How the environment determines banking efficiency: A comparison between French and Spanish industries

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Abstract

This paper investigates the influence the environmental conditions have on the cost-efficiency of French and Spanish banking industries. We propose a new methodology for cross-country comparisons of efficiency using a parametric approach. In particular, the specific environmental conditions of each country play an important role in the definition and specification of the common frontier of different countries. Our results suggest that, without environmental variables, the cost-efficiency scores of Spanish banks are quite low compared to those of the French banks. However, when environmental variables are included in the model, the differences between both banking industries are reduced substantially. Overall, our results demonstrate that environmental variables contribute significantly to the difference in efficiency scores between the two countries. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

Many members of the European Monetary Union (EMU) have adopted changes in the regulation of their financial markets to facilitate the process of financial integration and convergence in Europe. These changes were designed to liberalize the provision of services and to increase competition. Therefore, in an increasingly harmonized European market for banking services, the most efficient banks will have a competitive advantage. To predict the effects of the expected increase in cross-border competition, it is important to know how different or similar current banking performances are in different countries. However, cross-country comparisons have to account for potential differences arising from certain country-specific aspects of the banking technology on the one hand and from the environmental and regulatory conditions on the other. In particular, the economic environments are likely to differ significantly across countries, and could induce important differences in bank efficiency through various channels. For instance, differences in per capita income or in population density across countries could produce significant differences in the demand for banking products and services among households.

In our view, cross-country efficiency comparisons require the proper definition of a common frontier that incorporates country-specific environmental conditions. Moreover, integration of environmental variables into the analysis allows researchers to verify the degree of similarity between banking technologies. As pointed out by Berger and Humphrey (1997), this issue has not been addressed in the international banking efficiency literature.

In this paper, we focus on an international comparison of banking efficiency in two countries, France and Spain. We emphasize in our analysis the influence of environmental conditions on the cost-efficiency of French and Spanish banking industries. In particular, three categories of environmental variables are taken into account:

(i) those that describe the main macroeconomic conditions, which determine the banking product demand characteristics,
(ii) variables that describe the structure and regulation of the banking industry, and
(iii) those that characterize the accessibility of banking services.

Overall, this paper expands and improves on the existing methodology used in intercountry banking efficiency studies by introducing an improved and new methodology for international banking efficiency comparison. This is the first systematic comparison of efficiency measures across countries using a parametric approach and integrating environmental variables into the definition of the common frontier.

Our results suggest that, ignoring environmental variables, the cost-efficiency scores of Spanish banks are quite low compared to those of the French banks. However, when environmental variables are included, the differences
between the banking industries in the two countries are reduced substantially. Our results show that the Spanish banks seem to suffer from excessive costs (or structural disadvantages) compared to their French counterparts mostly due to their particular environmental and regulatory conditions.

A brief survey of the previous literature on cross-country comparisons of efficiency is presented in Section 2. The methodology for evaluating cross-country bank efficiency when particular environmental conditions to each country are accounted for is presented in Section 3. The data and specification of inputs, outputs and environmental variables are described in Section 4. Section 5 presents the empirical results, and Section 6 provides some concluding remarks.

2. Existing literature on international comparisons of banking efficiency

Recently there has been consolidation within the domestic banking industries in many European countries, due to the anticipation of lower barriers to competition among financial institutions within the EMU. Due to this, when they set up branches in other EMU countries (subject only to the regulations of their home country), banks will adjust better to their customers’ needs. As domestic markets become more competitive, current differences in productive efficiency and costs among the banking industries of EMU members will largely determine each country’s banking structure and future competitive viability. Thus, to predict the effects of an expected increase in cross-border competition, knowledge of the differences or similarities in the current banking costs and productive efficiencies between countries is important.

Only six studies in the literature regarding efficiency have compared banking performance differences across countries. Four of them used non-parametric approaches, while two used parametric approaches. Berg et al. (1993) relied upon data envelopment analysis (DEA) to capture the differences in banking efficiency between Norway, Sweden and Finland. Firstly they defined separate frontiers for each country and performed pair-wise comparisons of the countries using separate frontiers. They then defined a “common” frontier and again compared results across countries. Berg et al. (1995) did a follow-up study by adding Denmark to the above sample. The same four countries were investigated in Bergendahl (1995), using mixed optimal strategy.

Fecher and Pestieau (1993) as well as Pastor et al (1997) applied a distribution free approach (DFA) and DEA analysis to 11 OECD countries and eight developed countries, respectively. The two studies pooled the cross-country data to define a common frontier. The former study found results opposite to those obtained by Berg et al. (1993) and Berg et al. (1995) regarding the efficiency levels of the same set of countries.
Allen and Rai (1996) use DFA and stochastic frontier approach (SFA) for a systematic comparison of X-inefficiency measures across 15 developed countries under different regulatory environments. The countries were classified, a priori, into two groups – universal and separated banking countries – delineated by their regulatory environments. Universal banking countries permit the functional integration of commercial and investment banking, while separated banking countries do not. Once the inefficiency levels of these banks were measured, the firm-specific inefficiency measures were regressed against various bank and market characteristics instead of economic factors. The authors used environmental factors not to identify the common underlying technology that exists in the banking industries of the countries but to know the determinants of the country-by-country inefficiencies.

The main caveat on these cross-country studies is that the common frontier is built by pooling all cross-country banks and it measures banking efficiency differences between countries without considering environmental conditions. In other words, a common frontier is based on the belief that efficiency differences across countries are mainly attributable to managerial decisions within banks. However, it is possible that the underlying technology of the banking industry across European countries (and other developed countries) is quite similar but that the observed differences in efficiency can be primarily explained by country-specific differences (almost always excluded from cost and efficiency analyses), and not only by technological differences. Just as different relative prices of capital and labor inputs lead to different input intensities in production, different national environments will result in different observed inputs, liabilities, asset mixes and numbers of branches when banks minimize costs and technology is constant. If the country-specific variables are an important factor in explaining efficiency differences, then the common frontier estimates obtained by neglecting this factor generate biased and overestimated inefficiency levels.

When the regulatory and economic environments of financial institutions are very different across countries, it is difficult to interpret the cross-country comparisons of the preceding papers. In these papers, the specification of the common frontier ignores the influence of the country-specific environmental variables. These variables justify the use of a common frontier in cross-country comparisons of efficiency.

Here, we propose a comparison of the cost-efficiency of the banking industries in France and Spain, introducing the appropriate environmental variables in the cost frontier estimations. Our goal is to obtain a proper

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1 Although Allen and Rai (1996) take into account the regulatory environments in the distinction between groups of countries to compare the inefficiency levels, they specify bank variables and not country variables to explain these efficiency differences.
comparison of banking efficiency across countries by using a global best-
practice econometric frontier whereby the banks in each country are compared
against the same standard.

3. Methodology

Banking technology can be defined as the set of specific methods that banks
use to combine financial and physical inputs to generate a certain amount of
banking services, such as liquidity and payment services, portfolio services and
loan services. These methods are diversification, risk pooling, financial infor-
mation collection and evaluation, risk management, and so on.

These banking methods are more or less the same in large industrialized
countries. So there is a presumption that the technology used in countries like
France and Spain should be the same. However, the environmental conditions
faced by financial institutions are likely to differ substantially. For example, the
average level of wealth and the saving behavior of economic agents are dif-
gerent in countries like France and Spain. Also differences in the taxation of
saving products persist across European countries, even if banks can now
supply the same products all around Europe. Bankruptcy law still differs from
one country to another, so does the efficiency of the loan contracts, and so on.
Overall, these environmental conditions may affect the cost-country banking
industries in different ways.

To address the main caveat pointed out above in the methodology for in-
tercountry efficiency comparisons, we propose an alternative methodology. In
this alternative methodology, the specific environmental conditions of each
country play an important role in the definition and specification of the
common frontier of different countries.

3.1. Common frontier and international comparisons: control for technology

Our approach determines a common frontier based on the conjecture that
efficiency differences between banking industries are determined by country-
specific differences rather than by technological ones. We use this approach to
compare the French and Spanish banking industries.

We start from the assumption that the underlying technologies of the
banking service productions in France and Spain are quite similar. This as-
sumption allows us to correctly define a common frontier.

To contrast our initial assumption, we have to control for the technology
first – to verify whether or not the technology is the same in the two banking
industries. The country-specific environmental variables are taken into account
because we believe that these variables are major factors in explaining the
differences in the banking costs across countries.
To perform the test to control technology, we specify and estimate separate cost functions for each country, including the environmental variables as control variables. In our particular case, we have two equations: one for France and another one for Spain. Then, to test for the similarity in the technologies, we impose cross-equation equality restrictions on the parameters of each country’s cost frontier, but such restrictions are not imposed on the parameters of the country-specific environmental variables.

These cross-equation equality restrictions permit proper definition of the set of environmental variables and identify the common underlying banking technology in the French and Spanish banking industries. In fact, if most or all of the cross-equation equality restrictions on the technology parameters fail to be rejected, then we have identified the correct set of country-specific environmental variables determining costs, and, consequently, the common underlying banking technology of different countries.

The two-equation model is as follows:

\[ C_{it} = f(Y_{it}, P_{it}, Z_{it}^r), \]

where \( C \) is the cost vector; \( Y \) the output vector; \( P \) the input price vector; \( Z \) is the vector of country-specific variables – these variables take equal values for each bank of each country by year; \( i = 1, \ldots, n \), is the index of banks; \( t = 1, \ldots, T \), refers to years; and \( r = 1, 2 \) refers to the two countries.

After having identified the common frontier, the efficiency of banks in each country is measured. Therefore, a common stochastic cost frontier is estimated, holding the country-specific environmental factors constant at their respective mean values for each country:

\[ C_{it} = f(Y_{it}, P_{it}, Z_{it}^r). \]

The international comparison proposed here permits a proper comparison of banking efficiency across countries, namely one that is not influenced by the country’s technology benchmark.

This methodology can be generalized to the case of \( n \) countries following the same procedure as that for our particular case of two countries. Our empirical application is limited to the case of two countries because of information constraints. Using the information for the entire banking industry of France and Spain, known by the respective authors, allows us to obtain a clearer picture of the topic under investigation. So we preferred to use only these two countries instead of a wider set of countries, that does not incorporate all the banking information for each country. For example, in Allen and Rai (1996) or Pastor et al. (1997), the set of countries examined is bigger. But only about 10% of the total number of banks existing in each country are studied.
3.2. Cost specification and the distribution-free model

In this study, $X$-efficiency estimates for the Spanish and French banking industries are generated using the DFA. This requires specification of a functional form for the frontier that contains an error term with two components. One component represents, by assumption, $X$-inefficiencies, while the other one represents random disturbances, reflecting bad (good) luck or measurement errors. We use translog specification and estimate separate cost functions for each of the five years (from 1988 to 1992) for the country’s cost frontiers as well as for the common frontier. The cost frontier is estimated jointly with the factor share equations obtained by applying Shephard’s lemma. Thus, the complete model is the following:

$$
\ln C = z + \sum \beta_j \ln Y_j + \frac{1}{2} \sum \sum \kappa_{jk} \ln Y_j \ln Y_k + \sum_m \gamma_m \ln p_m
$$

$$
+ \frac{1}{2} \sum_m \sum_{n=mn} \ln p_m \ln p_n + \sum_j \sum_{m=mn} \ln Y_j \ln p_m + \ln x + \ln \omega, \tag{3}
$$

$$
S_m = \gamma_m + \sum_j \rho_{jm} \ln Y_j + \sum_m \gamma_{mn} \ln p_m + \ln v_m. \tag{4}
$$

In this model, $C$ represents the total of operating and financial (interests) costs. The $Y_j$ ($j = 1, 2, 3$) represent the banking products. The $P_m$ ($m = 1, 2, 3$) refer to the input prices. $S_m$ is the cost share paid to input $m$. The term $\ln x$ is the systematic error component, which appears as an $X$-inefficiency factor, and $\ln \omega$ is a random error term. The term $\ln x$ being an error term might be correlated with $\ln v_m$ and $\ln \omega$.

We adopt the value-added approach (Berger and Humphrey, 1992) to identify banking outputs and inputs. All items on both sides of the balance sheet may be identified as inputs or outputs depending on their contribution to the generation of value-added. In this sense, deposits as well as assets are considered to have some output characteristics. Deposits provide transaction

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2 However, as noted by Berger (1993), forcing the shares to be consistent with the cost equation implies that the input mix reacts consistently to relative price changes, that is that $X$-inefficiencies are only technical in nature. This assumption is probably too strong, although the introduction of the factor share equations surely improve the precision of the estimates. So, we ran the model alternatively with OLS and with iterative SUR without restrictions on the constant terms in the share equations and the results were very similar.

3 This assumes that the banks try to minimize total costs and not just operating costs.

4 The definition of the estimated common cost frontier corresponds to the equation system (3) and (4), where Eq. (3) contains as additional dependent variables the vector of country-specific variables as shown in Eq. (2).

5 The share equations sum to one. The physical capital share equation is omitted from the estimation.

6 Standard symmetry and input price homogeneity constraints are imposed on the total cost function (3).
and safekeeping output services, but add to input costs as well. In a value-added context, deposits typically account for more than half of the total capital and labor expenses of banks; in this sense, output services are clearly being produced. Accordingly, in this study, we specify three outputs: loans (composed of the value of home loans and other loans), produced deposits (the sum of demand, saving, and time deposits), and other productive assets (the sum of all existing deposits with banks, short-term investments and other investments). Prices for three inputs – labor, physical capital, and a financial factor – are also specified.

The input prices are computed using the data provided by the banks themselves. For example, the price of labor is estimated using the information relative to wages and taxes associated to the use of labor as they appear in the bank accounts. The price of physical capital is obtained by dividing capital equipment and occupancy expenses by the fixed assets. The price of the financial factor is computed by dividing total interest expenses by total interest bearing liabilities. Consequently, because we use the prices paid by a bank for each factor of production, inefficiencies associated with overpayments of real or financial inputs cannot be evaluated by our approach. This could be a source of underestimation of the inefficiencies for banks paying inputs above the market prices. 7

To compute inefficiencies using DFA in a panel data set, each firm’s inefficiency estimate is determined as the difference between the average residual of the firm and the average residual of the firm on the frontier. That is, the average of the annual residuals for each bank \( i \) is computed and serves as an estimate of \( \ln x_i \) for that bank, given that the annual random error terms \( \ln \omega_{it} \) tend to average out to zero over the period. These average residual of each bank \( i \) is used in the computation of \( X \)-efficiency. The efficiency score is given by the following equation:

\[
X-\text{EFF} = \exp(\ln x_{\text{min}} - \ln x_i),
\]

where \( \ln x_{\text{min}} \) is the minimum \( \ln x_i \), i.e., the average residual for the bank with the lowest average cost residual, which is assumed to be the completely efficient bank. Therefore, \( X \)-EFF is an estimate of the predicted cost ratio for the most efficient bank to predicted costs for any bank. It is just like measuring \( X \)-efficiency by the ratio of the predicted cost of the most efficient bank to predicted cost of each bank. Nevertheless, this efficiency measure is not completely

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7 Following DeYoung and Hasan (1997), there are two alternative methods to avoid this problem: (a) use market average prices rather than bank-specific prices, and (b) using a profit function approach. Nonetheless, rerunning the model using input market average prices yields qualitatively similar empirical results.
correct if the random error terms \( \ln x \) do not cancel each other out during the period. As noted by Berger (1993), this error is likely to be larger for banks near the extremes of the average residual. These banks may have experienced good (bad) luck over the entire period. Consequently, the minimum average residual that serves as a benchmark for the calculation of the \( X \)-efficiency here could be overestimated. To treat this problem, we compute truncated measures of \( X \)-efficiency, where the value of the average residual of the \( q \)th \((1 - q)\)th percentile was attributed to each observation for which the value of the average residual is below (above) the \( q \)th \((1 - q)\)th quantile value. We use three values of \( q \): 1%, 5%, and 25%.

We also re-estimate the models using the bootstrap technique in order to measure standard errors of the efficiency level estimates and to construct their confidence intervals (Eakin et al., 1990; Atkinson and Wilson, 1995).

4. The data and variables

4.1. Data

We use annual accounting data over the 1988–1992 period for commercial and savings banks in France and Spain. It should be emphasized that, in each country, banks are competing in the same markets and for the same customers. Furthermore, banks also have quite similar access to capital markets in each country. During the mid-1980s, financial innovation and deregulation generated an increase in competition in the banking industry in both countries. Therefore, the period under study is characterized by rapid technological changes in the production of financial and banking services. The banks had to make strategic decisions to adjust to the new environment and the new competition conditions. In particular, the banks began reducing the number of employees and adjusted to the new environment by substituting capital for labor, especially in France.

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8 Under the First and Second European Banking Directives, these two categories of banks are now submitted to the same regulatory entity.

9 During these years, new short-term securities were introduced, money markets were modernized and opened to non-financial firms, new derivative markets were created, interest rate controls were abolished and, finally, capital controls were suppressed.

10 Following Berger (1993), we allow all parts of the cost equation to vary over time in an unrestricted way. Thus, changes in technology, regulation and so on can be reflected freely in changes in the constant terms or slopes of the estimated cost functions.
Only banks that were operating during these five years are retained in the sample. The final sample consists of 223 French banks and 101 Spanish banks.  

4.2. Variable outputs and inputs

Table 1 presents, for each country, average values of bank outputs and inputs prices (converted to US dollars) over the 1988–1992 period. Observe that the average sizes of the total balance sheet and loan portfolio are very similar, due to the fact that the sample mainly contains regional medium-sized banks. However, the average size of deposits differs across countries; in France, time-deposit interest rate regulation created an incentive in favor of other liquid investments, such as investments in mutual funds and money market deposits (so-called OPCVM). Therefore, French banks have to substitute money market liabilities and bonds for time deposits in order to finance loans. Prices of inputs differ between countries. In particular, both the prices of labor and physical capital are higher in France. This is mainly the result of differences in structure and regulation of labor and real estate markets. Due to the increased competition in deposit markets, the average cost of bank liabilities is higher in Spain during the period studied. This is part of the explanation

<table>
<thead>
<tr>
<th>Metric</th>
<th>France</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs</td>
<td>263.4</td>
<td>368.5</td>
</tr>
<tr>
<td>Total assets</td>
<td>3462.2</td>
<td>3822.4</td>
</tr>
<tr>
<td>Y1: deposits</td>
<td>1193.5</td>
<td>2610.0</td>
</tr>
<tr>
<td>Y2: loans</td>
<td>1609.5</td>
<td>1756.6</td>
</tr>
<tr>
<td>Y3: other earning assets</td>
<td>1187.0</td>
<td>1100.7</td>
</tr>
<tr>
<td>P1: price of labor</td>
<td>36056</td>
<td>31897</td>
</tr>
<tr>
<td>P2: price of physical capital</td>
<td>1.34</td>
<td>0.56</td>
</tr>
<tr>
<td>P3: price of financial factor</td>
<td>5.17</td>
<td>7.83</td>
</tr>
<tr>
<td>Number of banks</td>
<td>223</td>
<td>101</td>
</tr>
</tbody>
</table>

*a Values in thousands of US dollars.

11 Data come from official sources: Anuario de la Confederación de Cajas de Ahorros y del Consejo Superior Bancario, and Commission Bancaire. For the purpose of this study, the three largest French banks were excluded from the French sample due to the important differences that these banks present, in terms of activity structure, with respect of the rest of banks under investigation. Also the smallest banks and the foreign banks were excluded from the French and Spanish samples because of questionable data quality.

12 All variables initially measured in domestic currencies – including outputs, inputs prices or environmental variables – were converted into a common currency, according to the purchasing power parity hypothesis. Here, we chose the US dollar.
for the difference in total costs. In fact, financial costs represent more than two-thirds of total banking costs in Spain.

4.3. Environmental variables

Macroeconomic variables as well as variables explaining the peculiar features of each country’s banking industry – such as regulatory conditions, banking structure and accessibility of banking services – are selected to identify the common frontier. Here, we emphasize that our goal is not to conduct a microlevel study, but to determine national average efficiency levels, so that national explanatory variable can become relevant. We categorized these variables into three groups (Table 2). The first group is called “main conditions” and includes a measure of population density, per capita income and density of demand. These indicators describe the main conditions under which banks operate. The supply of banking services in areas with a low population density generates higher banking costs, and does not encourage banks to increase their efficiency levels. Per capita income (GNP per inhabitant) affects numerous factors related to the demand and supply of banking services (mainly deposits and loans). Countries with a higher per capita income have a banking system that operates in a mature environment resulting in more competitive interest rates and profit margins. Finally, the density of demand, measured by deposits per square kilometer, is a relevant feature in determining efficiency. Banks operating in markets with a lower density of demand incur higher expenses because this demand factor may impose a ceiling on the reachable efficiency level of their branches.

Table 2
Average values of environmental variables in France and Spain

<table>
<thead>
<tr>
<th></th>
<th>France</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population density: population per square kilometer</td>
<td>104</td>
<td>77</td>
</tr>
<tr>
<td>Per capita income: GNP/ nb of inhabitants ($)</td>
<td>9.747</td>
<td>9.375</td>
</tr>
<tr>
<td>Density of demand: deposits per square kilometer</td>
<td>0.832</td>
<td>0.647</td>
</tr>
<tr>
<td><strong>Bank structure and regulation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herfindhal index of concentration</td>
<td>0.182</td>
<td>0.183</td>
</tr>
<tr>
<td>Average capital ratio: equity/total assets (%)</td>
<td>3.54</td>
<td>9.94</td>
</tr>
<tr>
<td>Intermediation ratio: loans/deposits</td>
<td>1.72</td>
<td>0.67</td>
</tr>
<tr>
<td><strong>Accessibility of banking services</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of branches per square kilometer</td>
<td>0.0474</td>
<td>0.0994</td>
</tr>
</tbody>
</table>

*Sources: Bank profitability, OECD, Main economic indicators, OECD, Eurostat, Anuario Estadistico (INE).
The second category of environmental variables, named “bank structure and regulation”, consists of variables such as the degree of concentration, the average capital ratio and the intermediation ratio of the banking industry in each country. Concentration of the banking industry is measured by the Herfindahl index, defined as the sum of squared asset market shares of all banks in each country. In analyzing market structure, we thus consider each country to be a single market. Since banks operate exclusively throughout each country, and since entry has until recently been restricted by national borders, this national market concept seems appropriate. Higher concentration may be associated with either higher or lower costs. If higher concentration is a result of market power, concentration and costs go in the same direction (Leibenstein, 1966). However, higher concentration can be associated with lower costs, if concentration is the result of either superior management or greater efficiency of the production processes (Demsetz, 1973). To proxy for regulatory conditions, we define an average capital ratio, measured by equity over total assets. Usually, a lower capital ratio leads to lower efficiency levels because less equity implies higher risk taken at greater leverage, which normally results in greater borrowing costs. The last variable, the intermediation ratio, is defined as the ratio of total loans to total deposits. It captures differences between the two domestic banking industries in terms of their ability to convert deposits into loans. The higher the intermediation ratio, the lower banking industry costs are.

The final category of environmental variables is the accessibility of banking services for customers; it is measured by the number of branches per square kilometer. This variable is a measure of branch density and takes into account the spatial dimension of each national market. A lower branch density leads to lower banking costs. It is also a good indicator of the potential overcapacity in the branch network. This variable could equally measure the degree of competition in the banking market. Before the banking deregulation of the mid-1980s, competition between banks took mainly the form of non-price competition. Banks competed by increasing their number of branches in France as well as in Spain.

Table 2 reports the average values of these environmental variables over the 1988–1992 period for France and Spain, it defines the final set of variables used in our empirical analysis. These arithmetic means suggest large differences in the main conditions of banking activities across countries. In particular, the population density and per capita income are higher in France than in Spain. Also, the density of demand is higher in France than in Spain. Thus, it could be more expensive to perform banking activities – to collect a given level of resources or manage a given assets portfolio – in Spain than in France.

The mean values of the banking industry and regulation variables show that there are important differences between France and Spain. In particular, the capital ratio is very different because during the period studied the solvency constraints imposed by banking authorities obliged Spanish banks to maintain
a higher capital ratio than French banks. Another difference between both domestic banking industries is that the intermediation ratio is lower in Spain than in France. This implies that Spanish banks have to collect a higher level of costly deposits (in terms of operating costs) to support the same volume of loans. Under these conditions, it is ceteris paribus more expensive to conduct banking activities in Spain than in France. The degree of concentration in banking industry however is quite similar in both countries.

Finally, banking services are more accessible in Spain than in France. However, recall that this higher accessibility is consistent with our previous observation regarding the density of population and the amount of deposits per square kilometer. Thus, Spanish banks produce under conditions requiring a higher level of operating costs. Furthermore, as it was pointed out before the number of branches could also be an indicator of imperfect competition in banking markets.

5. Empirical results

Our empirical analysis starts by measuring bank efficiency in each country based on its national frontier estimates, assuming that the bank technology in each country is different. These results are summarized in Table 3. We report mean efficiency estimates for several degrees of truncation, 0%, 5% and 25%. However, we focus our comments on the 5% truncation level, as most DFA practitioners typically do. Using a 5% truncation level yields about the same average efficiency as most of the parametric frontier efficiency studies. Moreover, we present the measures derived from the re-estimation of the cost

<table>
<thead>
<tr>
<th>$\chi$-EFF scores</th>
<th>France</th>
<th>Bootstrap estimates (means)</th>
<th>Bootstrap 95% confidence intervals</th>
<th>Spain</th>
<th>Bootstrap estimates (means)</th>
<th>Bootstrap 95% confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(\text{truncation at } 0.01)$</td>
<td>$0.775$</td>
<td>$0.778$</td>
<td>$(0.763, 0.794)$</td>
<td>$0.854$</td>
<td>$0.860$</td>
<td>$(0.844, 0.877)$</td>
</tr>
<tr>
<td>$(\text{truncation at } 0.05)$</td>
<td>$0.881$</td>
<td>$0.890$</td>
<td>$(0.875, 0.906)$</td>
<td>$0.883$</td>
<td>$0.894$</td>
<td>$(0.877, 0.910)$</td>
</tr>
<tr>
<td>$(\text{truncation at } 0.25)$</td>
<td>$0.960$</td>
<td>$0.959$</td>
<td>$(0.948, 0.970)$</td>
<td>$0.961$</td>
<td>$0.964$</td>
<td>$(0.953, 0.972)$</td>
</tr>
</tbody>
</table>

*Measures derived from parameter estimates of the cost frontiers.
frontiers using the bootstrap technique and the confidence intervals. Boot- strapped 95% confidence intervals for means of efficiency are defined from a sampling distribution obtained through repeated sampling (with replacement) of the set of banks belonging to each frontier sample.

Results show that, on average, French and Spanish banks are equally efficient in their respective countries. This average efficiency level is around 88% over the 1988–1992 period. However, the results in Table 3 cannot be used to compare differences in efficiency between France and Spain, because each country has a different frontier. Therefore, to make banking efficiency scores across countries comparable, we have to measure efficiency relative to a common frontier.

For our international efficiency comparison, we first defined the common frontier based on the traditional approach (i.e., without taking into account specific environmental conditions in each country). That is, a common frontier is built by pooling the data set of French and Spanish banks and estimating a cost frontier with three banking outputs and three banking inputs. Table 4 reports results for the average efficiency level for each country by using this traditional common frontier. France has a higher average efficiency level (around 58%) and Spain’s efficiency level is very low (around 9%), again at the 5% level of truncation.

Overall, the results show that average efficiency levels for each country are lower than the results obtained from the national frontiers. So far, the results

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Table 4

<table>
<thead>
<tr>
<th>X-efficiency scores</th>
<th>France</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Measures</td>
<td>Bootstrap estimates (means)</td>
</tr>
<tr>
<td>X-EFF (truncation at 0.01)</td>
<td>0.478</td>
<td>0.487</td>
</tr>
<tr>
<td>X-EFF (truncation at 0.05)</td>
<td>0.581</td>
<td>0.594</td>
</tr>
<tr>
<td>X-EFF (truncation at 0.25)</td>
<td>0.772</td>
<td>0.760</td>
</tr>
</tbody>
</table>

* Measures derived from parameter estimates of the cost frontiers.

---

13 The bootstrap exercise confirms the value coming from the estimated parameters of the cost frontiers.
confirm our presumption that if the country-specific variables are an important factor in explaining efficiency differences, then the common frontier estimates neglecting this factor generate too much inefficiency. For example, our study of the country-specific conditions in Table 2 showed that, on average, the environmental conditions in France were more favorable than in Spain. This fact could partly explain the observed differences in efficiency between French and Spanish banks showed in Table 4.

To properly define a common frontier, country-specific aspects of the banking technology and differences in environmental and regulatory conditions should be accounted for. This procedure allows us to check whether or not the wide differences in efficiency levels using a common frontier without environmental variables (Table 4) is due to a misspecification of the frontier. To define this common frontier, we first select the correct set of environmental variables.

As pointed out in Section 3, we define two separate cost frontiers – one for France, the other for Spain – with the country-specific environmental variables and verify which variables are significant. Then, we impose cross-equation equality restrictions on the parameters of each country’s cost frontier, except for the parameters of the country-specific environmental variables. We started with a set of 18 environmental variables. In the final analysis, only seven were significant. Three of these variables belong to the main condition group: population density, per capita income, and density of demand. Three other variables describe the structure of the industry: degree of concentration, average capital ratio and intermediation ratio. The accessibility of services is measured by the number of branches per square kilometer. The cross-equation equality restrictions on the technology parameters were not rejected when this set of seven environmental variables is used. This means these variables aid to explain the differences in banking costs between countries. This set also allows to identify the underlying common banking technology in the banking industries of France and Spain. When these environmental variables were introduced in the separate cost functions of each country and cross-equation equality restrictions on each country’s cost frontier parameter were imposed, we verified that most of these restrictions appeared insignificant. This means that we likely identified the correct set of country-specific environmental variables, but also the common underlying technology of both countries.

Once the environmental variables have been identified, the efficiency of banks in each country can be measured. Therefore, a common cost frontier is estimated, holding the selected country-specific environmental variables constant at their mean values for each country. Results are shown in Table 5. Two results are noteworthy: First, the French banks are on average more efficient than the Spanish banks. While the French banking industry reached an average efficiency score of around 88%, the Spanish banking industry score is around 75%. Second, comparing the results of Tables 4 and 5 show that the average
efficiency levels improve markedly in each country. Moreover, the less favorable the country-specific conditions the greater the improvement in average efficiency scores. Therefore, these findings confirm our belief that the environmental variables are an important factor in explaining differences in international banking efficiency. Also, comparing our results from the common frontier with environmental variables (Table 5) with the results obtained from the national frontier (Table 3), the efficiency estimates for France are nearly identical. This is further evidence that our method has successfully neutralized the environmental differences between both countries.

As pointed out before, the significance of our efficiency level estimates is illustrated using a procedure devised by Atkinson and Wilson (1995) and the results obtained from every frontier (separate cost frontiers, common cost frontier without and with environmental variables) appear to be statistically significant.

In general, the influence of the environmental variables is in line with our expectations (Table 6). All of the coefficients on the environmental variables in the estimation of the cost function are significant at the 1% confidence level. This demonstrates the contribution of the variables to the estimation. First, consider the role of the “main conditions”. Contrary to expectations, the coefficient of the population density variable has a positive sign. Higher density contributes to an increase in banking costs, instead of the expected decrease in costs. One reason can be found in the characteristics of banking competition. In particular, if banks compete by opening more branches for strategic reasons this creates excessive bank operating costs. Moreover, in this form of non-price competition banks also open branches in large cities where real estate is more

<table>
<thead>
<tr>
<th>$X$-efficiency scores</th>
<th>France</th>
<th>Bootstrap estimates (means)</th>
<th>Bootstrap 95% confidence intervals</th>
<th>Spain</th>
<th>Bootstrap estimates (means)</th>
<th>Bootstrap 95% confidence intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X$-EFF (truncation at 0.01)</td>
<td>0.779</td>
<td>0.775</td>
<td>(0.756, 0.793)</td>
<td>0.647</td>
<td>0.643</td>
<td>(0.626, 0.660)</td>
</tr>
<tr>
<td>$X$-EFF (truncation at 0.05)</td>
<td>0.888</td>
<td>0.893</td>
<td>(0.879, 0.908)</td>
<td>0.748</td>
<td>0.753</td>
<td>(0.739, 0.768)</td>
</tr>
<tr>
<td>$X$-EFF (truncation at 0.25)</td>
<td>0.969</td>
<td>0.973</td>
<td>(0.961, 0.985)</td>
<td>0.884</td>
<td>0.888</td>
<td>(0.877, 0.900)</td>
</tr>
</tbody>
</table>
expensive and salaries are higher. Per capita income is also positive, indicating that the more developed the economy, the higher the operating and financial cost banks incur when supplying a given level of services. The density of demand has a negative sign. It is indeed more costly to satisfy a less concentrated demand for banking services, because that demand is less informed and more dispersed.

Second, the variables describing the structure and competition of the domestic banking industry are discussed. Observe that banking costs increase with the degree of imperfection in banking competition. In particular, the coefficient of the Herfindhal index has a positive sign. If this index is indeed a measure of market power, the positive sign indicates that a higher market power induces banks to spend more on staff or on other personal expenses. The intermediation ratio variable has a negative coefficient. A higher amount of loans per unit of deposits thus decreases banking costs. Finally, the capital ratio has a negative sign. It is less costly for banks with more capital to provide banking services. As mentioned earlier, one explanation could be the existence of a negative relationship between bank risk and borrowing costs.

Third, the accessibility of banking products for the customers has a positive sign. Thus, the lower the density of bank branches, the lower are the banking costs.

Given the evidence found that the environmental variables accurately seem to explain most of the differences in international banking efficiency, knowledge of their particular influence on such differences could be important to predict cross-border competition. A first approximation in this sense could be to investigate which of the environmental variables is explaining the greatest difference in efficiency levels found between the results obtained from a common frontier with and without environmental variables, between Spanish and French banks. The number of branches per square kilometer, followed by density of demand (or deposits per square kilometer), are the environmental variables that are expected to have an influence on the banking costs. The expected and observed influence of these environmental variables on banking costs is shown in Table 6.

Table 6
The expected and observed influence of the environmental variables on the banking costs

<table>
<thead>
<tr>
<th>Main indicators</th>
<th>Structure and competition of the banking industry</th>
<th>Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density of population</td>
<td>Income per capita</td>
<td>Density of demand</td>
</tr>
<tr>
<td>Expected</td>
<td>–</td>
<td>+</td>
</tr>
<tr>
<td>Observed</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Countrya</td>
<td>France</td>
<td>France</td>
</tr>
</tbody>
</table>

a Country where the level of the indicator is the highest.
variables that play the most important role in such an explanation. However, the number of branches per square kilometer could reveal the role of imperfections in the competitive process. So, if it is true that a less competitive industry tends to increase costs, it is difficult to identify which of the two banking industries is the less competitive. Nevertheless, this finding could be used to make some assertion in terms of cross-border competition predictions. That is, this finding may be suggesting that a French bank entering the Spanish banking market (or vice versa) will be unable to alter the environment it faces and so will have to accommodate to the different environment. That is, banks entering each other’s market will likely have to make important adjustments in their behavior or structure in order to compete effectively with domestic banks.

6. Conclusion

We have undertaken a systematic comparison of efficiency measures across countries taking into account environmental variables in the definition of the common frontier. A new methodology based on parametric DFA reveals the importance of environmental variables in explaining the differences in cost efficiency levels between French and Spanish banks.

Our results show that when the common frontier is defined without environmental variables, the cost-efficiency scores of Spanish banks are quite low compared to French banks. Looking at specific-environmental conditions, we found that this result is mainly due to the differences in the environmental conditions in which banks perform services. So, when environmental variables are included in the common frontier the differences in efficiency are significantly reduced. Therefore, we corroborate our hypothesis that neglecting these variables leads to an important misspecification of the common frontier and overestimates inefficiency. Moreover, an important subset of environmental variables included in the specification of the cost function had a significant influence on banking costs and efficiency scores. In particular, the number of branches per square kilometer, followed by density of demand, are the two environmental variables helping to explain the greatest reduction in efficiency differences between Spanish and French banks models with and without environmental variables. This finding suggests that in terms of cross-border

\[ r \approx -0.61 \] so there is no high correlation involved in these variables.

\[ \text{It is possible to expect that if all bank branches had the same level of deposits then the measure of demand density used would be perfectly correlated with the number of branches per square kilometers. However, since they are both statistically significant in the model they are not perfectly correlated. Indeed, calculating the correlation coefficient between these two variables gave an } r \text{ of } -0.61 \text{ so there is no high correlation involved in these variables.} \]
competition banks entering each other’s market seem to have to accommodate to the different environment. That is, entry banks apparently will have to make important adjustments in their behavior or structure in order to compete effectively with domestic banks as the environment they are facing is beyond their immediate ability to change.

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