Competition and Efficiency in the Spanish Banking Sector: The Importance of Specialisation

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Abstract

This paper analyses the importance of productive specialisation in explaining cost efficiency differences between banking companies. Taking as reference the Spanish banking sector during the period 1985-96, the study shows that if cost efficiency measurements are corrected for the effect of different specialisation by the estimation of separate frontiers for four different groups of competitors, the efficiency of companies improves. The behaviour of costs would thus be compatible with that of other competition indicators, reflecting the effects of a more competitive situation in the Spanish banking sector at present than at the start of the period considered.

Key words: efficiency, specialisation
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1. Introduction

In recent years competition in banking has developed in an environment defined by four circumstances: a much less interventionist regulation of the sector, a fast-growing demand for banking services, intense technological change and an uninterrupted process of internationalisation of financial activities. In this context, banking firms have designed their competition strategies with greater autonomy with respect to many of the variables, but they have been more constrained by increasingly narrow margins as a consequence of operating in markets now freed of many barriers.

This combination of greater freedom and more competition should be reflected, overall, in a reduction of average costs and margins and in increased efficiency. The Spanish banking sector (SBS), in which the abovementioned factors of change have operated intensely in the last ten years, starting from a situation quite different from today´s, offers a suitable case for testing the validity of these affirmations.

Some studies have tried to analyse whether in fact competition has increased in these years by means of the analysis of cost and margin indicators (Gual, 1992; Freixas, 1996; Pérez et al., 1999), and whether it has encouraged companies to cut their costs and therefore to increase their efficiency (Pastor, 1995; Maudos, 1996; Grifell and Lovell, 1997). The empirical evidence found has not been at all conclusive, with regard to either the increase of competition or the improvement of efficiency.

However, none of these studies has considered the importance of product specialisation in companies' average cost levels and therefore in efficiency levels[1]. In recent years banks have tried to specialise in those areas of business in which they enjoyed competitive advantages, either because of their experience, or because of their particular characteristics. In this sense, the increase in competition does not drive companies towards the standardisation of their specialisations, but towards the definition of their differences, as companies select those specialisations that are more advantageous for them in the light of their experience. Thus, to the extent that these different specialisations persist, measurements of efficiency, biased by the influence of specialisation, will not tend to improve.

The aim of this study is to analyse the effects of the specialisation chosen by companies on their observed cost efficiency. The analysis takes into account that different specialisations imply different technologies, and therefore different cost frontiers, a company's efficiency being measured against the cost frontier corresponding to its range of products. Having defined the efficiency of each company against the specific frontier of its chosen line of business, the study attempts to analyse whether stiffer competition has indeed driven companies to improve their efficiency in comparison with other companies of the same productive orientation.

The structure of the study is as follows. Section 2 reviews the recent evolution of competition in the SBS in terms of margins. In section 3 a cluster analysis is performed, in order to group the many specialisation strategies into a small number of groups and describe their characteristics. On the basis of this grouping of competitors with similar productive orientations, we study the cost efficiency frontiers corresponding to each cluster. Section 4 describes the construction of the frontier by means of non-parametric techniques (DEA) and the calculation of the average efficiency. Section 5 presents the estimations and analyses the results obtained, paying special attention to the evolution of efficiency levels and comparing this with what happens when a common frontier is used. Also in this section an econometric analysis is made of the determinants of efficiency levels. Finally, section 6 is devoted to the conclusions.

2. Recent evolution of the Spanish Banking Sector

During the last decade, the different margins of the profit and loss accounts of Spanish banking companies have been appreciably reduced, especially from 1988 onwards, both among deposit institutions as a whole and among commercial and savings banks. Graph 1 shows the evolution of margins in relation to assets, while table 1 offers the percentage variation of these margins, on which the profits obtained depend.

The first feature that calls the attention is the huge reduction in all margins of the profit and loss accounts in the period of time considered (1985-96.) This reduction is to be attributed to the fall in margins from the late 1980s, starting fundamentally with the first

episode of price competition, which occurred in 1989 with the "war of the super-accounts". The reduction of margins was more intense in commercial banks sector, with a notable decrease in the net income 1988 (51.56%). On the other hand, the net income of the savings banks was also reduced, but by much less (16.27%). Since the effort to contain operating costs was of similar intensity in both groups, the better evolution of the savings banks´ net income is due to the behaviour of the gross income, which decreased less. Observe, in this sense, the substantial growth of the item "non-interest income" ; the percentage increase in this item in the savings banks is six times greater than that of the commercial banks, though it is important to take into account that they started from a situation where they obtained hardly any income from commissions. At the same time, the savings banks also achieved a smaller reduction in their net interest income.

With regard to returns on equity, graph 2 shows the evolution of the ROE during the last decade, which confirms in general the behaviour expected. The profile is similar to that of the returns on assets (ROA), and despite the irregularity of both a descent can be identified in the level of rates of return for the 1990s as compared with those of the second half of the 1980s. This descent is very pronounced in the case of the commercial banks - even excluding 1993 - and much less, but present, in the savings banks. Testing of the expected evolution of average costs - reduction in their level and dispersion - shows that this reduction did occur, but the evaluation of the dispersion of companies´ costs due to the changes in the composition of banking output may lead to wrong conclusions if not properly approached.

3. The importance of specialisation

The selection of a measurement for banking output is always a delicate matter, which may influence the valuations made on the basis of indicators such as economies of scale or the indicators of cost efficiency. The origin of the difficulty lies in the multi-product nature of banking companies[2], the implications of which become more serious when there are changes in the composition of the vector of production. Indeed, one of the characteristics of the SBS during these years is the intense change in the composition of its vector of production, with the appearance of new products, alterations in the composition of the demand for banking services, technological changes, development of new markets, etc[3].

These changes did not in most cases make companies more homogeneous in their specialisation, but meant that each one chose different strategies. This alteration of the product mix of banking companies may influence their average cost levels, although such rises or falls should not be interpreted directly as worsening or improvement in productive efficiency, or associated with the effects of more or less competition[4].

In this sense, these changes in specialisation may bias the traditional measurements of cost efficiency, which constitute a means of approaching the evaluation of the range of average costs that the intensity of competition permits at any moment in time. Thus, if it is considered that a more competitive market allows a smaller margin of inefficiency, the increase of competition should be reflected in an increase in the companies´ average efficiency. However, in some cases this forecast is not confirmed, one example being the evolution of cost efficiency of Spanish banking companies with respect to a frontier common to all of them. As we shall see in the course of this study, in spite of the indications of increased competition, this does not seem to have manifested itself in an increase of the average efficiency of the sector during the last decade when it is measured ignoring the influence on costs of changes in specialisation.

If two companies do not offer the same variety of products, and this circumstance is not taken into consideration, the differences in costs between them cannot be directly interpreted either as differences in efficiency levels or as indicators of the intensity of competition. One of the most interesting characteristics of the traditional techniques developed for the construction of cost frontiers is their flexibility for taking into account the multi-product nature of banking firms, but a correct evaluation of efficiency requires a comparison between firms that produce the same composition of output. The results of the studies that have explored the existence of scope economies, perhaps due to the limitations of the information and of the number of observations available, are inconclusive, as they do not identify lines of specialisation that translate into cost advantages[5].

In this sense, it is necessary to divide the total sample of companies into two groups according to their productive specialisation prior to the analysis of efficiency. For this we will use the cluster analysis technique. Intuitively, cluster analysis enables the identification of groups of similar behaviour on the basis of a set of variables, so that the differences within

each group are minimised and the differences among the different groups are maximised[6].

To identify groups of kindred specialisation[7], the reference variables used are: for assets, fixed-income securities (basically government debt), interbank loans and credit to firms and households; and on the liabilities side, savings deposits and interbank deposits[8]. All the variables are expressed as percentages of total assets.

To demarcate the different specialisation groups we have used the whole data pool for the commercial and savings banks for the period 1985-96. The results of the cluster analysis led to the identification of four clusters (table 2) and the following groups of companies[9].

1.- Cluster 1, which we will call *universal banks,* contains a set of banks of large size with a very evenly-balanced structure of the balance-sheet: on the liability side they capture 42% and 23% of their resources respectively as deposits and in the interbank market; on the asset side they place 20%, 25% and 42% of their resources respectively in public debt (government bonds), interbank and credit markets. With the exception of the *Banco Popular Español*, this group contains the big banks (*Banco Bilbao-Vizcaya, Banco Santander, Banco Central Hispanoamericano, Banco Español de Crédito*) and other banks of medium to large size (*Banco Sabadell, Banco Atlantico, Bankinter*). *"La Caixa"* (the biggest savings bank in Spain) also appears in this group, which represents 57.15% of the assets of the sector.

2.- The second group, which we will call the *small banks,* includes firms whose main characteristic is the high proportion of resources placed in the inter-bank market (49%) and their consequently low level of specialisation in the granting of credit (24%). In relative terms, this group is of little importance, as it represents only 3.95% of the total assets of the banking sector.

3.- The third group is that of the *regional banks* and the *savings banks* . This specialisation group is characterised by carrying out the traditional activity of intermediation by the capturing of deposits (68%) and the granting of credit (49%). It is formed by practically all the savings banks as well as banks of regional scope (*Banco de Alicante, Banca Catalana, Banco de Valencia*). Also in this group is the *Banco Popular Español*,

which shows greater similarity with the group of savings banks and medium sized banks, although it is usually classified with the *big banks*. Thy represent 33% of the total assets of the banking sector.

4.- The fourth cluster, which we will call *foreign banks*, is formed by a small number of banks whose main activity is the capture of resources from the interbank market (62%) to grant financing in the form of credit (43%) and place resources in the interbank market (36%). This group contains the *Banco Exterior de España*. They represent 5.86% of the assets of the sector.

Having identified the clusters, the can be used to study whether they explain the appreciable differences in margins, costs, efficiency or profitability. If these differences exist, it will be justified to assume that membership of one group or another influences both the points of reference that each company must take into account when defining its competitive strategy, and the results obtained.

Do there exist differences in margins, costs and profitabilities associated with the different specialisation strategies? With the aim of offering a first answer to this question, table 3 describes the cost structure and the different margins (as a percentage of assets) of the specialisation groups obtained from the earlier cluster analysis. It also offers the values of ROA and ROE. From this table the following conclusions can be drawn:

1.- The *universal banks* work with high net interest income (3.26) and also with high operating costs (2.52). The importance of extraordinary results is very high in this cluster, because the differences in net income with respect to the savings banks decrease in the accounting profit. At all events, their profit is among the highest, as compared both with assets (0.91) and with own resources (17.21).

2.- The group of *small banks,* specialising in the placing of funds in the interbank market, is formed by companies with a small number of offices which are in general of large size, which allows them to enjoy low operating costs (2.24) and consequently to operate with low net interst income (2.92).

3.- The third specialisation group shows the characteristics typical of the savings

banks: high operating costs (2.85) as a consequence of the high density of their network, with many office of small size, low financial costs (5.53) due to their high specialisation in the capture of deposits, and high return on both assets (1.02) and on equity (18.31).

4.- The high degree of resort to inter-bank finance of the *foreign banks* group is translated into a higher proportion of financial costs (7.14). The sparse network of large branches (14 workers per branch) leads to low operating costs (1.50%) which allow them to work with narrower net interest income (1.53%). The result is a reduced profitability both in ROA (0.39) and in ROE (9.27).

4. The measurement of efficiency in companies with different specialisations.

The indicators of efficiency traditionally calculated are based on the use of production, cost or profit functions. The frontier can be defined in each case for a set of observations, any observation above the frontier (in the case of production and profit functions) or below it (in the case of cost functions) being impossible. The measurements of efficiency are obtained from the comparison of the observed values of each company with the optimum as defined by the frontier estimated.

The models that exist differ in their manner of specifying and estimating the frontier[10]. Thus the frontier can be specified as a parametric relationship or as a non-parametric one. Secondly, a statistical relationship can be specified between observed output and that of the frontier, or mathematical programming methods may be used to construct a frontier compatible with the data and the underlying economic theory. Finally, the frontier may be deterministic (if the existence of observations above the frontier is not allowed) or stochastic (allowing some observations to be situated above the frontier due to random causes). On the basis of this scheme it is possible to classify methods of measurement of efficiency into three groups: a) parametric versus non-parametric; b) econometric versus mathematical; and c) deterministic versus stochastic.

The indicators of efficiency compare the costs of each company with the minimum costs determined by a frontier constructed on the basis of efficient companies, on the

assumption that the technology of all the companies analysed is the same. The measurement of cost efficiency is obtained from the ratio between the costs of the company being analysed and the costs of another, efficient, company. If there is no other company that with the same factor prices produces the same with less cost, the ratio will be equal to unity and the company will be efficient. But if on the contrary another company or other companies facing the same prices is able to produce the same with lower costs, the company will be inefficient.

Graph 3 represents how the indicator of cost efficiency is obtained for company A by comparing it with D (economically efficient). Cost efficiency (C_E) will be measured as the ratio between the costs of company A $\left(C_A\right)$ and the minimum costs attainable $\left(\hat{C}_M\right)$ given the prices of inputs. Thus, $C_E = \left(C_A / \hat{C}_M\right)$.

When the efficiency and productivity of companies are analysed, authors usually isolate the effects of technology by comparing companies over the same period of time. In this way they avoid attributing to in/efficiency what is actually technological regress or progress. This concern to avoid the influence of technology in the evaluation of efficiency has not been considered when the efficiency of different companies is measured over the same period of time. However, if the companies of a sector produce different varieties or combinations of goods, this diversity may be equivalent to the use of different technologies[11].

The consequences of ignoring the influence of this technological component are potentially very important. To illustrate them, consider Graph 4, where company A is observed to share the same business as companies B, F and G but not the same as companies C and D. By differentiating two distinct isoquants, which we can assume are each associated with a given level of aggregate output, it is indicated that the product of companies B, F and G requires more inputs than that of companies C and D. If this difference in technology derived from specialisation is ignored, the measurement of efficiency will penalise company A, by counting as inefficiency something that is only a difference in specialisation. Specifically, the measurement of inefficiency should be $\left(C_A / \hat{C}_A\right)$ instead of $\left(C_A / \hat{C}_M\right)$.

If we ignore the existence of different specialisations and therefore of different technologies, we would be committing a bias that would penalise the most input-intensive

specialisations. In the situation illustrated by the graph, the bias is $\left(\hat{C}_M / \hat{C}_A\right)$. In fact, in the studies that have tested the existence of different technologies the results are affirmative[12]. To avoid this bias, in this study we analyse cost efficiency by means of a two-stage method[13]. In the first stage the sample of banking companies was divided into the four groups of similar specialisation described above, using the clustering technique. In the second stage the internal efficiency of each group is analysed and compared with that obtained if this technological heterogeneity (different specialisation) is not considered.

A large number of clusters may pose problems for the analysis of efficiency. The greater the number of groups the smaller will be the variance within each group, but also the number of observations available for the estimation of the corresponding frontiers. This poses the problem of considering, when selecting a number of groups, how many observations are necessary for the estimation of the frontier. Of all the techniques for measuring efficiency, the one that requires the smallest number of observations is the non-parametric and determinist data envelopment analysis (DEA), as parametric techniques specify a large number of parameters, making it necessary to have available a large number of observations.

As well as not requiring any assumption to be made about the distribution of inefficiency, the DEA technique does not require any functional form to be specified for the frontier. The fundamental disadvantage is that the estimators do not have statistical properties (it is not possible to test hypothesis)[14] and that it may be sensitive to atypical observations.

The measurement of cost efficiency in a DEA model is done by calculating the following problem of linear programming for each of the N companies of the sample.

$$
\begin{aligned}
&Min_{\rho,\lambda} \ \textstyle\sum_k w_j \rho_{kj} \\
&s.a. \\
&\textstyle\sum_i \lambda_j y_i \geq y_j \\
&\textstyle\sum_i \lambda_i x_i \leq \rho_j \\
&\lambda_i \geq 0, \qquad \forall\, i;\ i=1,\ldots,N
\end{aligned}
\qquad [1]
$$

w_j being the vector of input prices faced by company j, x_i the vector of inputs, y_j the vector of outputs and λ_j the vector of weightings. The solution of the problem for a given company j constitutes the economically efficient vector of inputs (minimising costs), the cost efficiency of company j (CE_j) being obtained as a coefficient between the minimum costs ($\sum_k w_j \rho^*_{kj}$) and observed costs ($\sum_k w_j x_{kj}$).

$$ECj=(\sum_k w_j \rho^*_{kj})/(\sum_k w_j x_{kj}) \qquad [2]$$

These problems are solved for the whole sample of N companies and for each of the H groups ($N=\sum_h CL_h,\ h=1,...,H$).

5. Estimation of efficiency: variables used and results

The first problem faced by studies that analyse banking production is the identification and measurement of banking output, as there is no consensus regarding the treatment of the variable that defines banking output. As manifested by Humphrey (1992) there is no a priori reason for centring on a single type of bank output such as loans or other asset item, taking into account that there are many other activities and that the production of deposits absorbs a large part of the capital and labour used in production. In this study we use the approach of Berger and Humphrey (1992), considering deposits as inputs and outputs simultaneously. This approach to the problem of identification and measurement of banking output can be classified, in general terms, within the so-called *intermediation approach.*

The outputs used are: 1) Y_1 = loanable funds (credit institutions + debts to customers + debits represented by negotiable securities + other liabilities) and Y_2 = loaned funds (credit institutions + credits to customers + fixed income). The three assets and four liabilities considered are quantitatively the most important on the balance sheets of both commercial and savings banks.

With regard to costs, labour and physical capital represent inputs necessary for the production of bank output. The treatment of deposits as input is more debatable. However, if

only capital and labour were considered as inputs, the efficiency estimated, as well as the measurement of productivity, economies of scale and technical progress, would only refer to operating costs. However, financial costs represent approximately two thirds of total production costs. Therefore, the appropriate concept of costs when measuring efficiency in banking companies is that of total costs, which includes both operating and financial costs.

The third type of variable that appears in the cost function of banking companies is the prices of productive factors. Taking into account the approach adopted, in which deposits are treated simultaneously as output and as input, three prices will be used:

1.- The price of the labour factor (w_1), which has been calculated by dividing the personnel costs by the number of workers.

2.- The price of loanable funds (w_2). The profit and loss account of savings banks or commercial banks do not offer desegregated information on financial costs by type of liability from 1992 onwards. This, together with the need to introduce into the estimation the price of financial input, makes it necessary to combine under the generic name of *loanable funds* all liability items that imply financial costs, calculating their price (w_2) as a ratio of financial costs to Y_1.

3.- Finally, the price of physical capital (w_3) which has been defined as the ratio of expenditures on plant and equipment to the book value of physical capital .

With this approach to the identification and measurement of banking output and costs, we consider consecutively the levels of cost efficiency and their evolution in relation to the two types of frontiers estimated: the common one and that of each cluster.

Graph 5 and table 4 show the differences in efficiency of the four groups of banking companies when estimating a frontier for each of them or calculating only a common frontier. As was to be expected, the recognition of the differences among groups (separate frontiers) raises the efficiency of most companies, because the common frontier is, in fact, a *frontier of frontiers*.

Graph 6 enables this to be seen more clearly, each pair of curves corresponding a cluster. The first group (*universal banks*) experiences substantial gains in efficiency in relation to its specific frontier, of nearly 15%. Thus, in 1996, if the technology and specialisation of this group of companies is not considered, the result would be that the companies of this group, on average, could reduce their costs by about 25% (75% efficiency). On the other hand, these inefficiencies are reduced to little more than 10% when their different specialisation is considered.

Especially worthy of mention is the change in the efficiency levels of this group from 1989 onwards. In this year there appears to have been a change of system, from a less competitive one to a much more competitive one. The competition in interest rates that started then obliged companies to reduce margins, which was reflected in a very significant increase in efficiency levels.

Something similar occurs with the third group (*regional banks and savings banks*), which together with the first cluster represent the greater part of the assets of the sector. In this case, the potential saving in costs would be about 35% in the case of the common frontier and only 10% if the different specialisation is considered.

In the other two groupings the improvements in efficiency deriving from the separation of the frontiers are much smaller: in the fourth group (*foreign banks*) they are 3% and in the second (*small banks*) the improvements are imperceptible. This means that the the frontier of this cluster of small banks coincides with the common frontier, i.e. the banks of this group are those that define the common frontier. Also, it can be seen that this group is where the greatest heterogeneity in efficiency levels persists with respect to the frontier of cluster 2.

These results allow us to discern that some small banks, with little orientation toward the most costly specialisations of banking - specifically, credit or deposits - have lower average costs. If these banks are considered to be the relevant cost frontier for all companies, a biased view is obtained of the efficiency/inefficiency of other companies and of the system as a whole. Indeed, graph 7 shows the average efficiency of the SBS resulting from the comparison of each company with a single common frontier or with the frontier

corresponding to its group. As was to be expected in view of the movements experienced in Graph 6 by the average levels of efficiency of groups 1 and 3, which contain the great majority of the sector, the SBS as an aggregate is almost 20% more efficient when separate frontiers are considered. Thus, for the whole banking system, cost efficiency without taking into account the differences in technology due to specialisation would be a little over 70%, whereas considering the existence of different product ranges it is around 90%.

The lower part of graph 7 represents the ratio of average efficiency levels of the SBS considering separate frontiers and the common frontier. It has an increasing profile since 1988[15], indicating that the efficiency obtained by taking into account differences in specialisation improved more than that which does not consider this differential feature.

To evaluate the evolution of efficiency during this period it is important to indicate that with separate frontiers the average efficiency level of the SBS shows an increasing trend, and in recent years has been situated at about 90%. These two features - increasing trend and low cost inefficiency (dispersion) - are also characteristics of the two big clusters, which could be interpreted as indicative of the effects of stiffer competition. Thus, in group 1, while the intensity of competition in the second half of the 1980s allowed differences in total (operating plus financial) costs of between 20 and 30%, in recent years these differences were of 10%. In the case of the savings banks the initial differences were smaller, but the present situation does not show differences of above 10%, the current average level of efficiency being slightly higher in the savings banks than in the commercial banks[16].

The other two groups are more heterogeneous in their composition and evolution, not showing any definite trend to the reduction of inefficiency. Rather the opposite, dispersion in some cases seems to have increased, possibly as a consequence of the variety of experiences of many small companies.

Once the efficiency levels have been estimated, it is of interest to analyse the set of factors that influence the cost efficiency of Spanish banking companies. As indicated by Lovell (1993), the identification of the factors that explain differences in efficiency is essential for improving the companies' results.

Unfortunately, economic theory does not supply a complete theoretical model of the determinants of efficiency, due to the complexity of the factors that can influence it. We shall therefore have to limit ourselves to identifying variables that influence the results by estimating the models in reduced form, establishing correlations between efficiency and its determinants.

Berger and Mester (1997) propose a set of variables that can be related to efficiency: size, degree of capitalisation, the qualification of the productive factors, and the *quality* of banking output. However, although they posit the need to consider the importance of this last variable, which is related to the problem that we are studying, they do not use variables of productive specialisation.

One way to analyse the importance of productive specialisation in the explanation of the differences of efficiency among banking companies is to introduce dummy variables into the estimation, to reflect the companies' membership of one of the four clusters of specialisation identified above It is to be expected that, if the estimation of a common frontier for all companies implies bias deriving from difference of specialisation, membership of one or other of the clusters will be seen to explain the differences in efficiency.

The variables explaining efficiency considered in the estimation correspond to the scheme by Berger and Mester (1997) and are as follows:

a) the *size,* approximated by the total assets of each company (ASSETS).

b) the *qualification of the factors*, because companies that use higher quality inputs can achieve higher levels of efficiency in the use of resources, which will be reflected in lower average costs.

The qualification of the labour factor is reflected by the variable QUAL, defined as the percentage of managers and graduates among the total number of employees. For the qualification of capital, two variables have been considered. The variable FA/K is defined as

the percentage of capital in fixed assets. The variable ASSETS/K, defined as total assets over capital, measures the degree of financial leverage. The expected sign of the variable FA/K is negative, provided that the capital not invested in fixed assets (1-FA/K) is devoted to loanable funds: otherwise it will be positive. ASSETS/K for its part measures the degree of financial leverage (or percentage of outside resources over own resources). Its sign is expected to be positive, since a greater percentage of outside resources (loanable funds) than own resources decreases the financial costs.

c) the *productive specialisation,* For this, dummy variables are introduced into the estimation to identify the four specialisation groups: CL1 (*universal banks*) CL2 (*small banks*) CL3 (*regional banks and savings banks*) and CL4 (*foreign banks*).

d) *environmental* circumstances, because it may also be relevant that companies are subject to different regulatory frameworks and/or economic environments, including the phase of the economic cycle in which the economy finds itself. For all these reasons, time effects (TE) are introduced into the estimation to capture the influence of these factors which, being common to all companies, may vary over time.

Since efficiency (*E*) is a variable which, by definition, varies between zero and one, the estimation of the determinants of efficiency must be made on the basis of a Tobit type limited dependent variable model, as estimation by OLS may generate biased and inconsistent estimates of the parameters. The equation estimated is as follows:

$$E_i = a_1 \cdot ASSETS + a_2 \cdot QUAL + a_3 \cdot (FAK) + a_4 \cdot (ASSETSK) + \sum_{i=1}^{4} c_i \cdot CL_i + \sum_{i=85}^{96} d_i \cdot TE_i \qquad [3]$$

The results of the estimation of the determinants of cost efficiency (table 5) are as follows:

a) There is a positive correlation between the size of banking companies and their level of cost efficiency. This result coincides with those of several studies (Berger et al. 1993, Berger and Mester 1997, among others), indicating that greater size is no impediment for proper control of production costs.

b) the results referring to the qualifications of the productive factors reflect the fact that higher personnel qualifications (QUAL) have a significant positive influence on efficiency. Likewise, with regard to the qualification of capital, the variables considered imply that a higher percentage of fixed resources has a significant negative influence on efficiency (FA/K) whereas greater financial leverage (ASSETS/K) has a significant positive influence on efficiency.

c) the importance of productive specialisation in explaining differences in cost efficiency among banking companies is made manifest by the magnitude and significance of the dummy variables of specialisation introduced[17]. The results show important differences among groups of companies belonging to different clusters, the order of the clusters (CL) being identical to to that obtained earlier when estimating separate frontiers for each specialisation group. Thus, the *foreign banks* (CL4=0.7778) are the group with the highest efficiency level (lowest average costs) in relation to the common frontier, followed by the *small banks* (CL2=0.7215), the *universal banks* (CL1=0.6411), and finally the *savings banks* (CL3=0.6022).

d) Finally, the evolution and magnitude of the time effects agrees with the average behaviour of efficiency appearing in graph 7, a higher average efficiency being apparent in the 1990s than in the mid-1980s

6. Conclusions

The transformations experienced by the Spanish banking sector and financial markets have caused an intensification of competition, accompanied by a notable diversity in the productive specialisation of companies. The combination of both these circumstances may prevent observation of a trend to the reduction of dispersion among average costs, or high levels of efficiency whereas indicators like total factor productivity[18] and the different margins of the profit and loss account reflect higher productivity and lower profitability.

In this study we have shown that if measurements of cost efficiency are corrected for the effect of different specialisation, by estimating separate frontiers for four different groups

of homogeneous competitors, appreciable improvement in companies' relative efficiency can be seen. Furthermore, in the clusters that contain the companies of greatest weight in the sector, definite trends towards the reduction of cost dispersion can be observed. Thus the behaviour of costs would be compatible with that of the other indicators of competition mentioned, all of them reflecting the effects of a more competitive situation in the SBS at present than at the start of the period considered.

This analysis of the determinants of efficiency likewise demonstrates the importance of size, qualification of productive factors, and productive specialisation in explaining the differences in efficiency among banking companies. Finally, the significance of time effects is indicative of the importance for the costs of banking companies of the transition in forms of competition from the 1980s to the 1990s for the improvement of efficiency.

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[1] In the survey on efficiency in financial institutions by Berger and Humphrey (1997), there is no reference to the importance of specialisation in the measurement of efficiency. So far only the role of risk has been dealt with, as a proxy of asset quality, in the measurement of efficiency by Mester (1996).

[2] See Humphrey (1992).

[3] See Gual and Hernández (1991), Sáez, Sanchéz and Sastre (1994), Freixas (1996), Pastor and Pérez (2000), Pérez and Tortosa (1997) and Fernández (2000).

[4] See Kolari and Zardkoohi (1987).

[5] On this point, see Berger, Hunter and Timme (1993).

[6] There exist many methods and algorithms for obtaining clusters, as well as different measurements of the difference or similarity between individuals, though the Euclidian is the most used. Each of them is based on different criteria and therefore gives rise to different classifications (see Sanchez and Sastre (1995)). In this study we use the *k-means* optimisation algorithm.

[7] The methodological change in the presentation of balance sheets and profit and loss accounts that took place in 1991 makes it necessary to homogenise the information from before and after that year, which prevents a more desegregated analysis of specialisation.

[8] In this same line, see Kolari and Zardkoohi (1987), Sanchez and Sastre (1995), Freixas (1996), and Perez and Tortosa (1998).

[9] Initially up to 7 different clusters were considered, though we finally opted to work with four clusters due to the characteristics of the groups of companies obtained, and the need for a certain number of observations in order to estimate cost frontiers for each group. The analysis made by Sanchez and Sastre (1995) for the year 1992 also reaches the conclusion that the number of clusters that best verifies the usual criteria is four (national commercial banks, savings banks, foreign banks and non-commercial banks).

[10] See, among others, Lovell (1993) and Greene (1993).

[11] Some studies (Pastor, 1995 and Maudos, 1996 and 2000) have separated companies on the basis of their institutional nature. Thus for the Spanish case it is usual to find studies in which savings and commercial banks are evaluated separately, on the assumption (untested) that each group of companies shares the same type of business and the same specialisation.

[12] Pastor, Perez and Quesada (1997) find significant differences of technologies in the banking systems of the European Union and the USA.

[13] As pointed out by Berger and Mester (1997), one important decision when measuring and evaluating efficiency is the concept of efficiency to be used. However, cost efficiency is based on a process of optimisation which varies with market prices and the degree of competition, making it the most suitable for the objective of this study. Technical efficiency, on the other hand, is based only on the proper use of technology, without considering the role of competition and the evolution of market prices.

[14] Recently, on the basis of some properties of the technique, tests have been developed to evaluate the significance of the results and to value the significance of the variables introduced (Banker, 1996), Recently, on the basis of some properties of the technique, tests have been developed to evaluate the significance of the results and to value the significance of the variables introduced (Banker, 1996),

[15] The trough in 1993 is due to the *Banesto effect*.

[16] This result agrees with Maudos (1998).

[17] The null hypothesis of equality of the dummies of membership of different clusters is amply rejected ($X^2(1)$=430.36).

[18] On the evolution of total factor productivity, see Perez, Maudos and Pastor (1999).