generate financial costs, or because capital increases generate more costs than increasing deposits. If the first effect predominates, the banks with greatest leverage will have higher costs. If the second predominates, the banks with more capital will have higher costs. Secondly, inclusion enables differences in banks' aversion to risk to be taken into account, because banks with higher aversion to risk will wish to have a level of financial capital higher than the optimum (than the minimiser of costs or the maximiser of profits). If capital is not included, the banks that are most prudent or most averse to risk will be penalised, even though they behave optimally in terms of their preferences regarding risk[13].

For all these reasons, financial capital (equity –E-) is introduced into the estimation of cost and profit frontier functions in order to capture the banks' degree of risk. Thus, the translog frontier cost function finally estimated is as follows:

$$\ln(C) = \alpha + \sum_{i=1}^{3} \beta_i \ln(w_i) + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3} \beta_{ij} \ln(w_i)\ln(w_j) + \sum_{n=1}^{3} \gamma_n \ln(y_n) + \frac{1}{2}\sum_{n=1}^{3}\sum_{m=1}^{3} \gamma_{nm} \ln(y_n)\ln(y_m) + \sum_{i=1}^{3}\sum_{n=1}^{3} \rho_{in} \ln(w_i)\ln(y_n) + \delta_E \ln(E) + \frac{1}{2}\delta_{EE} \ln(E)^2 + \sum_{n=1}^{3} \lambda_{En} \ln(E)\ln(y_n) + \sum_{i=1}^{3} \tau_{Ei} \ln(E)\ln(w_i) + \ln v + \ln u \quad [12]$$

where the restrictions of symmetry and linear homogeneity have been imposed on input prices. 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 profit[14]. Because the alternative profit function does not contain output prices, we do not restrict profits to degree one price homogeneity[15].

In the alternative profit function the dependent variable is ln[(A) + $|(A)^{min}|$ + 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 estimated.

Table 3 shows average costs per unit of assets and the average return on assets of the banking systems considered for the period 1993-96. The coefficients of variation show greater dispersion for profit efficiency than for cost efficiency. ROAs over 1% (Spain, Portugal and Italy) coexist with rates around 0.5% (Belgium and France).

There is a low correlation between the rankings in terms of average costs and those in terms of profit rates. Furthermore, the value of the coefficient of rank correlation between average costs and the return on assets is close to zero (-0.019). This result suggests that higher (lower) costs do not necessarily imply lower (higher) profits, indicating the potential importance of the revenue side in the valuation of efficiency.

Tables 4 and 5 contain the average levels of costs and profit efficiency, estimated by the three methods, i.e. distribution-free approach (DFA), fixed effects (FEM) and random effects models (REM)[16]. Furthermore, to make adequate comparisons between the results obtained by the three methods, different truncation points are reported (0%, 1%, 5% and 10%).

The levels of cost efficiency depend greatly on the truncation point chosen. Thus, for example, in DFA the average cost efficiency of the countries considered changes from 49.6% to

65.9% when only 1% of the extreme values are replaced by the value of the truncation point. The efficiency increases to 82.7% with 5% truncation, but the increase tapers off after this point. This result suggests 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. As the change from 5% to 10% truncation does not substantially alter the levels of efficiency we have considered 5% a reasonable level of truncation for valuing the results[17].

The results at 5% truncation show an average cost efficiency of 82.7% for the 10 countries considered. According to this estimate it would be possible to reduce costs by about 17% simply by eliminating X-inefficiencies. Finland, Italy and France emerge as the least efficient countries, Austria standing at the opposite extreme with an inefficiency level of 8%.

The levels of efficiency estimated, and the dispersion of the values, are fairly similar in the REM. With a truncation of 5%, the average efficiency in the REM is 83.9%; in the FEM it is lower, 76.9%[18]. Identification of the most efficient and least efficient banking systems is independent of the frontier approach used: Austria and Germany are the most efficient countries and Finland the most inefficient . Thus, both in terms of average values and in identifying the most and least efficient banking systems, 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 efficiency[19].

The results for 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 very little change in magnitude, so we will concentrate on the results corresponding to 5%.

Profit efficiency levels are lower than those of cost efficiency, a result similar to those obtained in other studies (Berger and Mester (1997) and Rogers (1998) for the US banking system, Lozano (1997) for the Spanish savings banks). More precisely, profit efficiency is 45% in DFA and 52% in REM, lower in FEM (21.7%).

The range of variation among countries is greater than that of cost efficiency. The difference between the least efficient system (Belgium) and the most efficient (Luxembourg and Portugal) is around 26 percentage points. In every country profit efficiency is lower than cost efficiency, the extreme case being the difference of about 55 percentage points in Belgium.

Tables 6 and 7 contain the values of the rank correlation coefficients. Two results of the test for consistency can be highlighted:

1. For the same frontier technique, the ranking in efficiency is similar whatever the level of truncation chosen, because truncation only affects the efficiency level and not the ranking.

2. The coefficients of correlation between efficiency rankings using different techniques are very high, and statistically significant. Correlation between the REM and DFA methods is high, a logical result considering that in both methods inefficiency is estimated from the residuals of the regression[20]. The FEM gives the lowest values of the coefficients of correlation, although the magnitude of the coefficient is high in all cases.

Using the values of efficiency at 5% truncation, the coefficient of rank correlation between the two definitions of efficiency (table 8) is low but positive and statistically significant, whatever the frontier technique used. Thus, the most cost efficient banks are also the most profit efficient, although the correlation is very low.

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 on the other: average total costs per unit of assets (TC/A) and the return on assets (P/A). The most outstanding results are:

1. The rank correlation of average costs and the estimated cost efficiency is negative and significant, regardless of the frontier approach used. Thus the most cost-efficient banks have the lowest average costs, as expected.

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 profitable.

3. The correlation between the two accounting ratios, average costs and ROA, is negative (-0.019). Banks with higher average costs present lower profit rates. Positive correlations are found between cost efficiency and ROA, and negative correlations between profit efficiency and average costs.

5. Potential correlates of efficiency

Having estimated the cost and profit efficiency levels of each of the countries in the sample, it is of interest to analyse the factors that may explain the differences in efficiency among the banking systems of the European Union. In the absence of a theoretical model, we will speak of *potential correlates* of efficiency rather than *explanatory factors*.

Taking as our point of reference the study by Berger and Mester (1997), we will divide the variables used into four groups: size variables, specialisation variable, other characteristics specific to each bank, and characteristics of the markets in which banks operate.

Size: The size of each bank is measured by total assets. However, in order to allow for possible non-linear relationships between efficiency and size, three dummy variables are used: MEDBANK, LARGEBANK and HUGEBANK.

Specialisation: The information contained in IBCA distinguishes eight types of banking specialisation: bank holding & holding company (S1), Commercial bank (S2), Co-operative bank (S3), Investment bank (S4), Medium & long term credit bank (S5), real estate/mortgage bank (S6), savings bank (S7) and specialised governmental credit institution (S8). We shall therefore use 8 dummy variables that take the value 1 when the bank adopts specialisation i (i=1, ... , 8) and 0 otherwise.

Other bank characteristics: The first characteristic specific to each bank is its level of risk. Financial capital has been included in the estimation of cost and profit efficiency in order to control for the amount of risk taken by each bank, but may not capture it completely. We therefore introduce a further indicator of risk: the standard deviation of its return on assets (DEVROA). In principle, we would expect a positive correlation with profit efficiency (the banks that take more risks are more profitable) and a negative correlation with cost efficiency (a bank that takes more risks is under less pressure to control its costs).

The second risk-related characteristic specific to each bank is the composition of assets. Banks with a higher ratio of loans to assets (L/A) will be expected to be more efficient in profits as they take more risks.

Market characteristics: to describe these, we use three variables:

The degree of market concentration (CR) is related to the degree of competition. In the more concentrated markets firms can be expected to have greater market power, and consequently be more efficient in profits. Likewise, if there is a high degree of concentration, banks feel less pressure to be in control of their costs, and are thus less cost efficient. So we can expect concentration to be correlated positively with profit efficiency and negatively with cost efficiency. The variable used as a proxy for concentration is the Herfindahl index, defined as the square of the sum of the market shares of each bank in its national market.

The demand for banking services in a specific market is proxied by the growth rate of GDP (GDPGROWTH), and a positive correlation with profit efficiency is expected.

Finally, a variable that may affect both cost efficiency and profit efficiency in relation to the markets in which the banks compete is the network density (BRANCH) of each country, measured as the average number of branch offices per bank[21]. In those countries in which the population density is low banks must have an extensive network of branch offices to meet customer demand. This high network density leads to higher structural overheads and therefore lower cost efficiency. However, it also enables the banks to use their extensive branch network as a barrier against the entry of competition, thus obtaining higher profit efficiency.

The variables used, therefore, are:

- Bank size: dummy variables to allow for non-linearities: MEDBANK (=1 if bank has assets up to $10,000,000 thousand), LARGEBANK (=1 if bank has assets of $10,000,000 to $100,00,000 thousands) and HUGEBANK (=1 if bank has assets over $100,000,000 thousands).
- Specialisation: Bank holding & holding company (S1), Commercial bank (S2), Co-operative bank (S3), Investment bank (S4), Medium & long term credit bank (S5), Real estate/mortgage bank (S6), Savings bank (S7), Specialised government credit institution (S8)
- Other bank characteristics: Loans divided by total assets (L/A), Standard deviation over time of bank´s annual return on assets (DEVROA)
- Market characteristics: Concentration: Herfindahl index of national market concentration (CR); Real national income growth (GDPGROWTH), Network Density (BRANCH) measured as the number of branch offices divided by the number of banks in each country.

Table 9 shows the results of the multiple regression between efficiency and its explanatory variables. The results indicate that size does not bear a linear relationship to efficiency, but the medium sized banks present the highest levels of both cost and profit efficiency. The table of results shows that only the size dummy corresponding to the banks of medium size (MEDBANK) is statistically significant.

The type of banking specialisation does not seem to influence the differences observed in the banks' efficiency levels. Only the dummy representing "specialised government credit institutions" (S8) is statistically significant in the case of profit efficiency.

Of the remaining bank-specific variables, L/A does not present a significant correlation with efficiency. In the case of the standard deviation of return on assets (DEVROA) the banks that assume higher risk present, as expected, a higher level of profit efficiency and a lower level of cost efficiency. Banks with higher loan-to-asset ratios are therefore more profit efficient and are under less pressure to control costs[22].

Among the characteristics of the markets in which banks operate, the degree of concentration has a positive influence on profit efficiency and a negative one on cost efficiency. These results show that the banks operating in less competitive markets can charge higher prices and are under less pressure to control their costs[23].

The banks that operate in expanding markets - proxied by the real growth rate of GDP - present higher levels of profit efficiency. However, under expansive demand conditions, banks feel less pressured to control their costs and are therefore less cost efficient.

Finally, the results show that banks operating in markets with a high network density are less cost efficient as a consequence of the high structural overheads that they bear.

6. Conclusions

In recent years, studies of bank efficiency based on the use of accounting ratios and estimations of scale economies have been complemented by studies of X-inefficiencies. Most studies have paid attention to cost efficiency, disregarding possible inefficiencies on the revenue side, but studies that have analysed cost and profit efficiency using frontier profit functions have shown the existence of higher levels of inefficiency in profits than in costs. This result shows that a proper evaluation of efficiency should not be restricted to cost efficiency, but that profit efficiency should also be considered.

Insufficient evidence was available regarding international comparisons, and none of the studies included profit efficiency analysis.

In this context, the study analyses the cost and profit efficiencies of banks for 10 countries of the European Union, using IBCA information for the period 1993-96. Incomplete information and the possible influence of bank market power on pricing made it advisable to estimate *alternative profit efficiency,* the most suitable definition of efficiency to be used.

Using panel data frontier approaches, we find high levels of efficiency in costs and lower levels in profits, verifying the importance of inefficiencies on the revenue side of banking activity. Also, the low (though positive) correlation between the rankings of cost and profit efficiency is indicative of the partial view provided by cost efficiency analysis.

Having estimated the cost efficiency and profit efficiency of the different banking systems of the European Union, it is of interest to identify the possible explanatory variables of the differences in efficiency between countries. For this we have used four groups of variables: size, specialisation, other characteristics specific to each bank, and characteristics of the markets in which they operate. The results show that (a) medium sized banks reach the highest levels of efficiency in both costs and profits, (b) the type of banking specialisation is not significant in explaining the differences of efficiency between banks, and (c) the banks with a higher loans/assets ratio are more efficient. As to market characteristics, market concentration is positively related to profit efficiency - the higher the concentration, the greater the market power, and therefore higher profitability - and negatively with cost efficiency - banks operating in more concentrated markets are less pressured to control costs. Higher risk - proxied by the standard deviation of return on assets - is positively related, as expected, to profit efficiency, and has no significant relationship with cost efficiency. The growth of the market, measured by the real growth rate of GDP, allows higher levels of efficiency to be achieved. And finally, those banks that operate in markets with a higher network density - and therefore have higher structural overheads - are less cost efficient.

From these results, we can conclude that there is a notably wide range of variation in efficiency levels in the banking systems of the European Union, the variation in terms of profit efficiency being greater than in terms of cost efficiency. It is actually greater if we take into account that, although we have worked with individual data, we are presenting average results for countries. It would therefore 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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Notes:

1. Of the 130 studies reviewed in the extensive survey by Berger and Humphrey (1997) on efficiency in financial institutions, only 9 studies analysed efficiency in profits (two further papers should be added: Rogers (1998) and De Young and Hasan (1998)). With the exception of the study by Miller and Noulas (1996), profit efficiency is found to be 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 highest.
2. This result is also obtained in Rogers (1998), although with a positive correlation between revenue and profit efficiency.
3. Fecher and Pestiau (1993), Pastor et al. (1997), Ruthenberg and Elias (1996) and Allen and Rai (1996).
4. For more details see Berger and Mester (1997).
5. More general overviews regarding frontier approaches are to be found in Lovell (1993) and Greene (1993).
6. See Battese and Coelli (1988).
7. 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 firm level, and does not allow comparisons with the other methods.
8. London-based International Bank Credit Analysis Ltd´s ´Bankscope´ database.
9. Bank holding & holding company, medium and long term credit bank, investment banks, real estate/mortgage banks and specialised governmental credit institutions.

10. This 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.
11. Toevs and Zizka (1994) state that the standard ratios normally used by analysts as indicators of efficiency do not consider risk. They further affirm that for a bank to attempt to improve efficiency may be counter-productive and that they can achieve it by transferring their activities towards high risk business, with low operating costs and high profits.
12. However, in spite of its importance, very few studies consider this close relationship between risk and efficiency. Thus Berg et al. (1992), Hughes and Mester (1993), Mester (1994a, 1994b) and Pastor (1999) all attempted to obtain measurements of efficiency adjusted for risk, by including risk measured through "bad loans" as an additional input. Pastor (1999) further considers that part of the risk is due to exogenous circumstances beyond the firms' control and that this part of bad debt should be discounted at an earlier stage. Berger and Mester (1997) include financial capital in order to control for the risk of insolvency.
13. Once again, in spite of its importance, very few studies include financial capital (Berger and Mester (1997), Clark (1996), Hughes and Mester (1993), Hughes et al. (1996a and 1996b), Akhavein et al. (1997)).
14. The profits variable used is what the IBCA calls *operating profit*, which is the net income minus provisions (provisions for loan losses and other provisions).
15. See De Young and Hasan (1998).
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.
17. This result agrees with that obtained in Berger and Mester (1997) and Berger (1993).
18. Gathon and Perelman (1992) and Simar (1992) assert that individual fixed effects are not reliable as indicators of efficiency. Berger (1993 and 1995) shows how FEM tends to confound differences in bank size with inefficiency.
19. See Bauer et al. (1998) for a full description of conditions of consistency.
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, 1992).
21. The information comes from "Bank Profitability" by the OECD (1999).
22. The results are robust when the standard deviation of return on equity (ROE) is used.
23. On this point, see Berger (1995).

Table 1: Significance of the European banking systems in the sample (1996) [1]

	(1) Total Asset	(2) % over the EU-11	(3) Sample Asset	(4)=(3)/(1) % Asset included	(5) Number of firms	(6) Specialisation (% of firms)			
						Comm. Banks	Savings Bank	Coop. Banks	Other Spec.[2]
Germany	6,108,280,887.6	37.6%	4,743,097,781.8	77.7%	349	18.9%	52.7%	10.0%	18.3%
Austria	560,580,732.5	3.4%	450,314,924.9	80.3%	38	47.4%	28.9%	0.0%	23.7%
Belgium	736,004,714.9	4.5%	631,547,634.9	85.8%	27	66.7%	22.2%	3.7%	7.4%
Spain	1,059,434,764.9	6.5%	845,629,230.2	79.8%	81	35.8%	55.6%	2.5%	6.2%
Finland	124,781,589.6	0.8%	24,986,047.2	20.0%	1	100.0%	0.0%	0.0%	0.0%
France	3,038,584,831.0	18.7%	2,318,706,163.2	76.3%	142	45.1%	12.0%	33.1%	9.9%
Italy	1,695,221,001.9	10.4%	1,434,387,172.6	84.6%	126	29.4%	29.4%	24.6%	16.7%
Luxembourg	477,666,112.2	2.9%	392,391,962.5	82.1%	48	91.7%	2.1%	2.1%	4.2%
Portugal	211,758,335.8	1.3%	115,722,804.7	54.6%	10	70.0%	0.0%	10.0%	20.0%
United Kingdom	2,238,064,623.7	13.8%	74,097,554.0	3.3%	10	50.0%	0.0%	0.0%	50.0%
EU-10	**16,250,377,594.4**	**100.0%**	**11,030,881,276.0**	**67.9%**	**832**	**34.7%**	**36.2%**	**14.2%**	**14.9%**

(1) Values in 1000s of $US. All banks have over $1000 million in assets.

(2) Investment Bank, Medium & long term bank, Real Estate/Mortgage Bank, Specialised Governmental Credit Institutions.

Source: IBCA

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

	Average	Std. Dev.	Coef. of Var.
TC = total costs (financial + operating)	784,874	1,853,247	2.361
P = operating profit (net income - provisions)	96,491	213,569	2.213
A = total assets	11,721,908	29,587,006	2.524
E = financial capital (equity)	519,869	1,325,012	2.549
y_1= loans	5,531,256	14,752,905	2.667
y_2 = other earning assests	5,573,805	14,635,513	2.626
y_3 = loanable funds	7,938,821	20,132,693	2.536
w_1 = price of loanable funds	0.071	0.198	2.800
w_2 = price of labor	0.009	0.007	0.769
w_3= price of physical capital	0.548	4.082	7.450
TC/A	6.70%	0.022	0.335
P/A	0.82%	0.010	1.155

Note: TC, P, A, E, y_1, y_2 and y_3 in 1,000s of $US.

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

	TC/A	P/A
Germany	5.899	0.846
Austria	6.011	0.802
Belgium	6.448	0.498
Spain	8.144	1.326
Finland	6.109	0.605
France	6.755	0.527
Italy	8.410	1.094
Luxembourg	6.947	0.756
Portugal	8.942	1.233
United Kingdom	5.646	0.639
EU-10	**6.696**	**0.823**
Std. Dev.	0.022	0.010
Coef. of Var.	0.335	1.155

Source: IBCA

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	0.523	0.694	0.869	0.907	0.183	0.738	0.841	0.933	0.384	0.843	0.900	0.935
Austria	0.549	0.729	0.913	0.952	0.177	0.716	0.823	0.933	0.385	0.846	0.907	0.950
Belgium	0.509	0.675	0.846	0.883	0.168	0.679	0.781	0.886	0.363	0.799	0.856	0.897
Spain	0.509	0.676	0.846	0.883	0.170	0.684	0.787	0.889	0.366	0.805	0.862	0.901
Finland	0.411	0.545	0.683	0.723	0.132	0.534	0.614	0.697	0.311	0.683	0.732	0.767
France	0.468	0.620	0.778	0.817	0.154	0.610	0.703	0.803	0.333	0.728	0.782	0.825
Italy	0.458	0.608	0.769	0.807	0.151	0.610	0.708	0.806	0.321	0.708	0.764	0.808
Luxembourg	0.481	0.639	0.801	0.837	0.141	0.568	0.654	0.742	0.324	0.712	0.764	0.801
Portugal	0.501	0.665	0.833	0.870	0.155	0.623	0.717	0.813	0.349	0.767	0.822	0.861
United Kingdom	0.493	0.655	0.821	0.857	0.151	0.609	0.701	0.795	0.338	0.743	0.796	0.834
EU-10	**0.496**	**0.659**	**0.827**	**0.865**	**0.167**	**0.670**	**0.769**	**0.866**	**0.356**	**0.783**	**0.839**	**0.878**
Std. Dev.	0.057	0.072	0.078	0.074	0.037	0.089	0.093	0.092	0.044	0.082	0.081	0.076
Coef. of Var.	0.114	0.110	0.095	0.085	0.220	0.133	0.121	0.106	0.123	0.104	0.097	0.087

Source: IBCA

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	0.129	0.324	0.524	0.620	0.056	0.107	0.236	0.345	0.125	0.316	0.547	0.671
Austria	0.103	0.257	0.426	0.510	0.040	0.077	0.175	0.250	0.111	0.281	0.489	0.607
Belgium	0.070	0.175	0.287	0.365	0.028	0.054	0.118	0.188	0.080	0.203	0.352	0.439
Spain	0.113	0.284	0.455	0.559	0.071	0.136	0.295	0.410	0.125	0.315	0.539	0.667
Finland	0.073	0.183	0.295	0.349	0.047	0.091	0.196	0.274	0.062	0.156	0.270	0.334
France	0.078	0.198	0.338	0.415	0.034	0.066	0.155	0.226	0.099	0.251	0.446	0.564
Italy	0.121	0.304	0.489	0.576	0.092	0.177	0.380	0.523	0.124	0.314	0.540	0.662
Luxembourg	0.144	0.361	0.560	0.650	0.038	0.073	0.159	0.243	0.145	0.368	0.626	0.754
Portugal	0.134	0.335	0.540	0.639	0.090	0.173	0.374	0.522	0.120	0.304	0.525	0.649
United Kingdom	0.119	0.299	0.481	0.569	0.054	0.102	0.221	0.309	0.098	0.248	0.428	0.529
EU-11	**0.110**	**0.277**	**0.454**	**0.545**	**0.050**	**0.097**	**0.217**	**0.316**	**0.118**	**0.298**	**0.516**	**0.637**
Std. Dev.	0.061	0.133	0.184	0.198	0.063	0.117	0.192	0.230	0.057	0.123	0.181	0.201
Coef. of Var.	0.552	0.479	0.405	0.364	1.254	1.200	0.886	0.726	0.487	0.413	0.351	0.315

Source: IBCA

Table 6: Ranking correlation coefficients (Cost)

	DFA(0)	DFA(1)	DFA(5)	DFA(10)	FEM(0)	FEM(1)	FEM(5)	FEM(10)	REM(0)	REM(1)	REM(5)	REM(10)
DFA(0)	1.000											
DFA(1)	1.000	1.000										
DFA(5)	1.000	1.000	1.000									
DFA(10)	1.000	1.000	1.000	1.000								
FEM(0)	0.791	0.791	0.791	0.790	1.000							
FEM(1)	0.791	0.791	0.791	0.790	1.000	1.000						
FEM(5)	0.791	0.791	0.791	0.790	1.000	1.000	1.000					
FEM(10)	0.791	0.791	0.791	0.791	1.000	1.000	1.000	1.000				
REM(0)	0.838	0.838	0.838	0.838	0.927	0.927	0.927	0.927	1.000			
REM(1)	0.838	0.838	0.838	0.838	0.927	0.927	0.927	0.927	1.000	1.000		
REM(5)	0.838	0.838	0.838	0.838	0.927	0.927	0.927	0.927	1.000	1.000	1.000	
REM(10)	0.838	0.838	0.838	0.838	0.927	0.927	0.927	0.927	1.000	1.000	1.000	1.000

Note: all coefficients are statistically significant at 5%

Table 7: Ranking correlation coefficients (Profits)

	DFA(0)	DFA(1)	DFA(5)	DFA(10)	FEM(0)	FEM(1)	FEM(5)	FEM(10)	REM(0)	REM(1)	REM(5)	REM(10)
DFA(0)	1.000											
DFA(1)	1.000	1.000										
DFA(5)	1.000	1.000	1.000									
DFA(10)	1.000	1.000	1.000	1.000								
FEM(0)	0.585	0.585	0.585	0.584	1.000							
FEM(1)	0.585	0.585	0.585	0.584	1.000	1.000						
FEM(5)	0.585	0.585	0.585	0.584	1.000	1.000	1.000					
FEM(10)	0.585	0.585	0.585	0.584	1.000	1.000	1.000	1.000				
REM(0)	0.972	0.972	0.972	0.972	0.669	0.669	0.668	0.668	1.000			
REM(1)	0.972	0.972	0.972	0.972	0.669	0.669	0.668	0.668	1.000	1.000		
REM(5)	0.972	0.972	0.972	0.972	0.669	0.669	0.668	0.668	1.000	1.000	1.000	
REM(10)	0.972	0.972	0.972	0.972	0.669	0.669	0.668	0.668	1.000	1.000	1.000	1.000

Note: all coefficients are statistically significant at 5%

Table 8: Ranking correlation coefficients

	DFA(5)-C	FEM(5)-C	REM(5)-C	DFA(5)-P	FEM(5)-P	REM(5)-P	TC/A	P/A
DFA(5)-C	1.000							
FEM(5)-C	0.791	1.000						
REM(5)-C	0.838	0.927	1.000					
DFA(5)-P	0.139	0.116	0.115	1.000				
FEM(5)-P	-0.044	0.096	0.005	0.585	1.000			
REM(5)-P	0.078	0.091	0.071	0.972	0.668	1.000		
TC/A	-0.371	-0.358	-0.407	-0.110	0.203	-0.077	1.000	
P/A	0.028	-0.011	-0.008	0.388	0.470	0.379	-0.019	1.000

Note: all coefficients are statistically significant at 5%

Table 9: Regression analysis of the potential correlates of efficiency

	Cost efficiency		Profit efficiency	
Variable	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**
MEDBANK	-0.005	-0.715	-0.068	-3.893
LARGEBANK	0.916	39.961	0.438	7.984
HUGEBANK	-0.021	-1.031	-0.291	-0.598
S1	0.083	1.784	0.176	1.604
S2	0.004	0.226	0.070	1.831
S3	-0.009	-0.515	0.060	1.519
S4	0.033	1.234	0.006	0.085
S5	0.015	0.649	0.064	1.194
S6	0.026	0.898	0.064	0.892
S7	0.024	1.313	0.053	1.225
S8	0.025	1.596	0.106	2.842
L/A	-0.021	-1.438	-3.9E-04	-0.009
DEVROA	-3.382	-3.717	11.621	5.036
CR	0.290	1.844	-2.195	-5.782
GDPGROWTH	-3.439	-5.324	5.310	3.424
BRANCH	-1.7E-04	-2.638	-1.7E-03	-1.049
Adjusted R^2	0.095		0.090	

Figure 1. Average costs in the European banking systems. 1996
(% Total assets)

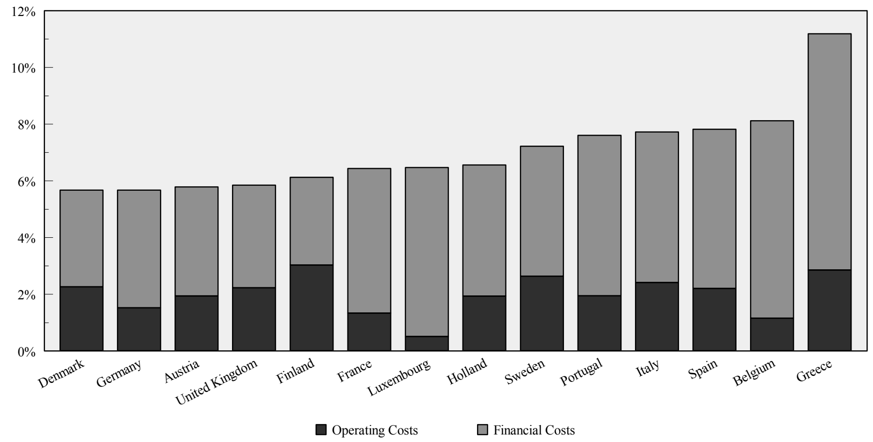
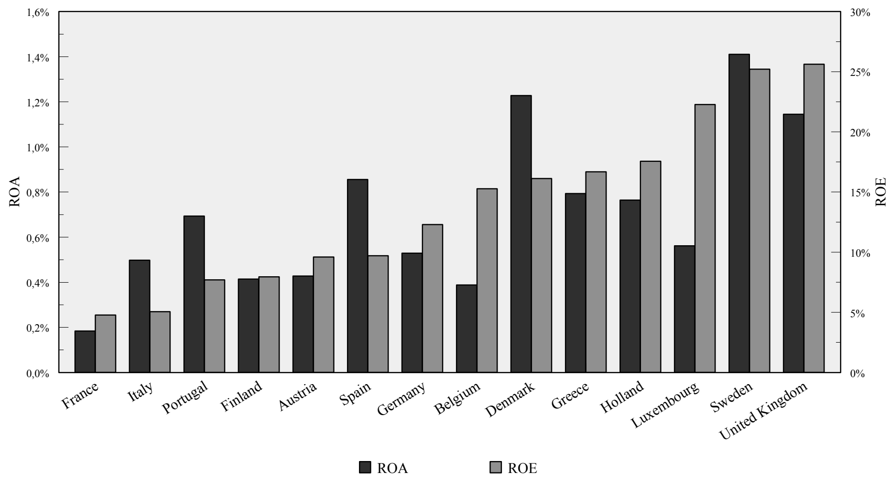


Figure 2. Profitability in the European banking systems. 1996



Source: Bank Profitability (OECD).