Profit efficiency for Spanish savings banks

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Abstract

Frontier profit efficiency is examined for Spanish savings banks over 1986–1991, a period in which the Spanish banking industry has seen considerable deregulation. In Spain, the standard assumption that firms operate in a perfectly competitive output market is unlikely to be met. Thus we use an alternative profit function specification which allows for market power in the output market. Profit efficiency is determined using the thick frontier approach, and estimated using both alternative and standard profit function specifications to illustrate the effect of different assumptions regarding the competitiveness of the output market. Estimation of the alternative profit function suggests that the profit inefficiency of Spanish savings banks, which averaged 28%, fell by forty percent between 1986 to 1991. The standard profit function, which we believe yields less reliable results, generated greater average inefficiency. There was no significant shift — up or down — in the profit frontier itself. © 1997 Elsevier Science B.V.

Keywords: Banking; Profit; Inefficiency

1. Introduction

As in many others countries, the Spanish banking industry has seen considerable deregulation. After a series of small steps toward this goal starting in 1969, deregulation efforts were extended substantially during the mid-1980s. The primary reason behind deregulation was the fear that Spanish institutions would be at a competitive disadvantage following the removal of barriers to inter-country competition in financial services within the EEC. As interest rate and geographical restrictions were removed, Spanish savings banks focused on expanding the size and convenience of their branch operations and undertook a series of mergers which reduced their number by nearly 30%. Overall, savings banks concentrated on providing services to retail customers holding low average balances and to whom convenience and proximity of branch offices are important.

Our purpose in this paper is to determine how deregulation has affected the profit efficiency of Spanish savings banks over 1986–1991. The effect of deregulation on the cost efficiency of these institutions has been investigated earlier, finding that cost inefficiency — deviation from a cost frontier — was not reduced and that the cost frontier shifted up over time — indicating higher unit costs (Grifell, Prior, and Salas, 1992; Grifell and Lovell, 1996; Lozano, 1997). Recently, Grifell and Lovell (1997) found evidence of positive productivity growth for Spanish savings banks — although they note that these contradictory results are due to the use of...
bank output in terms of the value of accounts instead of number of accounts as they used previously (Grifell and Lovell, 1996). Overall, in spite of the latter result, the deregulation of Spanish savings banks apparently worsened, rather than improved, the cost position of these institutions.

Cost efficiency, however, is only one part of a two-part response to deregulation. A more complete picture of the effects of deregulation is obtained from a profit function which reflects the joint impact of revenue as well as cost effects of deregulation. Furthermore, cost efficiency measures derived from a profit function can differ from those obtained from a cost function if the output quantities (taken as given in the cost function) are observationally inconsistent with profit maximization, so that revenue inefficiency exists. Summed up, a cost function deals only with inefficiencies in input use while a profit function deals with both input and output inefficiencies. In addition, input inefficiency measured in a profit function may differ from that derived from a cost function.

Profit efficiency — the deviation from the profit frontier — is determined using the thick frontier approach. We also determine how the profit frontier has shifted over time. While the thick frontier approach can account for error in the data and reduce the influence of outliers, its implementation requires ad hoc assumptions just as do all the other frontier methodologies. The main benefit of the thick frontier is that it can provide a firmer basis for determining the realizable efficiency of an industry. Instead of basing an efficiency estimate on one or a very small subset of firms, as the other “thin” frontier measures do, the thick frontier selects a relatively large subset of firms to define the frontier. Measured inefficiency is smaller because it is more realistic to expect firms to be able to achieve the efficiency level already obtained by (say) the most profitable 25% of firms than it is to expect all firms off of the frontier to be as efficient as the single most profitable firm. Even though all the existing methods for evaluating the efficiency of financial institutions differ primarily in how much shape is imposed on the frontier and the distributional assumptions imposed on the random error and inefficiency, the assumed data generating process for all the parametric approaches to measuring efficiency is that error exists in the data and that it can be adequately accounted for through the specification of an additive zero mean, constant variance, and symmetric error term.

Although the methodologies underlying the various thin and thick frontier approaches are seemingly quite different, they tend to yield “generally” similar average efficiency estimates for the banking industry (Berger and Humphrey, 1997). Even so, it is important to illustrate the robustness of our results from the thick frontier model. To do this we also determined the profit efficiency of savings banks using the distribution-free approach to frontier measurement, and these results were very close to those obtained from the thick frontier approach.

The standard profit function model assumes perfectly competitive markets for outputs and inputs (e.g., Berger, Hancock, and Humphrey, 1993). Recent studies of the Spanish banking industry, however, indicate that financial institutions operate in imperfectly competitive markets (Molyneux, Lloyd-Williams, and Thornton, 1994a, b; Vander Vennet, 1994). Thus we use an alternative profit function specification reflecting market power in the output market while retaining the assumption of perfect competition in the market for inputs (similar to Humphrey and Pulley, 1997). For purposes of comparison, profit efficiency is estimated using both the alternative and standard profit function specifications.

Results using the alternative profit function suggest that profit inefficiency averaged 28% at Spanish savings banks over 1986–1991 but fell from 32% in 1986 down to 19% in 1991 — a forty percent reduction. The standard profit function, which we believe yields less reliable results, generated greater average inefficiency (43%) and showed a smaller decrease over the period (6%).

There are a few frontier studies which also have considered Spanish banking sector. Beside the fact that none of them determine profit inefficiencies, but somehow inefficiencies in inputs, the mean differences between them and our study are as follows: Grifell, Prior, and Salas (1992), Pastor (1994), and Grifell and Lovell (1996, 1997) use a non-parametric approach, define different variable inputs and outputs, as well as analyse different time periods — except in Grifell and Lovell (1996) where also the time period 1986–1991 was analysed. Pastor, Pérez, and Quesada (1997) present the same differences as above, as well as analyse commercial banks instead of savings banks. Finally, Lozano (1997) takes some differences in bank output definitions.
In what follows, our alternative profit function is discussed in Section 2, and the data and variables used are discussed in Section 3. The thick frontier estimating model, and its associated efficiency measures, are presented in Section 4. The profit efficiency results are described in Section 5, along with an analysis of the stability of high and low profit savings banks. Section 6 concludes.

2. The profit frontier

2.1. Frontier analysis

Studies of financial institutions have typically focused on scale and scope economies using a cost function framework under the assumption that all firms are on their efficient frontier. Based on a number of recent studies, there is a virtual consensus in the literature that the majority of financial institutions are not on, or even very close to, their efficient frontier and that cost inefficiency — deviations from the efficient frontier — dominates scale and scope economies. This result appears to hold regardless of the approach chosen to determine the efficient frontier — data envelopment analysis (DEA), the stochastic frontier approach (SFA), the thick frontier approach (TFA), or the distribution-free approach (DFA) (see Berger, Hunter, and Timme (1993) for a discussion of this literature). While the different maintained assumptions of the various frontier approaches are able to lead to different estimated average efficiency levels and rankings for financial institutions — contrast the non-parametric DEA results of Rangan, Grabowski, and Pasurka (1988) for U.S. banks with the parametric results of Berger (1993) and Bauer, Berger, and Humphrey (1993); contrast also the DEA results of Grifell, Prior, and Salas (1992), Pastor (1994), Pastor, Pérez and Quesada (1997), and Grifell and Lovell (1996, 1997) for Spanish banks with the parametric results of Lozano (1997) — the end result is that cost efficiency appears to be markedly larger than the combined effects of scale and scope.

Cost frontier analysis determines cost or input efficiency while a revenue frontier determines revenue or output efficiency. A profit frontier determines both. Importantly, the efficiencies measured using cost and revenue frontiers may not correspond to the cost and revenue effects obtained from a profit function if the output (input) quantities that are taken as given in the cost (revenue) function differ from the quantities consistent with profit maximization. Put differently, the input (output) inefficiencies measured using the cost (revenue) function assume that the output (input) inefficiencies are zero. If either assumption is not met, then the input and output inefficiencies obtained from a profit function will be more accurate than those obtained from either a cost or a revenue function alone.

2.2. Standard and alternative profit functions

The standard profit function assumes perfectly competitive output and input markets. Given the price vector for outputs \((p)\) and inputs \((w)\), profits \(\pi\) are maximized by adjusting vectors of output \((y)\) and input \((x)\) quantities so firms solve:

\[
\text{Max } \pi = p'y - w'x \quad \text{s.t. } g(y, x) = 0
\]

where \(g(y, x)\) is a production transformation function of input quantities into output quantities. The Lagrangian solution to this maximization problem gives the standard indirect profit function:

\[
\pi = p'y(p, w) - w'x(p, w) = \pi(p, w)
\]

In this paper, an alternative profit function is specified which we feel is more realistic regarding the operation of the output market for financial institution services in Spain. Instead of assuming perfect competition and taking output prices as given, we assume imperfect competition, take output quantities as given, and permit firms a degree of market power to set their own prices. In Spain, an oligopolistic market structure reflects reality
better than perfect competition and prices for demand deposits, savings deposits, and loans for both businesses and individual customers are more likely endogenously rather than exogenously determined. This presumption is supported by Molyneux, Lloyd-Williams, and Thornton (1994a;b) who analyzed the relative competitive structure of EEC banking markets, finding that Spanish financial institutions operate in a monopolistic market and earn above normal profits due to market power. As well, Vander Vennet (1994) found that collusion appears to be predominant in the Spanish banking industry when the relationship between market structure and performance is analyzed in EEC banking markets, where efficiency measures are directly incorporated into the model (the results obtained by Vander Vennet (1994) about the structure of Spanish banking market contrast to the results of Goldberg and Rai (1996); they attributed these opposite finding to the different methods employed for estimating inefficiencies in the two studies). Coming to the same conclusion, Vives (1990) shows that barriers to entry into the Spanish banking industry are important and lead to imperfect competition.

Our alternative profit function follows Humphrey and Pulley (1997) and assumes that savings banks take output quantities \( y \) and input prices \( w \) as given and maximize profits \( \pi \) by adjusting output prices \( p \) and input quantities \( x \). The appropriate indirect profit function is derived as the solution to the problem:

\[
\text{Max } \pi = p'y - w'x \quad \text{s.t. } h(y, x, p) = 0
\]

where \( h(y, x, p) \) represents a bank's pricing opportunity set, incorporating pricing heuristics, market position, and demand conditions in transforming output quantities and input prices into output prices. The function \( h(\cdot) \) is similar to the production transformation \( g(\cdot) \) above and reflects pricing rules (such as differentially marking up the cost of funds), an assessment of competitive position, as well as a determination of the willingness of customers to pay the prices charged. The associated indirect profit function is derived by solving the Lagrangian for the optimal choice of output prices \( p = (y, w) \) and input quantities \( x = x(y, w) \) and is given by:

\[
\pi = p(y, w)'y - w'x(y, w) = \pi(y, w)
\]

This function need not be homogeneous of degree one. A doubling of output quantities and input prices can more than double profits since output prices may also be a function of the scale of output, as when customers obtain greater branch and ATM convenience at larger institutions that, as a result, can impose higher direct or indirect fees for their deposit services (and thereby more than proportionally raise profits). For purposes of comparison and completeness, we estimate and present efficiency results based on both the standard and the alternative profit functions, even though the alternative function is our preferred form as it assumes savings banks can set prices rather than take them as given in a competitive output market.

3. Data and variables

The data used in this study consists of a panel of 54 Spanish savings banks observed during the period 1986–1991. Information on these banks comes from the annual publication “Anuario de la Confederación de Cajas de Ahorros”. Due to mergers and acquisitions that took place over this period, the usable number of these banks decreased from 77 to 56. We constructed a balanced panel data set by aggregating the pre-merger data of the banks that merged into 15 new institutions (although two banks are excluded from the study because of questionable data). As a result, our sample consists of 54 savings banks, each observed annually from 1986 through 1991.

In the banking literature there has been considerable disagreement regarding the “proper” definition of inputs and outputs. We have adopted the value-added approach (Berger and Humphrey, 1992) to identify banking outputs and inputs. In the value-added approach, deposits as well as assets are considered to have some output characteristics. That is, deposits provide for transaction and safekeeping output services and also add to input costs. In a value added context, deposits typically account for over half of all capital and labor expenses at banks and so, in this sense, output services are clearly being produced. Accordingly, we specified three variable
outputs: loans (composed of the value of home loans and other loans), interbank loans, and produced deposits (the sum of demand, saving, and time deposits). Prices for three variable inputs were also specified: labor, materials, and deposits (capturing the interest cost of deposits). A fixed input — physical capital — is also specified. Noulas et al (1990) took deposits as fixed based on Flannery’s (1982) argument that banks essentially take core deposits as given and being determined by factors outside their control. Humphrey (1993) took physical capital as fixed while Hunter and Timme (1992) and Berger et al. (1993) took both as fixed. We have treated physical capital as fixed because we are estimating a short-run profit function. Physical capital usually accounts for around 6% of total bank expenses in Spain (around 10% of total bank expenses based on U.S. bank accounting data surveys) and so treating physical capital as fixed or variable typically has little effect on the overall results.

The estimated profit function also includes some additional variables: the number of branches, a dummy variable for bank mergers (which equals 1.0 in the merger year and all following years), and a variable defined as other assets (composed of securities and investments) which contributes importantly to bank revenues but adds little to costs. The dependent variable is defined as profit before taxes, loan loss reserves, and extraordinary items.

4. A thick frontier profit function model

A translog profit function is specified and estimated for a panel of 54 savings banks over 1986–1991. To improve the efficiency, the profit function is estimated jointly with cost and revenue profit share equations, with one share equation excluded. When the sample size is small, estimation efficiency may be improved further using a procedure devised by Bardhan, Cooper, Dozmetsky, and Kumbhakar (1994). First, the set of “best-practice” savings banks are identified — these are represented by the quartile of firms (stratified by size-class) that experienced the highest profitability (defined as the adjusted return on assets, or the ratio of profits, before taxes, loan loss reserves, and extraordinary items, to total asset value), on average, over the entire 6-year period. Second, using the entire data set, a dummy variable is specified to separate the best-practice firms — and their estimated own, second-order, and cross-product parameters in the profit function — from all other parameters estimated in the profit function. The dummy variable permits the thick frontier to be estimated using all 54 savings bank observations, rather than just a quartile subset of 13 observations, which has been the approach used previously (e.g., Berger and Humphrey, 1991). This selection and estimation procedure is repeated using the quartile of savings banks that experienced the “worst-practice” profitability over the entire period. Moreover, our efficiency results were all reestimated using only the subset of observations on the best-practice and worst-practice profit quartiles separately, rather than the dummy variable technique described in the text. Our results (not shown) were virtually identical to those obtained using the dummy variable procedure but the efficiency of estimators made worse. The profit function and all but one share equation were estimated jointly using ITSUR, with symmetry and cross-equation equality restrictions imposed — we reestimated the model with the constant term in the share equations allowed to vary freely to allow for some restricted forms of allocative inefficiency, similar to Ferrier and Lovell (1990), and Berger (1993), and the results were very similar. These equations were:

\[
\ln \pi = \alpha_0 + \sum_{i=1}^{3} \alpha_i \ln Y_i + \sum_{j=1}^{3} \beta_j \ln W_j + \alpha_k \ln X_k + \frac{1}{2} \sum_{i=1}^{3} \sum_{k=1}^{3} \gamma_{ik} \ln Y_i \ln Y_k \\
+ \frac{1}{2} \sum_{j=1}^{3} \sum_{l=1}^{3} \delta_{jl} \ln W_j \ln W_l + \frac{1}{2} \gamma_{kk} \ln X_k \ln X_k + \sum_{i=1}^{3} \sum_{j=1}^{3} \eta_{ij} \ln Y_i \ln W_j
\]
\[\begin{align*}
&+ \sum_{i=1}^{3} \eta_{ik} \ln Y_i \ln X_k + \sum_{j=1}^{3} \eta_{jk} \ln W_j \ln X_k + \nu_1 \ln OA + \xi_0 \ln B + \frac{1}{2} \xi_0^2 \ln B \ln B \\
&+ \theta_1 F + \mu_1 T + \frac{1}{2} \nu_1 TT + \sum_{i=1}^{3} \pi_{it} T \ln Y_i + \sum_{j=1}^{3} \sigma_{ij} T \ln W_j + \delta_{it} T \ln X_k + \phi_{it} T \ln OA \\
&+ \rho_{it} T \ln B + \xi_{it} T^2 F \\
&+ \alpha_i D + \sum_{i=1}^{3} \alpha_i Y_i + \sum_{j=1}^{3} \beta_j D \ln W_j + \alpha_i D \ln X_k + \frac{1}{2} \sum_{i=1}^{3} \sum_{k=1}^{3} \gamma_{ik} D \ln Y_i \ln Y_k \\
&+ \frac{1}{2} \sum_{j=1}^{3} \sum_{i=1}^{3} \delta_{ij} D \ln W_j \ln W_i + \frac{1}{2} \gamma^T DX_i X_k + \sum_{i=1}^{3} \sum_{j=1}^{3} \eta_{ij} D \ln Y_i \ln W_j + \sum_{i=1}^{3} \sum_{k=1}^{3} \eta_{ik} D \ln Y_i \ln X_k \\
&+ \sum_{j=1}^{3} \eta_{jk} \ln W_j \ln X_k + \nu_1 D \ln OA + \xi_0 D \ln B + \frac{1}{2} \xi_0^2 D \ln B \ln B + \theta_1 D F + \mu_1 D T \\
&+ \frac{1}{2} \nu_1 D T^2 + \sum_{i=1}^{3} \pi_{it} D \ln Y_i + \sum_{j=1}^{3} \sigma_{ij} D \ln W_j + \delta_{it} D \ln X_k + \phi_{it} D \ln OA \\
&+ \rho_{it} D \ln B + \xi_{it} D T^2 + u^1 \\
&= (S_i = \alpha_i + \sum_{k=1}^{3} \gamma_{ik} \ln Y_k + \sum_{j=1}^{3} \eta_{ij} \ln W_j + \eta_{ik} \ln X_k + \pi_{it} T + \alpha_i D + \sum_{k=1}^{3} \gamma_{ik} D \ln Y_k \\
&+ \sum_{j=1}^{3} \eta_{ij} D \ln W_j + \eta_{ik} D \ln X_k + \pi_{it} D T + u^2 \\
&- (S_j) = \beta_j + \sum_{i=1}^{3} \eta_{ij} \ln Y_i + \sum_{j=1}^{3} \delta_{ij} \ln W_i + \eta_{ik} \ln X_k + \sigma_{ij} T + \beta_j D + \sum_{i=1}^{3} \eta_{ij} D \ln Y_i \\
&+ \sum_{j=1}^{3} \delta_{ij} D \ln W_i + \eta_{ik} D \ln X_k + \sigma_{ij} D T + u^3)
\end{align*}\]

where:

- \(\tau\) = profits before taxes, loan loss reserves, and extraordinary items;
- \(Y_i\) = value of banking output \(i\), (1) loans, (2) interbank loans, (3) deposits (demand, savings, and time);
- \(W_j\) = input price \(j\), (1) labor, (2) materials, (3) deposit interest rate;
- \(X_k\) = value of physical capital;
- \(B\) = number of branches;
- \(F\) = dummy variable for bank mergers (equals 1.0 in the merger year and all following years);
- \(T\) = a time trend dummy variable, \(T = 1, \ldots, 6\) for the 6 years;
- \(D\) = dummy variable equal to 0.0 for the firms belonging to the frontier and equal to 1.0 for the remaining of firms in the total sample;
- \(S_i\) = revenue share equation \(i\), \((i = 1, 2, 3)\), (1) loan revenues over profits, (2) interbank loan revenues over profits, (3) deposit revenues over profits;
- \(S_j\) = cost share equation \(j\), \((j = 1, 2)\), (1) labor cost over profits, (2) deposit interest cost over profits — the materials cost share is excluded.
This specification of the profit function reflects our alternative profit function where output quantities and input prices appear as given. The standard profit function is specified and estimated by replacing output quantities \((Y_i)\) with output prices \((P_i)\) in the above equations — as well, the two loan categories, non-interbank loans and interbank loans, are aggregated, permitting us to resolve some problems with convergence in estimating the standard model. 

Although size can be an important factor in explaining differences in profit inefficiency within the banking industry, a common way that industry participants make profitability comparisons among themselves effectively excludes size from direct consideration. This occurs when profits are expressed as a percentage of total assets (ROA) rather than as a profit level as above. However, in a regression equation with ROA replacing the level of profits as the dependent variable, the estimated relationship effectively substitutes total assets with a parameter restricted to 1.0 to be the indicator of bank size on the RHS of the equation. To illustrate how this alternative measure of bank size may affect our results, we reestimated our alternative and standard profit functions using ROA in place of profits and dropped our current size indicator — the fixed input \(X_k\) — from the estimating equation.

4.1. Measurement of the inefficiency residual

The thick frontier approach to inefficiency measurement attempts to determine the unexplained difference in average savings bank profits over 1986–1991 between the most and least profitable quartiles of institutions, representing sets of best and worst-practice banks, respectively. The total difference in profitability — profits per unit of assets — is the average difference in predicted profits or \(\text{DIFF}\):

\[
\text{DIFF} = -\left(\overline{AP}_{Q_i} - \overline{AP}_{Q_s}\right)/\overline{AP}_{Q_s}
\]  

(4)

where

\[
\overline{AP}_{Q_i} = \hat{P}_{Q,i}(X_{Q_i})/TA_{Q_i},
\]

represents predicted unit profit: the first term on the RHS represents the estimated parameters of the profit function, the second term represents the data, and the divisor is total assets — all for the indicated profit quartile of banks. The part of \(\text{DIFF}\) in (4) that is explained by market factors such as scale, scope, input price, and branching influences on profitability is obtained from \(\text{MARKET}\):

\[
\text{MARKET} = -\left(\overline{AP}_{Q_i} - \overline{AP}_{Q_s}\right)/\overline{AP}_{Q_s}
\]  

(5)

where

\[
\overline{AP}_{Q_i} = \hat{P}_{Q_i}(X_{Q_i})/TA_{Q_i},
\]

is the predicted unit profit for the lowest profit banks (quartile 1) using the efficient technology estimated for the highest profit banks (quartile 4), rather than the inefficient technology that was actually used at the lowest profit banks. In this way \(\text{MARKET}\) captures the effects on profits of differences in the levels of the data, but not differences in the parameters of the profit function which we take to reflect efficiency differences.

The remaining difference in profitability is the unexplained residual which is presumed to reflect inefficiency and is determined by evaluating the effect of using different production techniques, as reflected in the profit function parameters for the best and worst-frontier banks, holding the data constant:

\[
\text{INEFF} = -\left(\overline{AP}_{Q_i} - \overline{AP}_{Q_s}\right)/\overline{AP}_{Q_s} = \text{DIFF} - \text{MARKET}
\]  

(6)

The numerator of \(\text{INEFF}\) represents the persistent unexplained difference between high and low profit banks in (4).
5. Empirical results

5.1. Parameter estimates

A number of estimated parameters either fail to conform in sign to a priori expectations and/or were statistically insignificant when the standard profit function was estimated. These include the price parameters for loans output — without the correct sign and statistically not significant — and produced deposit output — with the correct sign but statistically insignificant. However, the estimated parameters improved in terms of sign and significance when the alternative profit function, which does not take prices as given, was estimated. This result is consistent with our prior view that banks are not price takers in loan and deposit markets (detailed results for these models are not reported here, but can be obtained from the author upon request).

5.2. Profit efficiency: deviations from the profit frontier

The three measures — DIFF, MARKET, and INEFF — are shown in Table 1 using the alternative profit function where savings banks are assumed to be able to set prices in the output market. The predicted difference in profitability between high and low profit banks averaged 40% and was the same level at the end of the period as it was in the beginning (Column 1). Looking at the raw data for the banks belonging to the highest and lowest profit quartiles, we found that on average the latter had over 40% more branches, held 35% less loans per peseta of assets, had nearly 35% greater use of inputs, and had almost 65% more expenses for fixed inputs, than did banks in the highest profit quartile.

The portion of the difference in predicted profits attributed to market factors is shown in Column 2 and, on average, these factors account for 12 percentage points of the 40% difference in profits. Importantly, the profit difference accounted for by market factors rises steadily over the period. As a result, the remaining portion of the predicted difference in profits, which is attributed to inefficiency, shows a steady decrease over time. Inefficiency falls from 32% in 1986 down to 19% in 1991 (Column 3) and averages 28% overall. Thus more than two-thirds of the average predicted difference in savings bank profits (which was 40%) is attributed to differences in efficiency (28%).

As a simple sensitivity analysis, our efficiency estimates from the alternative profit function were reestimated using quintiles and then again using thirds in place of quartiles. When quintiles (thirds) were used our average inefficiency levels become 31% (24.5%). As expected, the larger are the subsets of the data used to reflect best

<table>
<thead>
<tr>
<th>Years</th>
<th>Difference in predicted average profits (DIFF)</th>
<th>Total market factors (MARKET)</th>
<th>Total inefficiency (INEFF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>1986</td>
<td>34.39%</td>
<td>2.87%</td>
<td>31.52%</td>
</tr>
<tr>
<td>1987</td>
<td>37.85%</td>
<td>5.16%</td>
<td>32.68%</td>
</tr>
<tr>
<td>1988</td>
<td>39.59%</td>
<td>5.26%</td>
<td>34.33%</td>
</tr>
<tr>
<td>1989</td>
<td>47.31%</td>
<td>19.94%</td>
<td>27.38%</td>
</tr>
<tr>
<td>1990</td>
<td>44.28%</td>
<td>22.15%</td>
<td>22.13%</td>
</tr>
<tr>
<td>1991</td>
<td>35.82%</td>
<td>17.08%</td>
<td>18.74%</td>
</tr>
<tr>
<td>Overall mean</td>
<td>39.87%</td>
<td>12.08%</td>
<td>27.79%</td>
</tr>
<tr>
<td>Overall mean ROA dependent variable</td>
<td>40.24%</td>
<td>15.91%</td>
<td>24.33%</td>
</tr>
</tbody>
</table>

Columns (2) and (3) sum to column (1).
Table 2
Decomposition of profits between the highest and lowest profit quartiles (Standard profit function)

<table>
<thead>
<tr>
<th>Years</th>
<th>Difference in predicted average profits (DIFF)</th>
<th>Total market factors (MARKET)</th>
<th>Total inefficiency (INEFF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>28.42%</td>
<td>-16.42%</td>
<td>44.84%</td>
</tr>
<tr>
<td>1987</td>
<td>27.58%</td>
<td>-15.05%</td>
<td>42.64%</td>
</tr>
<tr>
<td>1988</td>
<td>34.88%</td>
<td>-10.79%</td>
<td>45.68%</td>
</tr>
<tr>
<td>1989</td>
<td>38.81%</td>
<td>-6.69%</td>
<td>45.59%</td>
</tr>
<tr>
<td>1990</td>
<td>48.79%</td>
<td>12.97%</td>
<td>35.81%</td>
</tr>
<tr>
<td>1991</td>
<td>35.18%</td>
<td>-6.54%</td>
<td>41.72%</td>
</tr>
<tr>
<td>Overall mean</td>
<td>35.61%</td>
<td>-7.10%</td>
<td>42.71%</td>
</tr>
<tr>
<td>Overall mean ROA</td>
<td>37.90%</td>
<td>0.46%</td>
<td>38.36%</td>
</tr>
</tbody>
</table>

Columns (2) and (3) sum to column (1).

and worst-practice profitability, the smaller is the estimated average inefficiency. These results are akin to that for DEA when an "excessive" number of variables/constrains are specified, resulting in more banks being identified as 100% efficient simply because they can not be compared with any other bank. These results are also akin to that of the SFA frontier when one moves from assuming a half-normal distribution of inefficiency to a truncated-normal distribution, or when with the DFA first 1%, then 5%, and then 10% of the outliers are successively deleted from the efficiency calculations. Furthermore, in order to check robustness of results and consistency of approach, we also reestimated all our inefficiency results using DFA. Our results (not shown) were very close to those obtained in this study.

For comparison purpose, Table 2 presents the results from using a standard profit function. Here the predicted difference in profits averages 36%, which is just a bit lower than when the alternative function was used. However, the portion of this difference in predicted profits attributed to market factors — scale, scope, input prices, branching effects — is negative so that inefficiency averages 43%, which is more than 100% of the difference in predicted profits. This result — that inefficiency is greater than the difference in predicted profits — is counter-intuitive and suggests that the standard profit function — which maintains price-taking behavior — may not be appropriate for the Spanish banking industry.

In order to check the robustness of our results as well as to contrast the consistency of the frontier approach used in this study, efficiency estimates were all reestimated using DFA, as pointed out above. The results obtained (not shown) were very close to those obtained from the thick frontier approach shown in Tables 1 and 2.

Efficiency estimates were reestimated using the alternative and standard profit functions with return on assets (ROA) as the dependent variable. These results are shown at the bottom of Tables 1 and 2. The use of ROA represents an alternative way to control for scale effects compared to the specification of a fixed capital input as in the previous results. While inefficiency is somewhat lower when ROA is used in place of the level of variable profits and use of a fixed input, the reduction is not large — it was only 12% lower for both profit function specifications.

The significance of our inefficiency point estimates are illustrated using a procedure devised by Atkinson and Wilson (1995) and the results obtained from the alternative profit function appear to be statistically significant. Bootstrapped 95 percent confidence intervals for time means of inefficiency were defined from a sampling distribution obtained through repeated sampling (with replacement) of the set of banks belonging to the first and fourth profit quartiles. The significance of the inefficiency results is illustrated by first determining if $AP_{Q_i}$ lies within the bootstrap confidence interval formed around the predicted value of $AP_{Q_i}$, evaluated at the mean of the data. $AP_{Q_i}$ did not lie within this interval, suggesting that our inefficiency results may be significant. We then
computed the approximate 95% confidence interval around the predicted value of $\Delta P_{Q}^t$, to see if this interval overlapped with the interval formed earlier. As there was no overlap, this suggests that our inefficiency results may be significant. However, when the same exercise was performed for inefficiency results obtained from the standard profit function, there was some overlap in the confidence intervals for $\Delta P_{Q}^t$ and $\Delta P_{Q}$, suggesting insignificant results.

5.3. Shifts in the profit frontier

Shifts in the profit frontier are measured using a time trend variable which yields a measure of the average frontier shift over the entire time period. Overall, the average rate of profit frontier shift — from the alternative profit function — is estimated to have raised profit by 5% (not shown) a year, but was not statistically significant. This suggests that the set of high profit Spanish savings banks had unchanged profit levels over the time, even as profit efficiency — the deviation from the frontier — improved by 40% over the same period.

5.4. Contrast with separate cost efficiency estimates

Cost efficiency and technical change have been estimated for the same data set of savings banks over the same time period using a thick cost frontier methodology (Lozano, 1997). We compare our profit efficiency estimates to the cost efficiency estimates in Lozano (1997) because both studies analyze the same type of institutions, over the same period and using the same methodology, although the bank output definition in these two studies differs somewhat. Lozano (1997) used deposit accounts, average real value in a deposit account, and total real value of loans as variable outputs differing to our definition of output shown above. However, the rest of Spanish banking studies (Grifell, Prior, and Salas, 1992; Grifell and Lovell, 1996, 1997; Pastor, 1994; Pastor, Pérez and Quesada, 1997) differ from the present study in terms of time period, set of institutions, bank output and input definition, as well as in the methodology used. Therefore, we feel it is less realistic to contrast our profit efficiency estimates with the efficiency results obtained in those studies.

In order to compare the cost inefficiency results obtained by Lozano (1997), to our profit inefficiency findings we have put both efficiency measures into comparable terms (Berger et al. 1995), expressing cost inefficiency and profit inefficiency as the proportion of potential profits that are lost to inefficiency. By following Berger et al. (1995), we compute the ratio of the pesetas value of inefficiencies — average actual cost minus average minimum costs, average potential profits minus average actual profits — to average potential profits in order to obtained both cost and profit measured of inefficiency into comparable terms. Profit inefficiency averages 72% of potential profits while cost inefficiency averages 26% of potential profits. In this comparison, the implied revenue inefficiencies — setting inefficient output prices — appear to have a larger effect on potential profits than cost inefficiencies — overusing inputs — for Spanish savings banks.

Interestingly, the results shown in Table 1 indicate that profit inefficiencies decrease after 1989, which corresponds to the time immediately following the removal of geographical restrictions on branching. Even though inefficiency levels improved, they are still relatively high. This may be attributed to the traditional role of Spanish savings banks which provide services to customers with low average balances and who place a high value on being able to physically visit a bank close to where they live and work.

5.5. Behavioral conditions

The first order condition for profit maximization is that the predicted values of output prices for the alternative profit function (obtained from $S_1$), and the predicted value of input quantities (obtained from $S_j$) have the correct signs: positive for output prices and negative for input quantities. Not satisfying the sign conditions means that the profit function does not fit the data well. Table 3 shows the number of correct signs as a percentage of the total number possible for the alternative and standard profit functions. When only the profit
Table 3
Ratio of the number of optimal output and input with the right signs to the total number when the profit function is estimated without share equations

<table>
<thead>
<tr>
<th>Profit function</th>
<th>$W_1$ (interest)</th>
<th>$W_2$ (labor)</th>
<th>$W_3$ (capital)</th>
<th>$Y_1$ (loan)</th>
<th>$Y_2$ (deposit)</th>
<th>$Y_3$ (interbank)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-standard</td>
<td>Quantities</td>
<td>58%</td>
<td>32%</td>
<td>63%</td>
<td>Prices</td>
<td>79%</td>
</tr>
<tr>
<td>Standard</td>
<td>Quantities</td>
<td>50%</td>
<td>27%</td>
<td>44%</td>
<td>Quantities</td>
<td>72%</td>
</tr>
</tbody>
</table>

Table 4
Ratio of the number of optimal output and input with the right signs to the total number when the profit function is estimated with share equations

<table>
<thead>
<tr>
<th>Profit function</th>
<th>$W_1$ (interest)</th>
<th>$W_2$ (labor)</th>
<th>$W_3$ (capital)</th>
<th>$Y_1$ (loan)</th>
<th>$Y_2$ (deposit)</th>
<th>$Y_3$ (interbank)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-standard</td>
<td>Quantities</td>
<td>100%</td>
<td>100%</td>
<td>97%</td>
<td>Prices</td>
<td>100%</td>
</tr>
<tr>
<td>Standard</td>
<td>Quantities</td>
<td>100%</td>
<td>100%</td>
<td>86%</td>
<td>Quantities</td>
<td>100%</td>
</tr>
</tbody>
</table>

functions is estimated, these percentages range from 32% to 79% for the alternative function and from 27% to 72% for the standard approach. However, when the profit function is estimated jointly with the share equations, as in Table 4, the situation is considerably improved for both specifications and only one of the first order conditions is not met.

Swamy, Akhavein, and Taubman (1994) suggest that joint estimation of the profit function with the share equations yields price derivatives that are poor predictors of the profit-maximizing netput quantities, and, as result, inefficiency results so derived are biased because they include effects of excluded variables, have inaccuracies in the specified functional form, and use inconsistent parameter estimates. However, we found that inefficiency levels are basically unchanged when estimation occurs with or without the share equations.

5.6. The stability of profits at high and low profit savings banks

Profits can vary as a result of explanatory variables specified in the profit function (MARKET), inefficiency (INEFF), errors, or luck. We now look for additional evidence to support inefficiency as the chief reason for the observed variation in profit, rather than other alternatives. Since it is more likely that inefficiency differences will be persistent over time, rather than strongly vary each year, we investigate the persistence of profitability differences over time. The top of Table 5 examines the stability of banks in the highest and lowest profit quartiles over time. Recall that our quartiles are formed by looking at the average profitability of banks over the entire 6-years period, not each year separately. However, 73% of the banks that comprised our highest profit

Table 5
Stability and relation to profits and cost quartiles: Correspondence of high(low)-profit and low(high)-cost for 1986–1991

<table>
<thead>
<tr>
<th>$Q_1$</th>
<th>$Q_2$</th>
<th>$Q_3$</th>
<th>$Q_4$</th>
<th>$Q_1$</th>
<th>$Q_2$</th>
<th>$Q_3$</th>
<th>$Q_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Profits Banks</td>
<td>4%</td>
<td>5%</td>
<td>18%</td>
<td>73%</td>
<td>Low Profits Banks</td>
<td>62%</td>
<td>31%</td>
</tr>
<tr>
<td>Low Cost Banks</td>
<td>45</td>
<td>23</td>
<td>23</td>
<td>9</td>
<td>High Cost Banks</td>
<td>8</td>
<td>26</td>
</tr>
</tbody>
</table>
quartile also were in the highest profit quartile for each of the six years separately. Further, 91% of the banks in our highest profit quartile had profits each year that were above the median. Similarly, 62% of the banks placed in our lowest profit quartile had profits in the lowest quartile in each of the six years separately, while 93% were at least below the median in each year. From this we conclude that there is a high degree of stability in our profit quartiles and that the differences between the highest and lowest profit quartiles are reasonably persistent, suggesting efficiency differences rather than short-term differences in measurement error or luck (this method of examining profit stability over time to identify the presence of inefficiencies from luck is the same that used by Berger and Humphrey (1991) to examine cost stability).

The bottom of the Table 5 shows the same stability comparison for cost quartiles of savings banks over the same period. The fact that there is a strong negative relationship between profits and costs suggests that differences in profit are not likely due to important unspecified differences in the quality of bank services provided to customers. If quality differences were important, then costs and profits would not likely be negatively related. As higher quality presumably costs more, prices — either in an environment where they can be set by the seller or where they are taken as given in markets for a similar quality of output — would likely reflect this quality difference and lead to stable or rising profits (rather than their reduction). Finally, as a simple sensitivity analysis, three variables not related to efficiency but conceivably related to profits were added to the non-standard profit specification and the model reestimated. These additional variables — deposit account size, loan growth, and the deposit-loan rate spread — did not reduce our inefficiency measure.

6. Conclusions

This paper measures the profit efficiency of Spanish savings banks over 1986–1991 using a thick frontier approach. Instead of assuming that savings banks operate in perfectly competitive markets and take output and input prices as exogenous, which is the approach used in the standard (textbook) profit function, we specify what we believe to be a more realistic market structure and assume that savings banks are price-setters in the output market but remain price-takers in the input market. This gives an alternative specification of the profit function which is used to assess the efficiency of savings banks over 1986–1991.

Using the thick frontier approach to measuring efficiency, the average difference in (predicted) profits between quartiles of the most and least profitable savings banks was 40%. About one-third of this difference — from 12 to 16 percentage points — is associated with explanatory market factors such as scale, output mix, input prices, and branching intensity. The remaining two-thirds — from 24 to 28 percentage points — is deemed to be associated with persistent profit inefficiency, such as mispricing of output or overuse of inputs (which includes excessive branching). In the raw data, it turns out that banks belonging to the lowest profit quartile on average had over 40% more branches, held 35% less loans per peseta of assets, had nearly 35% greater use of inputs, and had almost 65% more expenses for fixed inputs, than did banks in the highest profit quartile.

The average difference in predicted profits of the most and least profitable banks using a standard profit function was similar (at 36% to 38%) to that for our alternative profit function specification. However, the difference explained by market factors was negative, leaving the portion of the profit difference attributed to inefficiency to be over 100% of the original predicted difference (so inefficiency is from 37% to 43%). This result suggests that the standard profit function may not be appropriate for the Spanish banking industry.

Savings banks that are in the highest quartile of profitability in any one year over the six in our sample period are also likely to be profitable in other years as well. Indeed, 73% (62%) of the firms in the highest (lowest) quartile of profitability over the entire six year period were also in the highest (lowest) quartile in each year separately. This stability in profitability for high and low profit institutions indicates that our identification of best-practice and worst-practice firms are not likely to be the result of luck or transitory influences but rather reflect the influence of persistent differences in efficiency.
The profit inefficiency measured here — which includes both cost and revenue inefficiencies — are more than twice as large as the cost inefficiency measured for the same set of savings banks over the same time period using a thick cost frontier approach (although the bank output definition in these two studies differs somewhat). This suggests that revenue inefficiencies may be larger than cost inefficiencies for Spanish savings banks. The one positive result of this analysis is the indication that profit inefficiency may have fallen from 32% in 1986 to 19% in 1991 — a forty percent reduction. In addition, shifts in the thick profit frontier would reflect adjustments in frontier profits over time. However, savings banks experienced no significant change in frontier profits over 1986–1991. Apparently, savings banks preferred to sacrifice their short term profits in order to maintain/expand their market share.

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