EFFICIENCY AND COST DIFFERENCES ACROSS COUNTRIES IN A UNIFIED EUROPEAN BANKING MARKET

J.A. Bikker

Abstract

The efficiency of European banks is crucial in the light of the current and expected increase in competition. This paper seeks to discover the level and spread of bank efficiency in Europe. In particular, it focuses on differences across countries, various sizes of banks (reflecting several market segments), various banking categories and over time. It considers two related but diverging dimensions of efficiency. X-efficiency measures managerial ability, whereas cost level differences reflect national economic and institutional conditions with respect to supervisory rules, government interference, customer preferences and level of development. Cost levels of banks in Luxembourg appear to be 20% below the European average and cost levels in Spain and Greece are, respectively, 25% and 35% higher. The X-inefficiency results are similar, be it that the spread is somewhat less. Large banks are twice as inefficient as small banks; apparently, shortcomings in managerial ability are manifested earlier in large financial institutions. Inefficiencies in 1997 are nearly 45% lower than in 1990; evidently, over time, deregulation, liberalisation and ongoing financial and monetary integration in the EU have increased competitive pressures and enforced European banks to operate more economically. The analysis provides evidence that X-efficiency estimates from single-country studies, as often found in the literature, can be very misleading. The large spread in inefficiencies and cost levels indicates that the process of scaling up and rationalisation to be prepared for increased foreign competition, is for at least part of the banks only still in its early stage.

1 Section Banking and Supervisory Strategies, Directorate Supervision, De Nederlandsche Bank, PO Box 98, NL-1000 AB Amsterdam, the Netherlands (email: j.a.bikker@dnb.nl). The views expressed in this paper are personally and do not necessarily reflect those of De Nederlandsche Bank. The author is grateful to Miriam Holman-Rijken for excellent research assistance.
EFFICIENCY AND COST DIFFERENCES ACROSS COUNTRIES IN A UNIFIED EUROPEAN BANKING MARKET

J.A. Bikker

1 INTRODUCTION

The banking industry is exposed to a multitude of new developments and challenges. Deregulation, liberalisation, information technology and the entry of new types of competitors have contributed to internationalisation of the existing capital markets and to the developments of new markets of sophisticated financial instruments. The benefits to operate on a larger scale have brought about a wave of mergers. The banking scenery changes even more radically in Europe, where the introduction of the 'European passport' (the EU-wide banking permission) in 1992 and the single currency (for EMU countries) in 1999 has removed institutional obstacles for banks to operate in other EU countries.

This changing banking environment focuses attention on the competitive conditions in Europe and on the viability of its - until recently - sheltered banks. After all, for long, domestic banks have enjoyed comparative advantages on the domestic markets for bonds and equity in the field of underwriting and trading activities based on the existence of national currencies. Nowadays, in particular after the constitution of the euro, the efficiency of European banks will become more and more crucial in the light of the current and expected increase in competition, which emerges in particular in the wholesale market segment. Less efficient banks run the risk to be driven from the market. Efficiency is also a decisive element in the game of mergers and take-overs, where inefficient banks are an easy and sought-after target.

This paper seeks to discover the level and spread of bank efficiency in Europe. In particular, it focuses on differences across countries, various sizes of banks, various banking categories and over time. Furthermore, it considers two related but diverging dimensions of efficiency. Differences between countries are contemplated too, as the national discrepancies in terms of institutions, supervisory rules, government interference, customer preferences and level of development may contribute in explaining differences in efficiency. For the European nations, the degree of inefficiency of their banks is vitally important for public policy with respect to the viability of its banking industry in the near future, including the outline and application of antitrust policies. Furthermore, they have to face the consequences of further consolidation and rationalisation in their banking sectors.

Differences between bank sizes may be important, as banks do not operate on one banking market. Large, international banks concentrate activities on international (wholesale) markets, whereas small,
national banks conduct their business mainly at local (retail) markets. Competitive conditions and the need to reduce cost and to increase efficiency may strongly vary between these markets. As banking data do fall short to distinguish precisely between the various markets, in this paper the size of banks is used in order to capture these differences by approximation. Differences between banking categories are important too, as activities of diverging bank types can be quite dissimilar and should not be ignored. Neglecting the impact of sizes and categories can lead to biased result, if for some countries sizes and categories are distributed deviantly. Finally, movements of efficiency over time are interesting as the banking landscape is subject to many shocks enforcing the need for further improvement of efficiency.

Many definitions of efficiency exist. Nowadays, X-efficiency, that is the managerial ability to decide on input and output in order to minimise cost (or maximise revenues), is seen as the most important type of efficiency. Apart from X-efficiency, this paper also considers differences in cost levels controlled for input prices and types of activities, which reflect diversion of national conditions banks are facing. Cost differences between countries can be seen as indicators of national inefficiencies, due to country-specific circumstances for banks, as mentioned above. In principle, managerial (in)ability and country-specific obstacles for banks can reflect mutual independent features of (in)efficiency. In practice, they may overlap in part, when differences in national conditions affect the measurement of X-efficiencies (that is when unfavourable conditions are mistaken for X-inefficiency) and when differences in average managerial abilities between countries exist (and then are mixed up with cost differences).

The literature is a treasure of country studies on efficiency in the banking industry. Studies on international comparison of efficiency, on the other hand, are rare. Actually, such an international comparison is really a heroic attempt, as the differences in banking behaviour and economic and institutional conditions between countries are huge. As activities of banks diverge strongly and as part of these activities are very complicated, it is even for one country quite a task to capture bank behaviour by one model. Moreover, international comparisons are easily distorted by national differences in distribution of banks over sizes and categories, as shown in this study. On the other hand, it can easily be proven that single-country studies are totally unsuitable for international comparisons and provide misleading results. X-efficiency of a bank is commonly measured as its cost level compared to that of the best-practise banks of similar size (the so-called frontier), controlled for its types of banking activities and the input prices it faces. It can be shown that the performance of best-practise banks strongly diverges between countries. Hence, for an international comparison of X-efficiency, one needs to compare efficiency of banks with the European best practise banks, and not with those of the separate countries.
The organisation of this paper is as follows. Section 2 is of a methodological nature and introduces the translog multiproduct cost model, which is used to estimate cost level differences, and the stochastic cost frontier approach which is applied to determine X-inefficiencies. Section 3 discusses the model specification, the employed data and econometric tests regarding to specification choices. Section 4 presents European wide empirical results for efficiency and cost level differences. Section 5 examines the impact of bank size on efficiency and cost levels differences, whereas Section 6 provides a similar analysis with respect to bank type categories. Section 7 investigates changes in efficiency and cost level differences over time. The final section summarises and draws conclusions.

2. METHODOLOGY

This paper seeks to measure two dimensions of efficiency of banks: X-efficiency, the managerial ability to decide on input and output in order to minimise cost, and national inefficiencies or differences in cost levels, reflecting national economic and institutional banking conditions. Cost differences are based on the translog cost function and X-inefficiencies on the stochastic cost frontier model, which is an extension of the former model. This section describes these models and explains their economic background.

2.1 Differences in bank cost levels

The measurement and analysis of differences in bank cost levels is based on the assumption that the technology of an individual bank can be described by a production function, which links the various types of banking output to input factors. Under proper conditions, a dual cost function can be derived, with output levels and factor prices as arguments. In line with most of the literature, this paper uses the translog multiproduct function to describe costs. This translog cost function (TCF) is a flexible functional form and has proven to be an effective tool for empirical assessment of efficiency. The TCF reads as:

\[
c_{it} = \alpha + \sum_j \beta_j x_{ijt} + \sum_j \sum_k \gamma_{jk} x_{ijt} x_{ikt} + v_{it}
\]

2 Most econometric models on efficiency of banks focus on cost efficiency (Berger and Humphrey, 1997). These models take the input prices and the level of output (components) as given. Alternative concepts are (standard) profit efficiency, which takes input prices and output prices as given, and alternative profit efficiency, which has the same explanatory variables as the cost function. Each efficiency concept adds some independent informational value (Berger and Mester, 1997). As profit can take a negative value, the models for profit efficiency, having a logarithm nature, are less satisfactory. In any case, in line with most of the literature, this paper concentrates on cost efficiency.

3 See for an overview, Berger and Humphrey (1997).
The dependent variable $c_{it}$ is the logarithm of the cost of production of the $i$-th firm ($i=1, \ldots,N$) in year $t$ ($t=1, \ldots,T$). The explanatory variables $x_{ijt}$ consist of output or output components and input prices. The two sum terms constitute the multiproduct translog cost function: the linear terms on the one hand, and the squares and cross-terms on the other, each accompanied by the unknown parameters $\beta_j$ and $\gamma_{jk}$, respectively. The last element of equation (1), $v_{it}$, is the error term which accounts for random effects due to the model specification.

The appropriate definition of output in banking has often been a topic of discussion. The *intermediation* approach and the *production* approach are the two main streams in this respect. The former assumes that a bank attracts deposits and other funds and transforms these into loans and investment in securities, using inputs such as labour, capital and materials. Interest payments are seen as part of the costs and the corresponding dual cost function does not include deposits as an input factor, but the interest rate paid on deposits. Loans and investment are the output components. The latter approach assumes that a bank provides services related to loans and deposits. In this view, interest payments are not regarded as banking costs. The output components consist of loans and deposits. Operating costs appear to contain the bulk of cost inefficiency at banks, hence, in line with most of the literature, the production approach has been adopted in this paper.

Apart from loans, both savings accounts and demand deposits are distinguished as production factors, each with its own kind of services. The number of branches as an indicator of additional service of a bank to its clients could also be seen as a production factor, but the limited availability of data forms a hindrance. To an increasing extent banks provide non-traditional services, such as trade in securities, asset management and investment funds for clients, trade on its own account, derivatives, guarantees and credit lines, securitisation, and equity and bond emissions. This type of production is hardly or not related to balance-sheet items, whereas other public information about the volume of these services for individual banks is not available. Following e.g. Resti (1997) and Berger and DeYoung (1997), this paper approximates this kind of off-balance sheet output by 'other (non-interest) income'. Two kinds of factor prices are included in the TCF, namely wages and the price of physical capital. The TCF can be used to estimate cost differences across countries or banking categories or over time, by adding dummy variables for countries, banking categories or years.

### 2.2 X-inefficiency

Two components of efficiency can be distinguished: *technical efficiency*, the ability to obtain maximum output from a given set of inputs, and *allocative efficiency*, the skill to use the inputs in optimal proportions, given their respective prices and the production technology (Farrell, 1957). These
two measures can be combined to provide a measure of total economic efficiency, or, when cost instead of production is considered, cost efficiency. Banks with lowest costs, controlled for volume of output and level of input prices, form the efficient frontier. Errors, lags between the choice of the production plan and its implementation, human inertia, distorted communications and uncertainty cause deviations from this efficient frontier of best-practise banks. These deviations reflect X-inefficiency \(^4\) (Leibenstein, 1966).

Various approaches are available to estimate X-inefficiency (see e.g. Lozano-Vivas, 1998). All methods involve determining an efficient frontier from minimal individual observations or sets of observations, rather than from some a priori known technologically-determined minima. Each method however uses different maintained assumptions and may result in diverging estimates of inefficiency. Berger and Humphrey (1997) report roughly an equal split between applications of non-parametric and parametric techniques. Non-parametric approaches such as data envelopment analysis (DEA) and free disposable hull (FDH) analysis have the practical advantage that no functional form needs to be specified. On the other hand, it also does not allow for specification errors, so that, if such errors do exist, it may be measured as inefficiency, raising the inefficiency estimate. The results of the DEA method are also sensitive to the number of constraints specified. A greater disadvantage of these techniques is that they generally ignore prices and can, therefore, account only for technical rather than economic inefficiency. Technical inefficiency does not correspond to the concept of cost efficiency.

One of the various parametric methods is the stochastic frontier approach, which assumes that the error term is composed of the sum of a specification error and an inefficiency term. These two components can be distinguished by one or more assumptions about the asymmetry of the distribution of the inefficiency term. Although such assumptions are not very restrictive, they are nevertheless criticised for being somewhat arbitrary. A flexible alternative for panel data is the distribution free approach, which avoids any assumption on the distribution of the inefficiency term, but supposes that the error term for each bank over time is (close to) zero. The average predicted error of a bank is its estimate for inefficiency. The assumption of - on average - zero errors for each bank is a very strong one, and, hence, a drawback of this approach. Moreover, shifts in time are not identified. Finally, the thick frontier method does not compare single banks with the best-practise banks on the frontier, but produces an inefficiency measure for the whole sample. Banks on or close to the frontier, the 25% of the banks with the lowest costs, are used to estimate a 'thick' frontier. A similar procedure is used for the 25% banks with the highest cost. The interquantile range between these two is taken as inefficiency. This approach avoids the influence of outliers, but, on the other hand, assumes that all errors of the first quantile reflect only specification errors and not inefficiency. All approaches have

\(^4\) For the sake of presentation, further on, efficiency and its complement inefficiency will be used alternately, and the prefix X will be dropped where possible.
pros and cons. All in all, the stochastic frontier approach, which has been applied widely, is selected as - in principle - being the most unbiased one. Berger and Mester (1997) have found that the efficiency estimates are fairly robust to differences in methodology, which, fortunately, makes the choice of efficiency measurement approach less crucial.

The stochastic cost frontier (SCF) model elaborates on the TCF. It contains an error term consisting of two components, one to account for random effects due to the model specification and another to account for X-inefficiencies:

\[
c_{it} = \alpha + j \beta_j x_{ijt} + j k \gamma_{jk} x_{ijt} x_{ikt} + v_{it} + u_{it} \tag{2}
\]

The \(v_{it}\)s are the specification errors of the TCF, which are assumed to be identically and independently \(N(0, \sigma_v^2)\) distributed and the \(u_{it}\)s are non-negative random variables, which describe cost inefficiency and are assumed to be identically and independently half-normally (|\(N(0, \sigma_u^2)\)|) distributed and independent from the \(v_{it}\)s. In other words, the density function of the \(u_{it}\)s is (twice) the positive half of the normal density function. The truncated-normal, gamma and exponential distributions are more general alternatives to describe \(u_{it}\).\(^5\) The exponential and the half-normal distributions assume that the density of observations of \(u_{it}\)s is highest at the frontier and declines gradually when moving away from the frontier, whereas the gamma distribution presupposes that the density of observations at first gradually increases when moving away from the frontier. In the following, the more general truncated normal distribution \(N(\mu, \sigma_v^2)\), with zero as truncation point, has been applied, which provides a rich family of distributions, dependent on the parameters \(\mu\) and \(\sigma_v^2\), and causes less technical problems than the gamma and exponential distributions. The cost inefficiency term can be constant over time for each bank (\(u_{it} = u_i\) for all \(t\)), as is assumed in the mayor part of this paper, depend on time in a structural way (\(u_{it} = u_i f(t)\)), as in Section 7, or be fully unrestricted.

Cost efficiency of a bank relative to the cost frontier estimated by model (2) is calculated as follows. As \(c_{it}\) is expressed in logarithms, costs are defined as \(C_{it} = \exp(c_{it})\), where 'exp' refers to the exponential function. X refers to the matrix containing the explanatory variables. Cost efficiency is defined as:\(^6\)

\[
\text{EFF}_{it} = E(C_{it} | u_{it} = 0, X) / E(C_{it} | u_{it}, X) = 1/\exp(u_{it}) \tag{3}
\]

---

\(^5\) See Coelli et al. (1998) for a more comprehensive discussion of this issue.

\(^6\) This expression relies upon the predicted value of the unobservable \(u_{it}\), which can be calculated from expectations of \(u_{it}\) conditional upon the observed values of \(v_{it} + u_{it}\) (see Battese and Coelli 1992, 1993, 1995).
In other words, efficiency is the ratio of expected costs on the frontier (that is the case where the production would be completely efficient, or \( u_{it} = 0 \)) and expected costs, conditional upon the observed degree of inefficiency. Nominator and denominator are both conditional upon \( X \), the given level of output components and input prices. Values of \( E_{it} \) range from 0 to 1. The inverse of \( E_{it} \) is inefficiency, \( \text{INEFF}_{it} = \exp(u_{it}) \), which is bounded between 1 and \( \infty \).

The SCF model encompasses the TCF, namely when the inefficiencies \( u_{it} \) can be ignored. A test on the restriction, which reduces the former to the latter, is available after reparameterisation of the model of equation (2) by replacing \( \sigma_v^2 \) and \( \sigma_u^2 \) by, respectively, \( \sigma^2 = \sigma_v^2 + \sigma_u^2 \) and \( \lambda = \sigma_u^2/(\sigma_v^2 + \sigma_u^2) \), see Battese and Corra (1977). The parameter \( \lambda \) can be employed to test whether a SCF model is essential at all. Acceptance of the null hypothesis \( \lambda = 0 \) would indicate that \( \sigma_u = 0 \) and hence that the term \( u_{it} \) should be removed from the model, so that equation (2) narrows down to the TCF of equation (1).

3. MODEL SPECIFICATION, DATA AND ECONOMETRIC ISSUES

For each bank, the translog cost model aims at linking the level of the multiproduct output and the prices of the input factors as good as possible to the total operating costs, exclusive of interest rate income. There is, of course, the trade-off between the advantage of more output factors, which allow a higher degree of accuracy in explaining costs, on the one hand, and the possible disadvantage of an increase in multicollinearity between these output factors, on the other. After examining the results of preliminary calculations, the output components loans, savings and demand deposits are taken, as well as other income as proxy of other services. Anyhow, for the US, Berger and Mester (1997) have found that functional form and choice of variables usually make fairly little difference in terms of either average efficiency or the ranking of individual banks.

The definitions of the variables are as follows: loans consist of commercial, consumer and mortgage loans, demand deposits include current accounts, savings is made up of savings accounts, saving deposits and time deposits, and non-interest income consists mainly of commission and revenues from financial transactions. For each bank, the wage rate is calculated as the ratio of total wages and the number of employees, whereas the price of capital is the ratio of 'other non-interest expenditure' and 'premises and fixed assets'. Both variables are rough approximations, as interbank differences in labour productivity and average working time are ignored, while 'other non-interest expenditure' is not quite proper as it includes outlay on information technology and materials. The balance item premises and fixed assets (PFA) may also be rather unreliable, due to book-keeping tricks, but, further on, a solution is proposed and applied to mitigate this problem.

\[ \text{Note that the } E(C_{it} | u_{it}, X) \text{ differs from actual costs, } C_{it}, \text{ due to } v_{it}. \]
To estimate inefficiency, the model has been applied to data on banks from the fifteen countries, which are nowadays Member State of the European Union, plus Switzerland, where many prominent banks have their seat. Austria is not represented in the sample, as for none of its banks the full required set of data was available. The sample of banks consists of all banking categories, such as enumerated in the lower part of Table 1, both in foreign and domestic hands, over the years 1990-1997, as far as included in the IBCA-Fitch database. Any bank-year combination, for which at least one of the dependent or explanatory variables is zero or missing, has been deleted from the sample. In particular, the absence of data on (one of) the two input prices reduced the sample. For Austria, data on demand deposits were lacking. This selection resulted in a sample of 2,563 banks and 6,358 bank-year observations.

Table 1 presents an overview of a few country-specific characteristics of the selected European banks. For most countries, in particular for part of the smaller ones, the banks in the sample are a limited subset of the banks occurring in the IBCA-Fitch database. This is the price to be paid for applying a more extensive model to explain costs. The trade-off between sample size and model accuracy will also be discussed in Section 3.1. On the other hand, for most of these countries, the remaining banks constitute a fairly large sample, which in most cases at least contains the larger banks. Results based on this sample still allow the drawing of clear conclusions. This does not hold for Finland, Ireland and Sweden, where the sample is too small.

Cost as share in the balance sheet total is an early indicator of efficiency, even though, of course, costs are explained in part by the output composition and input prices. The average cost level is high in Greece, Italy, Portugal and Spain, sometimes seen as countries with less efficient banks, but also in Switzerland and the UK, which are considered as countries with more advanced banks, and low in Belgium and Germany and, in particular, Luxembourg. Most banks in Luxembourg are branches of foreign banks with relatively little costs. Loans as share of total assets range from 20% in Belgium and Luxembourg to 67% in Ireland. The share of savings and demand deposits varies from 32% in Sweden to 77% in Greece. In most countries, the universal ‘commercial’ bank is the most widespread type. However, in Germany and Italy, most banks - and in France many banks - are of the cooperative category, which is hardly found in the other countries. In Germany and Italy a substantial share of banks is of the traditional ‘savings bank’ type; in Spain, in terms of numbers, it is even the

---

8 Zero values do not fit into a model of a logarithmic nature.
9 The fourth and fifth rows of Table 1 give the distribution of these numbers over the countries.
10 In Bikker (1999), the input prices have been dropped, which resulted in an abundance of available data (as data on wages and capital prices is a limiting factor), but a rather reduced explanatory model for costs.
11 Other assets such as securities or interbank loans are not included in the model as output components, because there are fewer costs involved. Moreover, we don’t see these activities as typical bank services.
12 In the Netherlands, there is only one cooperative bank (Rabobank), but with a large market share.
predominant banking category. Investment banks occur mainly in the Netherlands, the UK and Switzerland. Many of these differences between countries are due to institutional or regulatory reasons.

Table 1  
Country-specific characteristics of selected European banks

<table>
<thead>
<tr>
<th></th>
<th>Belgium</th>
<th>Denmark</th>
<th>Finland</th>
<th>France</th>
<th>Germany</th>
<th>Greece</th>
<th>Ireland</th>
<th>Italy</th>
<th>Luxembourg</th>
<th>Netherlands</th>
<th>Portugal</th>
<th>Spain</th>
<th>Sweden</th>
<th>Switzerland</th>
<th>UK</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBCA, 1990-97</td>
<td>number of banks</td>
<td>94</td>
<td>99</td>
<td>12</td>
<td>392</td>
<td>1,826</td>
<td>22</td>
<td>48</td>
<td>611</td>
<td>128</td>
<td>66</td>
<td>42</td>
<td>189</td>
<td>22</td>
<td>350</td>
<td>317</td>
</tr>
<tr>
<td></td>
<td>no. of banks sample</td>
<td>23</td>
<td>21</td>
<td>7</td>
<td>265</td>
<td>1,503</td>
<td>15</td>
<td>10</td>
<td>311</td>
<td>74</td>
<td>41</td>
<td>27</td>
<td>34</td>
<td>8</td>
<td>150</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>no. of observations</td>
<td>44</td>
<td>57</td>
<td>13</td>
<td>964</td>
<td>2,983</td>
<td>40</td>
<td>20</td>
<td>1,221</td>
<td>177</td>
<td>164</td>
<td>67</td>
<td>105</td>
<td>17</td>
<td>299</td>
<td>187</td>
</tr>
<tr>
<td>balance sheet total</td>
<td>0.77</td>
<td>0.32</td>
<td>0.21</td>
<td>3.14</td>
<td>8.13</td>
<td>0.08</td>
<td>0.13</td>
<td>2.26</td>
<td>0.61</td>
<td>1.60</td>
<td>0.35</td>
<td>0.95</td>
<td>0.60</td>
<td>0.53</td>
<td>3.45</td>
<td>23.14</td>
</tr>
</tbody>
</table>

|               | shares in balance sheet total (in %) | 1.2 | 2.0 | 2.1 | 1.3 | 2.9 | 1.8 | 2.8 | 0.6 | 2.0 | 2.3 | 2.4 | 1.6 | 2.1 | 2.3 | 2.0 |
|               | costs | 19.7 | 47.1 | 49.3 | 47.7 | 43.1 | 40.2 | 66.6 | 50.9 | 20.1 | 48.9 | 41.4 | 45.0 | 61.3 | 56.1 | 56.1 |
|               | savings | 51.1 | 26.6 | 23.6 | 35.1 | 30.5 | 70.2 | 39.5 | 20.7 | 31.4 | 24.7 | 44.9 | 39.9 | 5.9 | 25.5 | 27.1 | 30.0 |
|               | demand deposits | 8.3 | 24.8 | 25.8 | 10.5 | 8.2 | 6.6 | 26.3 | 24.5 | 9.2 | 26.5 | 16.5 | 9.1 | 26.2 | 29.3 | 30.2 |
|               | other income | 0.5 | 0.7 | 1.4 | 1.0 | 0.5 | 1.9 | 0.9 | 1.2 | 0.1 | 0.3 | 1.2 | 1.1 | 0.9 | 2.0 | 1.4 | 0.9 |

Table 1  
Country-specific characteristics of selected European banks

|               | shares in number of observations (in %) | 66 | 95 | 62 | 69 | 7 | 85 | 55 | 24 | 92 | 78 | 69 | 36 | 88 | 57 | 70 | 32 |
|               | commercial | 16 | 0 | 15 | 23 | 48 | 0 | 0 | 46 | 2 | 4 | 4 | 8 | 0 | 2 | 0 | 35 |
|               | cooperative | 2 | 5 | 15 | 5 | 43 | 0 | 10 | 26 | 1 | 1 | 13 | 52 | 12 | 7 | 1 | 27 |
|               | savings | 11 | 0 | 0 | 2 | 0 | 15 | 25 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 27 |
|               | real estate/mortg. | 5 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 4 | 1 | 0 | 2 | 2 | 1 |
|               | spec. gov. credit | 0 | 0 | 8 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 10 | 0 | 1 |
| OECD, 1997   | number of banks | 131 | 92 | 348 | 567 | 3,111 | 51 | 52 | 935 | 215 | 169 | 237 | 307 | 124 | 360 | 468 | 7,167 |
|               | id. per capita | 13 | 17 | 68 | 10 | 38 | 5 | 14 | 16 | 512 | 11 | 24 | 8 | 14 | 51 | 8 | 159 |
|               | id. excl. coop. b. | 131 | 92 | 54 | 440 | 691 | 44 | 52 | 283 | 215 | 169 | 67 | 210 | 124 | 360 | 468 | 3,400 |
|               | id. per capita | 13 | 17 | 51 | 8 | 8 | 4 | 14 | 5 | 512 | 11 | 7 | 5 | 14 | 51 | 8 | 9 |
|               | id. sample as % | 17 | 23 | 11 | 45 | 102 | 34 | 19 | 52 | 33 | 24 | 39 | 15 | 6 | 41 | 16 | 45 |
|               | no. of inhabitants | 10.2 | 5.3 | 5.1 | 58.4 | 81.9 | 10.5 | 3.6 | 57.4 | 0.4 | 15.5 | 9.9 | 39.3 | 8.8 | 7.1 | 58.8 | 372.2 |
|               | balance-sheet total | 1.42 | 0.34 | 0.22 | 4.26 | 7.91 | 0.24 | 0.40 | 3.08 | 1.06 | 1.94 | 0.43 | 1.59 | 0.49 | 2.15 | 7.27 | 32.79 |
|               | id. per capita | 140 | 64 | 43 | 73 | 97 | 22 | 110 | 54 | 2529 | 125 | 43 | 40 | 55 | 304 | 124 | 88 |
|               | id. sample as % | 54 | 96 | 93 | 74 | 103 | 35 | 34 | 73 | 57 | 82 | 82 | 60 | 123 | 25 | 48 | 71 |

The lower part of Table 1 presents figures from the OECD for the whole banking sector of each country. This allows a closer view on the relative size of our IBCA sample. The fifth row of the lower part of the table shows the number of banks of the sample as % of the OECD number, exclusive of the non-cooperative banks. Apart for Finland, Ireland and Sweden, as mentioned earlier, the sample used has a substantial volume in terms of number of banks, being, on average, half of the total. The last row gives the balance-sheet total of IBCA sample as % of the OECD balance-sheet total. For all countries, but Switzerland, our sample in terms of the balance sheet total is larger, being, on average, more than 70% of the total. For Switzerland, a few of the largest banks (among which UBS) are missing in our

13 The figures may be slightly distorted due to differences in definitions, as has happened for Germany. IBCA contains both national and international definitions of the banking categories. The OECD uses the former, where we use the latter to be able to make international comparisons.
sample, due to missing data. Hence, our sample contains a larger share of the bigger banks. Apparently, larger banks publish more data and earlier provide the data set employed in this paper. We conclude that our sample covers the larger part of the balance-sheet total of the banking industry.

The data may also provide some additional information on the national banking systems. Therefore, Table 1 presents numbers of banks and balance-sheet totals, both per capita. In this respect, Luxembourg, in particular, and Switzerland appear to be outliers. This is mainly because of the privileged position of banks in these countries with respect to attracting funding from foreigners, due to banking secrecy, the lack of tax on income from wealth for non-inhabitants and the stable currency. This phenomenon has resulted in many branches of foreign banks.

The number of banks, whether or not per capita, is at times said to reflect some aspects of the national history of banking evolution in terms of mergers and acquisitions. Germany is an example of a country with relatively many banks of, in part, limited size, reflecting a lagging position in the process of scaling up. For that and various other reasons, efficiency in part of the German banking industry is often seen as lower than in countries where mergers and acquisitions have already reduced the banking population. This may also hold for Finland and Portugal. On the other hand, a low number of banks such as in Greece may also indicate a less developed financial system. Probably, the balance-sheet total per inhabitant provides a better indication of banking development. Low values for Greece, Italy, Portugal and Spain and the Scandinavian countries may indicate a late development of banking and less efficient banks, where high values for Belgium, the Netherlands, Ireland and the UK could point to a more mature financial system.

Reliable simple indicators of efficiency are lacking. The cost-income ratio, the interest-rate margin, the labour-cost share and many other indices or ratio's, which are often used, fail as such, as have been proven by Bikker (1999). The balance sheet total per inhabitant may be an indicator of inefficiency, but its value as such has not yet been proven. In order to have a reference for the discussion on the empirical results in later sections, we present here a certain *communis opinio* on the ranking of the inefficiency of the countries’ banking sectors, based on direct observation, in-depth knowledge or, maybe, prejudice. This opinion states that banks in France, Germany and, in particular, Southern European countries, such as Greece, Italy, Portugal and Spain, are on average less efficient than banks in the other Western European countries. Arguments for the alleged diverging level of efficiency are more severe regulation by the supervisory authorities, interference by the local government in the Länder, which reduces competition, financial conservatism, low level of consolidation and extended net of branches (Germany), strong direct interference by the government (France and Italy) and lagging economic development (Greece, Spain, Portugal). In the Scandinavian countries, the process
of concentration has also been lagging. Banks in the UK are often seen as more advanced and enduring stronger competition. It remains to be seen how and to what extent these diverging national institutional and economic conditions affect inefficiency. Of course, in each country there may exist large differences in efficiency between, for instance, the major international banks and the small local banks. Furthermore, the banking industry is developing quickly, so that settled popular views may by now be superseded. It is obvious that a convincing empirical assessment of the efficiency of the banking sectors in the European countries would be highly welcome and the remainder of this paper indeed seeks to provide such a yardstick.

3.1 Model specification and econometric issues

The specification of the translog cost function, which also constitutes the SCF model, requires many choices. As mentioned above, loans, savings, demand deposits and other income (as proxy of other services) have been chosen as output components. A few other choices are discussed here in order to further justify the model, which is henceforth used in this paper. Table 2 presents the statistics that have contributed in selecting one of the various models considered, namely the logarithms of the likelihood (\(\ln L\)) for, respectively, the SCF model and the TCF, ditto per observation (\(\ln L/n\)) and the corresponding standard deviations. For the SCF model, the latter includes both the specification error and the inefficiency term. The likelihood per observation is included, as the number of observations is (slightly) different, when the loan/assets ratio is included as an additional variable. Of course, in theory, this distorts a statistical correct comparison, but in this case the difference can practically be disregarded. Apart from that, the more expanded models encompass the elementary ones.

According to economic theory, the models applied in this paper should include input prices. Data of the wage rate and price of capital are available, but the quality of the observed prices is rather poor. For each bank, the wage rate is calculated as the ratio of total wages and the number of employees, and the price of capital is proxied as the ratio of 'other non-interest expenditure' and 'premises and fixed assets'. Both variables are rough approximations, as interbank differences in labour productivity and average working time are ignored, while 'other non-interest expenditure' also includes outlay on information technology and materials. Moreover, the balance item premises and fixed assets (PFA) may be rather unreliable, due to bookkeeping operations. Nevertheless, notwithstanding these shortcomings in the data, none of the two considered input prices could be deleted, for neither the SCF nor the TCF: the likelihood falls significantly, when wages or capital prices are omitted (compare in Table 2 Columns 2 and 3 with Column 1). By far, the best result is obtained, when both input prices are included (Column 5).

---

14 For Luxembourg, its small population also affects the per capita ratios.
Table 2 Specifications of the SCF and TCF models

<table>
<thead>
<tr>
<th>Wages</th>
<th>Capital prices</th>
<th>Wages and capital prices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>corrected</td>
<td>corrected</td>
</tr>
<tr>
<td>incl.</td>
<td>loans/assets</td>
<td>restrict.</td>
</tr>
<tr>
<td>columns</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>n</td>
<td>6358</td>
<td>6358</td>
</tr>
<tr>
<td>Stochastic cost frontier (SCF)</td>
<td>ln $L$</td>
<td>-626.1</td>
</tr>
<tr>
<td></td>
<td>ln $L/n$</td>
<td>-0.098</td>
</tr>
<tr>
<td></td>
<td>$\sigma^2$</td>
<td>0.289</td>
</tr>
<tr>
<td>Translog cost function (TCF)</td>
<td>ln $L$</td>
<td>-2130</td>
</tr>
<tr>
<td></td>
<td>ln $L/n$</td>
<td>-0.335</td>
</tr>
<tr>
<td></td>
<td>$\sigma^2$</td>
<td>0.115</td>
</tr>
</tbody>
</table>

In order to correct for the alleged poor quality of PFA, we follow Resti (1997) in replacing the original data of this variable by the model values of the translog regression of PFA on costs (C) and total assets (TA): \(^{15}\)

$$\ln \text{PFA} = \alpha_0 + \alpha_1 \ln C + \alpha_2 \ln TA + \alpha_3 (\ln C)^2 + \alpha_4 (\ln TA)^2 + \alpha_5 \ln C \ln TA + \varepsilon$$

The adjusted $R^2$ of this equation is 0.835. This correction brings the bookkeeping values of PFA more in line with the size of the bank, proxied by costs and total assets. In general, the adjustments are small, but they are influential, as they avoid the values of PFA to be too close to zero, which has a major affect on the ratio of 'other non-interest expenditure' and PFA. The correction reduces the proportion between the 5th and 95th percentile of capital prices from 13.1 to 2.4, the latter proportion being much more plausible than the former. The correction increases the logarithm of the likelihood of the SCF model by 61 points, or when wages are also included, 94 points (compare, respectively, Columns 3 and 4, with 5 and 6). In the latter case, the logarithm of the likelihood of the TCF improves also by 28 points. In the remainder of this paper we use corrected instead of original data of capital prices.

The relation between efficiency and the risk involved by the bank's asset behaviour is usually ignored in the literature on efficiency in the banking industry. In general, banks which extend more risky loans will also incur additional costs in monitoring borrowers and, for instance, employ more skilled labour and use advanced computer programming to manage these risks (see Diamond, 1984). Hence, higher risk goes with additional operating costs. Ruthenberg and Elias (1996) discuss three available risk variables and find that the ratio of loans to total assets (L/A) is the most appropriate for European

\(^{15}\) For all countries, the series are expressed in one currency, namely Deutsche Mark.
banks. Inclusion of this risk measure indeed improves the models tremendously in terms of increase of the logarithm of the likelihood (around 500 points, see Column 7).\footnote{The sample reduces by 8 to 6350 observations and by 5 to 2558 banks, due to a few missing observations of the variable L/A.} Hence, this risk variable is maintained in the remainder of this paper.

Two standard properties of costs functions are linear homogeneity in the input prices and cost-exhaustion (Jorgenson, 1986). They imply the following restrictions on the parameters, assuming - without loss of generality - that the index \( j \) in equation (1) is 1 and 2, respectively, for wages and capital prices:

\[
\beta_1 + \beta_2 = 1, \quad \gamma_{11} + \gamma_{12} = \gamma_{21} + \gamma_{22} = 0, \quad \text{and} \quad \gamma_{k,1} + \gamma_{k,2} = 0 \quad \text{for} \quad k = 3, ..., 7 \tag{5}
\]

The index \( k \) refers to output components and other explanatory variables, such as the risk variable. The first restriction stems from cost exhaustion, which reflect that the sum of cost shares is equal to unity. In other words, the value of the two inputs is equal to total cost. Linear homogeneity in the input prices requires that cost shares and cost flexibility are homogeneous of degree zero in the input prices, see Jorgenson (1986). This is reflected in the second and third sets of the restrictions in (3). These eight restrictions reduce the logarithm of the likelihood of the SCF by 8.6 points. According to the likelihood ratio test, which as a matter of fact holds only asymptotically, these restrictions would be rejected at the 5% significance level but accepted at the 2.5% level.\footnote{At the 5% significance level, two times the difference in the logarithms of the likelihood is larger than the critical value of the chi-square distribution: \( 2 \times 8.6 = 17.2 > 15.5 = \chi^2_{0.05}(8) \), but at the 2.5% level it is smaller, so that the restrictions can not be rejected \( (\chi^2_{0.025}(8)=17.5) \). Actually, the loglikelihood ratio test statistic has a mixed \( \chi^2 \) distribution, see Lee (1993).} However, it is well known that restrictions tend to be rejected when the sample size increases. This holds in particular in this case, where the inaccuracy of the data prevents exact fulfilment of the restrictions. Based on economic theory as well as the 'nearby fulfilment' of the restrictions, henceforth price homogeneity and cost exhaustion has been imposed. This is equivalent to rewriting cost and prices using one of the prices as a numerary, by which the number of parameters drops from 35 to 27.

Hence the model in the far-left column of Table 2 is selected for the next analysis.

4. MEASUREMENT OF EFFICIENCY

As a first step to assess banking efficiency in Europe and to establish efficiency differences across countries, the SCF model has been applied to all banks. For each country, the level of efficiency has been calculated as an average across its banks (Table 3). For Finland, Ireland and Sweden, these numbers may be less reliable, as they are based on less than 20 observations, and even, as a matter of
fact, on fewer banks. Therefore, in the following discussions we ignore the outcomes for these three countries and, to indicate that, show their results in Tables 3 and 4 as shaded.

<table>
<thead>
<tr>
<th>Countries</th>
<th>Number of observations</th>
<th>Standard SCF</th>
<th>Ranking</th>
<th>Extended SCF</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>44</td>
<td>0.521</td>
<td>14</td>
<td>0.484</td>
<td>14</td>
</tr>
<tr>
<td>Denmark</td>
<td>57</td>
<td>0.597</td>
<td>9</td>
<td>0.543</td>
<td>13</td>
</tr>
<tr>
<td>Finland</td>
<td>13</td>
<td>0.690</td>
<td>5</td>
<td>0.677</td>
<td>5</td>
</tr>
<tr>
<td>France</td>
<td>964</td>
<td>0.568</td>
<td>12</td>
<td>0.552</td>
<td>12</td>
</tr>
<tr>
<td>Germany</td>
<td>2,983</td>
<td>0.740</td>
<td>2</td>
<td>0.755</td>
<td>1</td>
</tr>
<tr>
<td>Greece</td>
<td>40</td>
<td>0.500</td>
<td>15</td>
<td>0.395</td>
<td>15</td>
</tr>
<tr>
<td>Ireland</td>
<td>20</td>
<td>0.798</td>
<td>1</td>
<td>0.697</td>
<td>4</td>
</tr>
<tr>
<td>Italy</td>
<td>1,221</td>
<td>0.578</td>
<td>11</td>
<td>0.601</td>
<td>10</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>177</td>
<td>0.738</td>
<td>3</td>
<td>0.717</td>
<td>2</td>
</tr>
<tr>
<td>Netherlands</td>
<td>164</td>
<td>0.641</td>
<td>8</td>
<td>0.623</td>
<td>8</td>
</tr>
<tr>
<td>Portugal</td>
<td>67</td>
<td>0.685</td>
<td>6</td>
<td>0.649</td>
<td>6</td>
</tr>
<tr>
<td>Spain</td>
<td>105</td>
<td>0.548</td>
<td>13</td>
<td>0.577</td>
<td>11</td>
</tr>
<tr>
<td>Sweden</td>
<td>17</td>
<td>0.590</td>
<td>10</td>
<td>0.617</td>
<td>9</td>
</tr>
<tr>
<td>Switzerland</td>
<td>299</td>
<td>0.731</td>
<td>4</td>
<td>0.705</td>
<td>3</td>
</tr>
<tr>
<td>UK</td>
<td>187</td>
<td>0.666</td>
<td>7</td>
<td>0.649</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weighted Avgs</th>
<th>0.690</th>
<th>0.696</th>
</tr>
</thead>
</table>

Explanation: 'Standard' is the stochastic cost frontier model and 'Extended' includes also dummy variables for banking categories. Shading refers to countries with a limited number of observations.

At the end of Section 2, a test has been described to compare the SCF as a model of the cost structure of banks with the TCF. The former appears to be superior as the hypothesis of the test, $\lambda = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$, is zero is rejected at the highest level of significance. Hence, efficiency differences are important to explain cost differences between banks.

The average efficiency in Europe is estimates at 69%. This implies that 31% of the costs could be avoided by improving efficiency. This loss is high compared to many studies, which indicate a loss of around 20%, as is found in particular for the US (Berger and Humphrey, 1997). As a matter of fact, the range of estimates is wide. Using one model for banks from so many countries may lead to overestimation of inefficiency, as the differences across countries may contribute to the heterogeneity of the sample Mester (1996).

These first results indicate that banks from Germany, Luxembourg, Switzerland and Portugal are amongst the most efficient ones, whereas, on average, banks of Greece, Belgium, Spain and France are least efficient. Banks from the UK, the Netherlands, Italy and Denmark take intermediate positions in these respects. Part of the results coincides with the common opinion expectations described above. Banks in Greece, Spain, France are often mentioned as being less efficient. Higher efficiency of banks
in Luxembourg and Switzerland are in line with expectations; they are in part due to special circumstances such as bank secrecy, zero tax rates for foreigners and a stable currency in their country, which makes it more easy to attract (foreign) money cheaply.\footnote{Moreover, international banks may have branches in these countries, in particular in Luxembourg, while costs may mainly weigh down on the mother bank in the home country, see also the low cost share of banks from Luxembourg in Table 1.}

Not all results are keeping with what is commonly believed (not to say that the latter is the truth). Germany is often seen as probably less efficient, but the efficiency estimates in Table 3 suggest the opposite. By the way, the favourable efficiency assessment for Germany is also supported by the low cost share in Table 1. Probably, the German efficiency estimate is strongly affected by the composition of the German banking sample in terms of categories, where, at least in numbers, savings and cooperative banks dominate the more common commercial banks. This will be investigated in more detail in Section 6. A first step, the extension of the standard model with dummies for the banking categories, to take possible differences in cost levels into account (as far as these differences are constant and not related to, for instance, the size of the explanatory variables), did not affect the ranking nor the leading position of Germany, see left columns of Table 3.

Actually, due to the low level of consolidation and the size of Germany, the German banks dominate the European-wide sample in numbers. The question may arise whether this German overrepresentation in any way has affected the results of Table 3. To investigate this further, Table A.1 in the Annex presents estimation results of three alternative samples, where the number of German observations (or banks) has strongly been reduced. The effects on both the efficiency estimates and the ranking are very limited, even in the sample where the number of German observations is reduced to less than one quarter (see, for instance, the correlations between the results of the various estimates). German banks remain to be among the most efficient ones. Hence, the overrepresentation of German banks has not distorted the results.

Other unexpected results may be that banks from the UK, on average, take an intermediate position only and that Belgian banks are among the least efficient ones. Probably, many would not expect Portugal among the more efficient countries. However, liberalisation and increased competition in the Portuguese banks during 1987 and 1992 and strong investment in information technology may have contributed to a substantial increase in efficiency.

Empirically, the SCF approach appears to be a superior tool to explain costs. However, this does not imply that this method is best in explaining differences in cost efficiencies across countries. Far that reason, the next section presents an alternative approach.
4.1 Differences in cost levels across Europe

The preceding section regards X-efficiency, that is the managerial ability to decide on input and output quantities in order to minimise cost. This section considers differences in cost levels, controlled for types of activities and input prices, which should reflect diverging national institutional and economic conditions banks are facing. Cost differences between countries can be interpreted as national inefficiencies, due to country-specific obstacles for banks. In principle, managerial (in)ability and country-specific obstacles for banks can reflect mutual independent features of (in)efficiency. In practice, they may overlap in part, when differences in national conditions affect the measurement of X-efficiencies (that is when unfavourable conditions are mistaken for X-inefficiency) or when differences in average managerial abilities between countries exist (and then are mixed up with cost differences). Differences between countries are measured by adding country dummies to equation (1).

### Table 4 European-wide estimates of cost effects using a translog cost model

<table>
<thead>
<tr>
<th>Countries</th>
<th>Standard TCF</th>
<th>Extended TCF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dummy coeff.</td>
<td>Cost effects</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.093 (1.6)</td>
<td>1.15</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.088 (2.0)</td>
<td>1.14</td>
</tr>
<tr>
<td>Finland</td>
<td>-0.214 (2.6)</td>
<td>0.84</td>
</tr>
<tr>
<td>France</td>
<td>0.114 (4.4)</td>
<td>1.17</td>
</tr>
<tr>
<td>Germany</td>
<td>-0.048 (1.9)</td>
<td>1.00</td>
</tr>
<tr>
<td>Greece</td>
<td>0.234 (3.9)</td>
<td>1.32</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.299 (4.4)</td>
<td>0.77</td>
</tr>
<tr>
<td>Italy</td>
<td>0.114 (4.4)</td>
<td>1.17</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>-0.240 (6.7)</td>
<td>0.82</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0</td>
<td>1.04</td>
</tr>
<tr>
<td>Portugal</td>
<td>-0.124 (2.8)</td>
<td>0.92</td>
</tr>
<tr>
<td>Spain</td>
<td>0.172 (4.5)</td>
<td>1.24</td>
</tr>
<tr>
<td>Sweden</td>
<td>-0.039 (0.5)</td>
<td>1.00</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.337 (10.1)</td>
<td>0.75</td>
</tr>
<tr>
<td>UK</td>
<td>-0.116 (3.6)</td>
<td>0.93</td>
</tr>
</tbody>
</table>

**Bank type categories**

| Commercial | 0 | 1.03 |
| Cooperative| 0.007 (0.6) | 1.04 |
| Savings   | 0.066 (5.0) | 1.10 |
| Investment| 0.175 (6.9) | 1.23 |
| M & L term| -0.355 (8.1) | 0.72 |
| Real Estate| 0.091 (2.4) | 1.13 |
| Spec. Gov. | -0.347 (9.2) | 0.73 |

σ^2_ols = 0.0797, \ R^2 = 0.969

A t-values between parenthesis; b Geometric mean for ‘cost effects’ is set at 1. Explanation: ‘Standard’ is the translog cost model and ‘Extended’ includes also dummy variables for banking categories. Shading refers to countries with a limited number of observations.

The first four columns of Table 4 presents the estimates of the relative cost levels of the countries considered. The high degree of fit of 97% indicates a satisfactory model performance. On the whole, the ranking of countries based on cost levels corresponds to that based on X-inefficiencies, which is
rather remarkable given the different underlying concepts. Apparently, these concepts show a certain degree of overlap or are tangled up. For some countries, however, this cost-based ranking is more in line with the 'common view' than the ranking based on inefficiency. According to the cost-related criterion, the German banks are no longer among the most efficient ones, their place in the 'top 4' being taken now by the British banks. Obviously, cost inefficiency in Germany is not attributable to weak managerial behaviour - indeed, X-efficiency is high - but due to institutional or economic conditions, which is in line with what is observed directly (severe regulation, interference by government, financial conservatism, etc.). The cost-based ranking of the Belgian banks is with an 8th position less humble than according to the X-efficiency ranking (11th). Evidently, in Belgium, managerial performance might be relatively weak, whereas the institutional or economic conditions with regard to costs are not far from the average European level.

The right hand columns of Table 4 repeat the analysis for a model, which takes the various banking categories into account using dummies. The results in terms of rankings are rather similar. The dummy estimates indicate that, on average, some specialised (medium and long-term credit institutions) or privileged (specialised government credit) banks have significant lower cost, where others (investment banks) have substantial higher cost.

This sections presented European-wide estimates of X-efficiency and cost level differences using a extended sample of banks of various size-classes and bank type categories and from many countries. Mester (1996) pointed out that the heterogeneity of such samples might affect the estimates, in particular, that they may cause overestimation of inefficiency. Besides, such an all-bank sample may distort the comparison across countries, when certain size-classes or bank type categories have deviating behaviour in terms of efficiency or costs and, in addition, are over- or underrepresented in certain countries. As explained above, single country studies would not make much sense (see also Bikker, 1999), and would not allow comparisons across countries. Therefore, in the next two sections, heterogeneity is reduced by examination of, respectively, separate size-classes and separate bank type categories. Note that a simultaneous analysis is impossible, as we can not split the sample in both size and bank type categories - the resulting samples would simply be too small.

5. THE IMPACT OF SIZE ON EFFICIENCY AND COST DIFFERENCES

In order to obtain more homogeneous samples, the SCF model has been applied to four bank-sizes classes, where the volume of total assets have been used to split the all-bank sample. The small-bank class have total assets of less than 500 million US$, the large-bank class have assets above 5 billion US$ and the two intermediate classes are split at 1250 million US$. The average efficiency estimates for countries are presented in Table 5. Of course, the split in size classes reduces the available number
of banks in each cell. Where less than 10 banks are involved, (light) shading indicates that the estimate of the country efficiency is based on a (too) small sample. Note that the estimation results themselves are based on large samples, and hence are steady, and that only the reliability of estimated country effects may suffer from the sometimes small (country-specific) samples. For the latter reason, we do not investigate the country effects in Table 5 in detail, but only draw general conclusions.

Table 5 Mean X-efficiency by country and by bank-size class

<table>
<thead>
<tr>
<th>Total assets</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
<th>Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500-&lt;1250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1250-&lt;5000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5000+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Belgium      | 0.88    | 0.51    | 0.26    | 0.35    | 0.44     |
| Denmark      | 0.57    | 0.57    | 0.51    | 0.24    | 0.48     |
| Finland      | 0.62    | 0.62    | 0.73    | 0.27    | 0.44     |
| France       | 0.64    | 0.59    | 0.44    | 0.37    | 0.49     |
| Germany      | 0.80    | 0.78    | 0.70    | 0.52    | 0.75     |
| Greece       | 0.57    | 0.50    | 0.20    | 0.15    | 0.37     |
| Ireland      | 0.79    | 0.79    | 0.69    | 0.53    | 0.67     |
| Italy        | 0.71    | 0.61    | 0.48    | 0.33    | 0.56     |
| Luxembourg   | 0.67    | 0.73    | 0.63    | 0.65    | 0.67     |
| Netherlands  | 0.63    | 0.83    | 0.63    | 0.45    | 0.59     |
| Portugal     | 0.57    | 0.79    | 0.58    | 0.31    | 0.49     |
| Spain        | 0.56    | 0.52    | 0.48    | 0.40    | 0.43     |
| Sweden       | 0.50    | 0.64    | 0.48    | 0.36    | 0.44     |
| Switzerland  | 0.77    | 0.72    | 0.61    | 0.46    | 0.68     |
| UK           | 0.76    | 0.74    | 0.50    | 0.28    | 0.53     |

Total: 0.77 915 0.73 725 0.61 689 0.42 437 0.66

Number of observations: 1910 1664 1581 1195

σ_mle: 0.138 0.196 0.474 1.459
σ_v: 0.888 0.912 0.979 0.994
σ_ols: 0.015 0.017 0.010 0.009
R^2: 0.874 0.787 0.825 0.941

Differences in efficiency between size classes appear to be substantial. Efficiency is high for the smallest banks at 76.8% and low for the largest banks at 41.5%. As larger banks are more difficult to manage, being more complex, it is no surprise that differences between strong and weak management increase with the size of the bank. An alternative explanation could be that small banks are more similar, whereas large banks constitute a less homogenous class, where the assumption of one common underlying frontier may cause overestimation of inefficiency (Mester 1996). However, remarkably enough, the results indicate that the translog cost function itself fits better for the larger banks (see, in Table 5, the lower values for σ_v, for the last two classes), in spite of the relatively more

19 In general, the number of observations is 2 or 3 times larger than the number of banks.
complex production structure of larger banks. This makes the alternative explanation less plausible, as - in a sense - a better fit implies similarity and not heterogeneity.

The limited reliability of country effects due to the small country-specific samples does not prevent a (rough) comparison of inefficiency levels across countries. For each country, the last columns in Table 5 presents, respectively, the weighted average of efficiencies over the four classes, its ranking and the ranking of the weighted average of rankings over the four classes, in short: weighted rankings. In principle, this weighted efficiency and its ranking are more precise than the results in Table 3, as they are based on more refined estimates (implying an own frontier for each class). For a number of countries, the ranking is somewhat different, but the general picture does not change substantially. An important issue is that, if the size distribution of banks over the classes within each country is not uniformly, a certain kind of systematic distortion may occurs, due to the correlation between inefficiency and bank size. The weighted rankings aims at avoiding this type of distortion. This is explained best using Spain, where 73% of the observed banks fall in the highest size class. As these large banks on average are estimated to be highly inefficient, Spain was ranked in the overall sample as a country with rather inefficient banks (13th in Table 3, 14th in Table 5). However, in terms of efficiency, the Spanish large banks perform well compared to other large banks, resulting in a favourable 6th ranking in Class 4, and also in the 'ranking of the weighted average of rankings over the four classes'. A similar major shift occurs also for Sweden, be it based on a much smaller sample.

We conclude that the bank-size class efficiency estimates for the countries considered are more accurate, as they use more homogeneous samples. Even more important is the weighted ranking, although it is a rather forced index, sensitive to the small country-specific samples, which nevertheless is able to correct for systematic distortion, if the bank-size distribution for certain countries deviates from the average one.

Table A.2 in the Annex presents a similar exercise for cost effects based on the application of the translog cost model for the various bank-size classes. The various cost functions fit very well, as indicated by high adjusted R²s; the goodness of fit is even the highest for the largest banks (0.95). Nonetheless, different from the SCF approach, residual errors increase with the bank size, so some heterogeneity exists even in this logarithmic specification. The weighted cost differences and the weighted ranking based on the four size classes (last column in Table A.2) are rather similar to the results based on the all-banks sample in Table 4. Exceptions are Belgium, with a 6th instead of 11th ranking, and Portugal with a 9th instead of a 5th ranking. These countries have mainly large banks and the more refined large-bank estimation results deviate from those of the all-bank sample. Here we do not find systematic distortions as observed with the inefficiency estimates above.
6. EFFICIENCY AND COST DIFFERENCES FOR VARIOUS BANK CATEGORIES

After examining separate size-classes, this section reduces heterogeneity by investigation of separate bank type categories. Our all-bank sample contains a wide diversity of bank categories. The assumption of one frontier for all these bank types may cause overestimation of inefficiency. Table 6 presents results of the application of the SCF model on the various categories. Efficiency estimates appear to vary strongly across categories. Cooperative banks form a category with mainly small and less complex banks where the estimated inefficiencies are small, on average 16% (Table A.3 in the Annex shows how the banking categories are allocated over the bank-size classes). Saving banks have limited inefficiencies too, on average 20%. Although these banks are often rather large, their structure is still less complex. Investment banks, 'other categories' (token together as the samples of the three other categories are too small to estimate a separate SCF model) and commercial banks are increasingly inefficient. Apparently, these categories consist still of too heterogeneous kind of banks. Note that the observed inefficiency differences across the various categories do clearly deviate from the cost level differences as estimated in Table 4. For instance, savings banks are efficient, but have higher costs than other bank types categories, whereas commercial banks are inefficient but deal with an average cost level. Here it is clear that efficiency and cost measure different phenomena.

Table 6 Mean X-efficiency by country and by bank categories (1990-1997)

<table>
<thead>
<tr>
<th>Country</th>
<th>Commercial</th>
<th>Cooperative</th>
<th>Savings</th>
<th>Investment</th>
<th>Other categor.</th>
<th>Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>0.252</td>
<td>0.916</td>
<td>0.372</td>
<td>0.710</td>
<td>0.347</td>
<td>0.375</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.278</td>
<td>0.895</td>
<td>0.688</td>
<td>0.559</td>
<td>0.305</td>
<td>0.384</td>
</tr>
<tr>
<td>Finland</td>
<td>0.336</td>
<td>0.802</td>
<td>0.759</td>
<td>0.536</td>
<td>0.423</td>
<td>0.430</td>
</tr>
<tr>
<td>France</td>
<td>0.330</td>
<td>0.762</td>
<td>0.825</td>
<td>0.387</td>
<td>0.483</td>
<td>0.492</td>
</tr>
<tr>
<td>Germany</td>
<td>0.388</td>
<td>0.855</td>
<td>0.685</td>
<td>0.370</td>
<td>0.799</td>
<td>0.666</td>
</tr>
<tr>
<td>Greece</td>
<td>0.265</td>
<td>0.666</td>
<td>0.740</td>
<td>0.189</td>
<td>0.255</td>
<td>0.270</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.519</td>
<td>0.794</td>
<td>0.801</td>
<td>0.330</td>
<td>0.520</td>
<td>0.530</td>
</tr>
<tr>
<td>Italy</td>
<td>0.244</td>
<td>0.701</td>
<td>0.987</td>
<td>0.749</td>
<td>0.520</td>
<td>0.530</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.548</td>
<td>0.656</td>
<td>0.508</td>
<td>0.961</td>
<td>0.520</td>
<td>0.530</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.444</td>
<td>0.903</td>
<td>0.704</td>
<td>0.279</td>
<td>0.482</td>
<td>0.493</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.323</td>
<td>0.718</td>
<td>0.664</td>
<td>0.645</td>
<td>0.453</td>
<td>0.463</td>
</tr>
<tr>
<td>Spain</td>
<td>0.223</td>
<td>0.982</td>
<td>0.701</td>
<td>0.584</td>
<td>0.557</td>
<td>0.567</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.361</td>
<td>0.821</td>
<td>0.651</td>
<td>0.222</td>
<td>0.471</td>
<td>0.481</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.442</td>
<td>0.985</td>
<td>0.985</td>
<td>0.961</td>
<td>0.942</td>
<td>0.952</td>
</tr>
<tr>
<td>UK</td>
<td>0.415</td>
<td>0.985</td>
<td>0.985</td>
<td>0.961</td>
<td>0.942</td>
<td>0.952</td>
</tr>
</tbody>
</table>

Notes: a Medium and long term credit institutions, real estate and mortgage banks and specialised government banks; b Weighted average across banks; c Number of banks; d Ranking based on weighted average of category related rankings; e For efficiency: weighted averages across banks; Explanatory note: Shading refers to countries with a limited number of banks.
The estimation results themselves are based on large samples, and hence are steady. However, the reliability of estimated country effects may suffer from the sometimes small country-specific samples. For the latter reason, we do not investigate the country effects in Table 6 in detail, but only draw general conclusions. In principle, the country specific estimates of efficiency in the last but one column are more accurate than the results in Table 3, as they are based on desaggregated samples (implying an own frontier for each class). For a number of countries, these efficiency estimates deviate somewhat from those of the all-banks sample of Table 3, remarkably enough, in a similar manner as the bank-size corrected estimates in Table 5. More important is that if the distribution of banks over the categories within each country is not uniformly, a certain kind of systematic distortion may occurs, due to the relation between inefficiency and bank categories. Similar as in the previous section, the weighted rankings aims at avoiding this type of bias. Actually, across countries, banks are distributed quite differently over the various banking categories. A striking example is Germany, where more than 90% of the banks are of the cooperative and savings bank type, plain banking institutions where inefficiency is limited (or the estimates of inefficiency are low due to the fact that these categories are less heterogeneous). This strong concentration of relatively efficient cooperative and savings banks in Germany resulted in a high average level of efficiency (see Table 3 or Table 6, last column but one). However, among these - and other - categories, the German banks are not the most efficient ones. After correction for this category effect, the German efficiency appears to be just slightly above average (see last column in Table 7). Similar biases has occurred for Italy and Spain where, respectively, 73% and 64% of the banks are cooperative and savings banks. A big ranking shift in the reverse direction occurs for the Dutch banks, which are for 78% commercial banks. Commercial banks have on average high inefficiencies, but relatively the Dutch commercial banks are among the most efficient ones. After correction, the Dutch ranking is 3rd (see Table 7) instead of 8th (as in Table 3).

Table A.4 in the Annex presents a similar exercise for cost effects based on the application of the translog cost model for the various bank type categories. The weighted cost differences, its ranking and the weighted ranking based on the five bank type categories (lowest left hand section of the table) are rather similar to the results based on the all-banks sample in Table 4. Here we do not find systematic distortions as observed with the inefficiency estimates above.

We conclude that the separate bank-type category efficiency estimates for the countries considered are more accurate, as they use more homogeneous samples. More important is that the weighted ranking,

---

20 Note that a simultaneous analysis is impossible, as we can not split the sample in both size and bank type categories - the resulting samples would simply be too small.
21 Actually, that is not so clear for the cooperative and savings banks, where the numbers of banks in the other countries are too low to obtain reliable results, but it is clear for commercial banks and other categories.
22 However, the corrected rankings of these countries are not substantial lower than in Table 3. The correction compensates the shift due to the category specific estimates in Table 7 (last column, but one).
unless its artificial nature, is able to reveal systematic distortion, if the banks in certain countries have an uncommon concentration of some bank type categories, as in Germany.

7. **CHANGES IN EFFICIENCY AND COST DIFFERENCES OVER TIME**

In particular in Europe, it is plausible that the degree of inefficiency is not constant over the years but rather gradually falls over time, due to increased knowledge and experience of management, or enforced by increased competition and pressure from shareholders. There are various ways to investigate whether and how efficiency and cost differences have changed over time. One way to reveal the dynamics in efficiency is to extend model (1) in order to allow the inefficiency terms to become time dependent:

\[ c_{it} = \alpha + j \beta_j x_{ijt} + j k \gamma_{jk} x_{ijt} x_{ikt} + v_{it} + u_i \exp(-\eta(t-T)) \]  

so that \( u_i \) is replaced by \( u_{it} = u_i \exp(-\eta(t-T)) \), where \( t \) refers to the time period \( (t = 1, \ldots, T) \) and \( \eta \) is an unknown parameter (see Battese and Coelli, 1992). The non-negative random variable \( u_{it} \), which reflects inefficiency, decreases gradually over time if \( \eta > 0 \), or increases if \( \eta < 0 \). For application of this panel data model, it is not necessarily to have observations of the full panel set at one’s disposal. In other words, the model allows for an unbalanced set of panel data.

<table>
<thead>
<tr>
<th>Time trend (( \eta ))</th>
<th># of banks</th>
<th>SCF</th>
<th>TCF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear time trend</td>
<td></td>
<td>0.0229 (7.5)</td>
<td>-1.837 (6.0)</td>
</tr>
<tr>
<td>Efficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficiency year dummies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficiency cost effect</td>
<td></td>
<td>-0.010 -1.0</td>
<td>-0.040 -3.9</td>
</tr>
<tr>
<td>1990</td>
<td>31</td>
<td>0.563</td>
<td>-</td>
</tr>
<tr>
<td>1991</td>
<td>52</td>
<td>0.543</td>
<td>-0.010 -1.0</td>
</tr>
<tr>
<td>1992</td>
<td>220</td>
<td>0.563</td>
<td>-0.040 -3.9</td>
</tr>
<tr>
<td>1993</td>
<td>364</td>
<td>0.564</td>
<td>-0.117 -11.0</td>
</tr>
<tr>
<td>1994</td>
<td>515</td>
<td>0.590</td>
<td>-0.030 -3.0</td>
</tr>
<tr>
<td>1995</td>
<td>1126</td>
<td>0.653</td>
<td>-0.069 -6.7</td>
</tr>
<tr>
<td>1996</td>
<td>2135</td>
<td>0.733</td>
<td>-0.105 -10.0</td>
</tr>
<tr>
<td>1997</td>
<td>1907</td>
<td>0.739</td>
<td>-0.133 -12.5</td>
</tr>
</tbody>
</table>

The third column of Table 7 presents estimation results of the time-dependent version of the employed stochastic frontier model. The time-trend coefficient appears to be positive which indeed indicates a decrease in inefficiency, and this coefficient is even very significant. This pattern also reveals when average efficiencies are calculated for the eight years considered. Apart from a small U-turn in the first years, where the number of observations was rather limited and, hence, the results are less reliable, a continuous and strong improvement of efficiency over time shows up. Actually, this improvement is
absolutely remarkable: between 1990 and 1997, average inefficiency in Europe has fallen by not less than 43%.

Similar results can also be obtained with respect to the cost level, using the applied translog cost function (fourth column). When a linear time trend is included in the TCF model, the downward slope in the average cost level, controlled for the banking activities considered, is very significant. When, alternatively, year-dummies are introduced, a similar trend of lower costs over time emerges, be it less regular for some years. The average cost level in 1997 appears to be 12.5% below that of 1990 (last column). Average costs has fallen much less than inefficiency, which may point to a reduction in the spread between good and poor management. Note that inefficiency is a relative measure – efficiency of a certain bank compared to the best practise bank – whereas cost level is an absolute yardstick. All these results reflect that the changing institutional and economic environment for banks in terms of deregulation, liberalisation and globalisation, and the prospect of the single currency in the Economic and Monetary Union in 1999, indeed, in some way or another, has affected competition and efficiency in the European banking industry in a favourable manner.

### Table 8 European wide estimates of X-efficiency for two sub periods

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Efficiency</td>
<td>Rank</td>
<td># banks</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.515</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.564</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Finland</td>
<td>0.557</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>France</td>
<td>0.576</td>
<td>10</td>
<td>256</td>
</tr>
<tr>
<td>Germany</td>
<td>0.728</td>
<td>1</td>
<td>399</td>
</tr>
<tr>
<td>Greece</td>
<td>0.352</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.685</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Italy</td>
<td>0.638</td>
<td>7</td>
<td>267</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.629</td>
<td>8</td>
<td>41</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.643</td>
<td>5</td>
<td>37</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.640</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Spain</td>
<td>0.542</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.665</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.666</td>
<td>3</td>
<td>57</td>
</tr>
<tr>
<td>UK</td>
<td>0.623</td>
<td>9</td>
<td>49</td>
</tr>
<tr>
<td>Total(^a)</td>
<td>0.650</td>
<td>1183</td>
<td>0.734</td>
</tr>
</tbody>
</table>

\[^a\] For efficiency: weighted averages. *Explanatory note:* Shading refers to countries with a (relatively) limited number of banks.

The question arises whether the structural changes over time have shown up in all countries in a similar way. Or, in other words, whether the ranking of countries in terms of efficiency and costs have been affected. In principle, this could be investigated by re-estimation of the models for shorter
periods, or even years. However, as the number of observations for the earlier years is rather low, in particular when the analysis aims at efficiency and cost levels for individual countries, the possibilities to estimate more detailed changes over time are limited. In order to be left with sufficient observations per country, the sample has been split into (only) two shorter periods, 1990-1995 and 1996-1997. The results for efficiency and cost levels are presented in Tables 8 and 9. Both the statistical distortion observed in Sections 5 and 6 and the limited number of observations for some countries, might reduce the clear view on developments over time for some countries. Therefore, below, only a few more remarkable developments are mentioned.

In line with earlier observations, average efficiency appears to improve over time, being one quarter lower in the last period, compared to the first period. Greece, the most lagging country in both periods, has shown the largest improvement both in terms of efficiency and costs, be it not in ranking. Spanish banks also improved their position in terms of efficiency, even improving their ranking, but not in the area of cost. The average efficiency of the Dutch banks deteriorated over time, both in ranking and absolute value. The Dutch average cost level ranking fell also. It should be mentioned, however, that, given that a few banks dominate the Dutch banking market, the average over 37 banks contain many small banks, which may make this overall result less representative. The position of the French banks took a turn for the worse, whereas cost levels developed also less favourable in Germany and the UK than in other countries.

Table 9   Estimates of cost effects in a translog cost model for two sub periods

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dummy coeff.(^a)</td>
<td>effects(^b)</td>
<td>ranking # banks</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.285</td>
<td>1.16</td>
<td>13 6</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.192</td>
<td>1.06</td>
<td>11 15</td>
</tr>
<tr>
<td>Finland</td>
<td>0.100</td>
<td>0.96</td>
<td>7 1</td>
</tr>
<tr>
<td>France</td>
<td>0.195</td>
<td>(4.9)</td>
<td>1.06 12 256</td>
</tr>
<tr>
<td>Germany</td>
<td>0.029</td>
<td>(0.6)</td>
<td>0.90 5 399</td>
</tr>
<tr>
<td>Greece</td>
<td>0.612</td>
<td>(5.5)</td>
<td>1.61 15 10</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.221</td>
<td>(1.1)</td>
<td>0.70 1 3</td>
</tr>
<tr>
<td>Italy</td>
<td>0.190</td>
<td>(4.4)</td>
<td>1.05 10 267</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.144</td>
<td>(2.2)</td>
<td>1.01 9 41</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.87</td>
<td>(4)</td>
<td>8 37</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.101</td>
<td>(1.2)</td>
<td>0.96 8 15</td>
</tr>
<tr>
<td>Spain</td>
<td>0.365</td>
<td>(5.7)</td>
<td>1.26 14 22</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.089</td>
<td>(0.6)</td>
<td>0.95 6 5</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.131</td>
<td>(2.0)</td>
<td>0.76 2 57</td>
</tr>
<tr>
<td>UK</td>
<td>-0.024</td>
<td>(0.4)</td>
<td>0.85 3 49</td>
</tr>
<tr>
<td>(\sigma_{ols}^2)</td>
<td>0.111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.963</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) t-values between parenthesis. \(^b\) Geometric mean for 'cost effects' is set at 1. Explanatory note: Shading refers to countries with a limited number of banks.

In short, the results reveal that, in most European countries, in recent years both the inefficiencies and cost levels are, on average, substantially lower than in the earlier years of the nineties. Apparently,
deregulation, liberalisation and ongoing financial and monetary integration in the EU have increased competitive pressures and enforced European banks to operate more economically.

8. SUMMARY AND CONCLUSIONS

This paper assesses cost efficiency of the European banking industry, examines efficiency and cost levels difference across European countries and provides sensitivity analysis with respect to bank size, bank type category and time. As is well known, the level of cost inefficiency depends, among other things, on the methodology applied. Using the stochastic cost frontier approach, we observe that X-inefficiency in Europe is rather high at on average 30%, in general higher than the 20% often found in the literature. However, most studies analyse only one single country, thereby seriously underestimating inefficiency, as they ignore foreign best-practise banks. We pay special attention to differences across countries. In terms of X-efficiency, banks in Luxembourg and Switzerland are the most efficient ones, which however at least in part is due to their privileged position as tax haven for foreign investors. On average, German banks appear to be among the most efficient ones, but this observation is biased, as most banks belong to the very efficient categories of cooperative and savings banks. Compared to their peers, the efficiency of German banks is only just above the average. Banks in Denmark, the Netherlands, Portugal and the UK take an intermediate position, whereas those from Belgium, France, Greece and Italy are less efficient. On average, Spanish banks appear to be among the least efficient ones, but this observation is also biased, as most Spanish banks are large banks, which make up a class of rather inefficient institutions. Compared to their peers, the efficiency of Spanish banks is just near the average.

Apart from X-efficiency, a related but deviating measure of efficiency is employed, namely the cost level. Where the former measures managerial competence, the latter rather reflects institutional and economic conditions. Cost levels in Luxembourg and Switzerland, corrected for input prices and banking activities, are 20% below those of Germany, the Netherlands, Portugal and the UK. Of course, many banks in the former countries are branches of foreign banks with relatively little costs. Costs in Belgium, Denmark, France and Italy are 15% higher and in Spain and Greece even, respectively, 25% and 35% higher. This stresses vast differences in institutional and economic conditions among European banks. Of course, inefficiency and high costs are related, but there are also deviations. Apparently, managerial performance in Germany is strong, but institutional conditions are less favourable.

The estimated inefficiency appears to be proportional to the bank size. Large banks are twice as inefficient as small banks. Apparently, shortcomings in managerial ability are manifested earlier in large financial institutions. If mergers aim at reduction of inefficiency, this should be seen more as a
challenge than as an easy target. The estimated inefficiency is also dependent on the type of bank. Cooperative and savings banks have, on average, relatively small inefficiencies of over, respectively, 15% and 20%, whereas commercial banks have inefficiencies, which are two or three times higher. Inefficiencies and cost levels show a different pattern with respect to categories, as savings and investment banks deal with almost, respectively, 10% and 20% higher costs than cooperative and commercial banks, whereas some specialised bank types operate 25% more economical. Differences over time appear to be also vast. Inefficiencies in 1997 are nearly 45% lower than in 1990, whereas also the cost level has fallen by more than 10%. Apparently, deregulation, liberalisation and ongoing financial and monetary integration in the EU have increased competitive pressures and enforced European banks to operate more economically.

The large spread in inefficiencies and cost levels, which of course is much wider across banks than across countries, indicates that the process of scaling up and rationalisation to be prepared for increased foreign competition, is for at least part of the banks only in its early stage. Banks with poor management and high inefficiency, amply present in numbers, are an easy target for hunting institutions with better performing management, looking for take-over game. In particular in the countries where banks are less efficient, large-scale consolidation and rationalisation of the banking industry will be unavoidable and even is necessary in order to improve its soundness and survival probability.
REFERENCES


ANNEX AUXILIARY TABLES

Table A.1 Sensitivity analysis for the number of German banks or observations: efficiencies and ranks for various samples

<table>
<thead>
<tr>
<th></th>
<th>Original sample</th>
<th>Less German observ.</th>
<th>Less German banks I</th>
<th>Less German banks II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>efficiency</td>
<td>rank</td>
<td>efficiency</td>
<td>rank</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.521</td>
<td>14</td>
<td>0.573</td>
<td>14</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.597</td>
<td>9</td>
<td>0.616</td>
<td>10</td>
</tr>
<tr>
<td>Finland</td>
<td>0.690</td>
<td>5</td>
<td>0.731</td>
<td>5</td>
</tr>
<tr>
<td>France</td>
<td>0.568</td>
<td>12</td>
<td>0.593</td>
<td>12</td>
</tr>
<tr>
<td>Germany</td>
<td>0.740</td>
<td>2</td>
<td>0.746</td>
<td>4</td>
</tr>
<tr>
<td>Greece</td>
<td>0.500</td>
<td>15</td>
<td>0.551</td>
<td>15</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.798</td>
<td>1</td>
<td>0.799</td>
<td>1</td>
</tr>
<tr>
<td>Italy</td>
<td>0.578</td>
<td>11</td>
<td>0.604</td>
<td>11</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.738</td>
<td>3</td>
<td>0.754</td>
<td>3</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.641</td>
<td>8</td>
<td>0.646</td>
<td>8</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.685</td>
<td>6</td>
<td>0.719</td>
<td>6</td>
</tr>
<tr>
<td>Spain</td>
<td>0.548</td>
<td>13</td>
<td>0.577</td>
<td>13</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.590</td>
<td>10</td>
<td>0.637</td>
<td>9</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.731</td>
<td>4</td>
<td>0.764</td>
<td>2</td>
</tr>
<tr>
<td>UK</td>
<td>0.666</td>
<td>7</td>
<td>0.703</td>
<td>7</td>
</tr>
<tr>
<td>Averages</td>
<td>0.690</td>
<td>0.699</td>
<td>0.396</td>
<td>0.586</td>
</tr>
<tr>
<td>no. of observations</td>
<td>6350</td>
<td>4526</td>
<td>4074</td>
<td>4215</td>
</tr>
<tr>
<td>idem, for Germany</td>
<td>2983</td>
<td>1159</td>
<td>707</td>
<td>848</td>
</tr>
<tr>
<td>no. of banks</td>
<td>2558</td>
<td>2214</td>
<td>1431</td>
<td>1431</td>
</tr>
<tr>
<td>idem, for Germany</td>
<td>1503</td>
<td>1159</td>
<td>376</td>
<td>376</td>
</tr>
</tbody>
</table>

Correlations over twelve countries\(^a\)

<table>
<thead>
<tr>
<th></th>
<th>Original sample</th>
<th>Less German observ.</th>
<th>Less German banks I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.987</td>
<td>0.972</td>
<td>0.971</td>
</tr>
<tr>
<td>Less German observ.</td>
<td>0.952</td>
<td>0.951</td>
<td>0.947</td>
</tr>
<tr>
<td>Less German banks I</td>
<td>0.999</td>
<td>0.983</td>
<td>0.961</td>
</tr>
</tbody>
</table>

\(^a\) Exclusive of Finland, Ireland and Sweden; Explanatory notes: 'Less German observations' means that, for Germany, only 1997 observation are included in the sample (and not those of earlier years). 'Less German banks I and II' means that, for Germany, only, respectively, the first and second quarter of the banks are included in the sample (and the other quarters are left out). Shading refers to countries with a limited number of observations.
Table A.2  Cost effects in a translog cost model by country and by bank-size class

<table>
<thead>
<tr>
<th>Class 1 (total assets &lt;500)</th>
<th>Class 2 (500–&lt;1250)</th>
<th>weighted effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>dummy coeff.</td>
<td>effects</td>
<td>ranking</td>
</tr>
<tr>
<td>Belgium</td>
<td>-0.590 (5.4)</td>
<td>0.68</td>
</tr>
<tr>
<td>Denmark</td>
<td>-0.088 (1.3)</td>
<td>1.12</td>
</tr>
<tr>
<td>Finland</td>
<td>-0.185 (4.5)</td>
<td>1.02</td>
</tr>
<tr>
<td>France</td>
<td>-0.308 (7.5)</td>
<td>0.90</td>
</tr>
<tr>
<td>Greece</td>
<td>0.094 (0.9)</td>
<td>1.34</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.054 (0.7)</td>
<td>0.78</td>
</tr>
<tr>
<td>Italy</td>
<td>-0.182 (4.5)</td>
<td>1.02</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>-0.053 (0.7)</td>
<td>1.16</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1.22</td>
<td>10</td>
</tr>
<tr>
<td>Portugal</td>
<td>-0.028 (0.2)</td>
<td>1.19</td>
</tr>
<tr>
<td>Spain</td>
<td>-0.054 (0.7)</td>
<td>1.16</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.125 (0.5)</td>
<td>1.39</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.565 (10.6)</td>
<td>0.69</td>
</tr>
<tr>
<td>UK</td>
<td>-0.430 (8.4)</td>
<td>0.79</td>
</tr>
<tr>
<td>σ²_ols</td>
<td>0.046</td>
<td>0.060</td>
</tr>
<tr>
<td>R²</td>
<td>0.889</td>
<td>0.804</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class 3 (1250–&lt;5000)</th>
<th>Class 4 (5000+)</th>
<th>weighted effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>dummy coeff.</td>
<td>effects</td>
<td>ranking</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.723 (5.0)</td>
<td>1.52</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.250 (2.5)</td>
<td>0.95</td>
</tr>
<tr>
<td>Finland</td>
<td>0.255 (1.3)</td>
<td>0.95</td>
</tr>
<tr>
<td>France</td>
<td>0.503 (9.9)</td>
<td>1.22</td>
</tr>
<tr>
<td>Germany</td>
<td>0.330 (6.6)</td>
<td>1.03</td>
</tr>
<tr>
<td>Greece</td>
<td>0.260 (2.1)</td>
<td>0.96</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.124 (1.4)</td>
<td>0.84</td>
</tr>
<tr>
<td>Italy</td>
<td>0.567 (10.9)</td>
<td>1.30</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.107 (1.6)</td>
<td>0.82</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.74</td>
<td>2</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.103 (1.4)</td>
<td>0.82</td>
</tr>
<tr>
<td>Spain</td>
<td>0.635 (8.5)</td>
<td>1.40</td>
</tr>
<tr>
<td>Sweden</td>
<td>-0.074 (0.5)</td>
<td>0.69</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.048 (0.8)</td>
<td>0.78</td>
</tr>
<tr>
<td>UK</td>
<td>0.395 (6.3)</td>
<td>1.10</td>
</tr>
<tr>
<td>σ²_ols</td>
<td>0.069</td>
<td>0.104</td>
</tr>
<tr>
<td>R²</td>
<td>0.843</td>
<td>0.951</td>
</tr>
</tbody>
</table>

Explanatory note: Shading refers to countries with a limited number of banks.

Table A.3  Distribution of bank categories over bank-size classes

<table>
<thead>
<tr>
<th>Total assets</th>
<th>Commercial</th>
<th>Cooperative</th>
<th>Savings</th>
<th>Investment</th>
<th>Others</th>
<th>All banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-500</td>
<td>193</td>
<td>606</td>
<td>86</td>
<td>29</td>
<td>1</td>
<td>915</td>
</tr>
<tr>
<td>500-1250</td>
<td>189</td>
<td>289</td>
<td>214</td>
<td>19</td>
<td>14</td>
<td>725</td>
</tr>
<tr>
<td>1250-5000</td>
<td>191</td>
<td>134</td>
<td>325</td>
<td>18</td>
<td>21</td>
<td>689</td>
</tr>
<tr>
<td>5000+</td>
<td>205</td>
<td>62</td>
<td>99</td>
<td>21</td>
<td>50</td>
<td>437</td>
</tr>
<tr>
<td>Total</td>
<td>778</td>
<td>1091</td>
<td>724</td>
<td>87</td>
<td>86</td>
<td>2766</td>
</tr>
</tbody>
</table>
Table A.4  Average cost level by country and by bank category ('90-'97)

<table>
<thead>
<tr>
<th>Dummy coeff.</th>
<th>Costs effects</th>
<th>Ranking</th>
<th># banks</th>
<th>Dummy coeff.</th>
<th>Cost effects</th>
<th>Ranking</th>
<th>#banks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commercial banks</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>Cooperative banks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>0.211 (2.2)</td>
<td>1.21</td>
<td>13</td>
<td>14</td>
<td>-0.248 (2.2)</td>
<td>0.99</td>
<td>3</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.189 (2.9)</td>
<td>1.18</td>
<td>12</td>
<td>20</td>
<td>-0.351 (2.6)</td>
<td>0.89</td>
<td>2</td>
</tr>
<tr>
<td>Finland</td>
<td>-0.074 (0.5)</td>
<td>0.91</td>
<td>5</td>
<td>4</td>
<td>-0.010 (0.1)</td>
<td>1.25</td>
<td>6</td>
</tr>
<tr>
<td>France</td>
<td>0.160 (3.8)</td>
<td>1.15</td>
<td>11</td>
<td>166</td>
<td>-0.032 (0.7)</td>
<td>0.95</td>
<td>7</td>
</tr>
<tr>
<td>Germany</td>
<td>0.107 (1.0)</td>
<td>1.09</td>
<td>10</td>
<td>13</td>
<td>-0.181 (2.1)</td>
<td>1.05</td>
<td>4</td>
</tr>
<tr>
<td>Greece</td>
<td>-0.324 (2.5)</td>
<td>0.71</td>
<td>1</td>
<td>6</td>
<td>0.99</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.248 (2.2)</td>
<td>0.91</td>
<td>5</td>
<td>4</td>
<td>-0.010 (0.1)</td>
<td>1.25</td>
<td>6</td>
</tr>
<tr>
<td>Italy</td>
<td>0.249 (5.4)</td>
<td>1.25</td>
<td>14</td>
<td>66</td>
<td>0.99</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>-0.125 (2.3)</td>
<td>0.86</td>
<td>3</td>
<td>67</td>
<td>-0.085 (0.5)</td>
<td>1.16</td>
<td>5</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.160 (3.8)</td>
<td>1.15</td>
<td>11</td>
<td>166</td>
<td>-0.032 (0.7)</td>
<td>0.95</td>
<td>7</td>
</tr>
<tr>
<td>Portugal</td>
<td>-0.050 (0.7)</td>
<td>0.93</td>
<td>6</td>
<td>18</td>
<td>0.045 (0.3)</td>
<td>1.32</td>
<td>9</td>
</tr>
<tr>
<td>Spain</td>
<td>0.287 (3.7)</td>
<td>1.30</td>
<td>15</td>
<td>9</td>
<td>0.074 (0.6)</td>
<td>1.36</td>
<td>10</td>
</tr>
<tr>
<td>Sweden</td>
<td>-0.005 (0.0)</td>
<td>0.97</td>
<td>8</td>
<td>7</td>
<td>0.99</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.128 (2.2)</td>
<td>0.86</td>
<td>4</td>
<td>86</td>
<td>-1.355 (11.1)</td>
<td>0.33</td>
<td>1</td>
</tr>
<tr>
<td>UK</td>
<td>-0.152 (2.9)</td>
<td>0.84</td>
<td>2</td>
<td>52</td>
<td>0.023</td>
<td>0.987</td>
<td></td>
</tr>
<tr>
<td><strong>Savings banks</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>Investment banks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>2.232 (4.3)</td>
<td>3.56</td>
<td>14</td>
<td>1</td>
<td>2.232 (4.3)</td>
<td>3.56</td>
<td>14</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.715 (5.2)</td>
<td>0.78</td>
<td>4</td>
<td>1</td>
<td>0.715 (5.2)</td>
<td>0.78</td>
<td>4</td>
</tr>
<tr>
<td>Finland</td>
<td>0.861 (5.4)</td>
<td>0.90</td>
<td>5</td>
<td>1</td>
<td>0.861 (5.4)</td>
<td>0.90</td>
<td>5</td>
</tr>
<tr>
<td>France</td>
<td>1.105 (7.9)</td>
<td>1.15</td>
<td>10</td>
<td>21</td>
<td>-0.088 (0.6)</td>
<td>1.70</td>
<td>9</td>
</tr>
<tr>
<td>Germany</td>
<td>0.864 (6.6)</td>
<td>0.91</td>
<td>6</td>
<td>560</td>
<td>-1.123 (3.3)</td>
<td>0.61</td>
<td>1</td>
</tr>
<tr>
<td>Ireland</td>
<td>1.010 (6.6)</td>
<td>1.05</td>
<td>9</td>
<td>1</td>
<td>-0.872 (4.7)</td>
<td>0.78</td>
<td>3</td>
</tr>
<tr>
<td>Italy</td>
<td>1.126 (8.6)</td>
<td>1.18</td>
<td>11</td>
<td>63</td>
<td>-0.378 (2.3)</td>
<td>1.27</td>
<td>7</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>-0.048 (0.3)</td>
<td>0.36</td>
<td>2</td>
<td>1</td>
<td>-0.256 (1.3)</td>
<td>1.44</td>
<td>8</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.38</td>
<td>3</td>
<td>1</td>
<td>0.99</td>
<td>3</td>
<td>1</td>
<td>0.99</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.949 (7.3)</td>
<td>0.99</td>
<td>8</td>
<td>3</td>
<td>-1.085 (7.7)</td>
<td>0.63</td>
<td>2</td>
</tr>
<tr>
<td>Spain</td>
<td>1.185 (8.8)</td>
<td>1.25</td>
<td>12</td>
<td>19</td>
<td>-0.395 (2.0)</td>
<td>1.25</td>
<td>6</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.904 (5.4)</td>
<td>0.94</td>
<td>7</td>
<td>1</td>
<td>0.904 (5.4)</td>
<td>0.94</td>
<td>7</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.079 (0.6)</td>
<td>0.35</td>
<td>1</td>
<td>12</td>
<td>-0.780 (5.7)</td>
<td>0.85</td>
<td>4</td>
</tr>
<tr>
<td>UK</td>
<td>1.699 (10.2)</td>
<td>2.09</td>
<td>13</td>
<td>7</td>
<td>-0.612 (5.4)</td>
<td>1.01</td>
<td>5</td>
</tr>
<tr>
<td><strong>Other categories</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>Weighted Its</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>0.953 (0.7)</td>
<td>1.05</td>
<td>9</td>
<td>2</td>
<td>1.31</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.715 (5.2)</td>
<td>0.78</td>
<td>4</td>
<td>1</td>
<td>1.16</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Finland</td>
<td>3.162 (6.5)</td>
<td>9.53</td>
<td>13</td>
<td>1</td>
<td>2.14</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>France</td>
<td>0.422 (2.2)</td>
<td>0.62</td>
<td>4</td>
<td>8</td>
<td>1.16</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Germany</td>
<td>1.129 (7.2)</td>
<td>1.25</td>
<td>11</td>
<td>30</td>
<td>0.99</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Greece</td>
<td>1.179 (3.7)</td>
<td>1.31</td>
<td>12</td>
<td>2</td>
<td>1.12</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.761 (4.4)</td>
<td>1.05</td>
<td>10</td>
<td>2</td>
<td>0.82</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Italy</td>
<td>0.460 (2.7)</td>
<td>0.64</td>
<td>5</td>
<td>15</td>
<td>1.22</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>-0.041 (0.1)</td>
<td>0.42</td>
<td>2</td>
<td>1</td>
<td>0.88</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.40</td>
<td>1</td>
<td>1</td>
<td>0.99</td>
<td>8</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.876 (2.4)</td>
<td>0.97</td>
<td>8</td>
<td>1</td>
<td>0.91</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Spain</td>
<td>0.578 (1.8)</td>
<td>0.72</td>
<td>6</td>
<td>2</td>
<td>1.24</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.97</td>
<td>6</td>
<td>8</td>
<td>8</td>
<td>1.74</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.314 (1.3)</td>
<td>0.55</td>
<td>3</td>
<td>16</td>
<td>0.77</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>UK</td>
<td>0.818 (1.8)</td>
<td>0.91</td>
<td>7</td>
<td>2</td>
<td>0.90</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>σ² / R²</strong></td>
<td>0.151</td>
<td>0.962</td>
<td>0.023</td>
<td>0.987</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Shading refers to countries with a limited number of banks.

- t-values between parenthesis; Geometric mean for 'effects'; Explanatory note: Shading refers to countries with a limited number of banks.