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Efficiency and Cost Differences Across Countries in a Unified European Banking Market

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I. 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 the internationalisation of existing capital markets and to the development of new markets for sophisticated financial instruments. The benefits of operating on a larger scale have prompted a wave of mergers. The banking scenery is changing 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 and practical obstacles for banks to operating in other EU countries. In the near future, the (prospect of a) new Basle Capital Accord might contribute to a further increase in scale, as large banks are in a better position to develop sophisticated risk measurement methods, such as the advanced internal rating-based approach.

This changing banking environment focuses attention on competitive conditions in Europe and on the viability of its – until recently – sheltered banks. After all domestic banks have long 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 introduction 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,[2] which is particularly evident in the wholesale market segment. Less efficient banks run the risk of being pushed out of the market. Efficiency is also a

1 The views expressed in this article are personal and do not necessarily reflect those of the Nederlandsche Bank. The author is grateful to Miriam Holman-Rijken for excellent research assistance.

2 Which is, by the way, difficult to assess empirically, see *Bikker* and *Haaf* (2002).

decisive element in the game of mergers and take-overs, where inefficient banks are an easy and sought-after prey.[3]

This article 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 bank type categories and over time. Furthermore, it considers two related but diverging dimensions of efficiency. *Differences between countries* are contemplated, as national discrepancies in terms of institutions, supervisory rules, government interference, customer preferences and level of development may help to explain differences in efficiency. For each of 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 design and application of antitrust policies. In addition, they have to face the consequences of ongoing consolidation and rationalisation in their banking sectors.

Size differences between banks 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 (Bikker and Haaf, 2002). As banking data provide insufficient information to make precise distinctions between the various markets, this article uses the size of banks 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 results if the distribution of sizes and categories is not the same for all countries. Finally, *movement of efficiency over time* is interesting as the banking landscape has been undergoing (and will continue to undergo) many shocks, necessitating 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 article also considers *differences in cost levels* controlled for input prices and types of activities, which reflect the diversity of national conditions banks are facing. Cost differ-

[3] Though, efficiency gain is only one among the many incentives for mergers, see e.g. *Dermine* (1999).

ences between countries may be seen as indicators of national inefficiencies, caused by country-specific circumstances for banks, as mentioned above. In principle, managerial (in)ability and country-specific obstacles for banks may reflect mutually 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 there are differences in average managerial abilities between countries (and then are confused with cost differences).

The literature is a treasury of country studies on efficiency in the banking industry. Studies on international comparison of efficiency, on the other hand, are rare.[4] In fact, such an international comparison is a truly heroic attempt, as the differences between countries in banking behaviour and in economic and institutional conditions are huge. As activities of banks diverge strongly and as some of these activities are highly complicated, capturing bank behaviour in a single model is a daunting task, even for a single country. Moreover, international comparisons are easily distorted by national differences in the distribution of banks over sizes and categories, as will be 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-practice 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-practice banks strongly diverges between countries. Hence, for an international comparison of X-efficiency, one needs to compare efficiency of banks with the European best practice banks, not with the best practice banks of the respective countries.

The organisation of this article is as follows. Section II. 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 III. discusses the model specification, the data employed and some econometric tests regarding specification choices. Section IV. presents

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[4] The few studies dedicated to international comparison of efficiency which include at least the major EU countries are based on quite different methodologies and obtain diverging results in terms of ranking of countries and magnitude of inefficiencies (*Allen* and *Rai,* 1996, *Pastor* et al., 1997, *Wagenvoort* and *Schure,* 1999, *Altunbas* et al., 2000). Related studies are *Maudos* et al. (1999, 2001) and *Hasan* et al. (2000).

Europe-wide empirical results for efficiency and cost level differences. Section V. examines the impact of bank size classes and bank type categories on efficiency and Section VI. investigates changes in efficiency and cost level differences over time. The final section summarises and draws conclusions.

II. Methodology

This article seeks to measure two dimensions of efficiency of banks: (i) X-efficiency, the managerial ability to decide on input and output in order to minimise cost, and (ii) national inefficiencies or differences in cost levels, reflecting national economic and institutional banking conditions.[5] Cost differences are based on the translog cost function and X-inefficiencies are based on the stochastic cost frontier model, which is an extension of the translog cost function model. This section describes these models and explains their economic background.

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 article uses the translog multiproduct function to describe costs.[6] This translog cost function (TCF) is a flexible functional form and has proven to be an effective tool for the empirical assessment of efficiency. The TCF reads as:

$$(1) \qquad c_{it} = \alpha + \Sigma_j \beta_j x_{ijt} + \Sigma_j \Sigma_k \gamma_{jk} x_{ijt} x_{ikt} + v_{it}$$

[5] Most econometric models on efficiency of banks focus on cost efficiency (*Berger* and *Humprey,* 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, being logarithmic in nature, are less satisfactory. In any case, in line with most of the literature, this article concentrates on cost efficiency.

[6] 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 β_j and γ_{jk}, respectively. The last element of equation (1), v_{it}, is the error term which accounts for random effects caused by the model specification.

The appropriate definition of output in banking has been a frequent topic of discussion, the two mainstreams being the *intermediation* approach and the *production* approach. 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, but the interest rate paid on deposits as an input factor. 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. Since operating costs appear to contain the bulk of banks' cost inefficiency, this article, in line with most of the literature, takes the production approach.

Apart from loans, both savings accounts and demand deposits are distinguished as production factors, each with its own range of services. The number of branches, regarded 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 an impediment. To an increasing extent banks provide non-traditional services, such as trade in securities, asset management and investment funds for clients, proprietary trading, derivatives, guarantees and credit lines, securitisation, and equity and bond emissions. This type of production is hardly if at all related to balance-sheet items, whereas other public information about the volume of these services is not available for individual banks. Following e.g. Resti (1997) and Berger and DeYoung (1997), this article approximates this type of off-balance sheet output as "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. *X-inefficiency*

Two components of efficiency may 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 available production technology (Farrell, 1957). These two measures may be combined to provide a measure of total *economic efficiency,* or, if cost instead of production is considered, *cost efficiency.* Banks with the lowest costs, controlled for volume of output and level of input prices, form the efficient frontier. Errors, lags between the adoption of the production plan and its implementation, human inertia, distorted communications and uncertainty cause deviations from this efficient frontier of best-practice banks. These deviations reflect *X-inefficiency*[7] (Leibenstein, 1966).

Various approaches are available to estimate X-inefficiency (see e. g. Lozano-Vivas, 1998). All methods involve determining an efficient frontier on the basis of observed (sets of) minimal values rather than taking 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 a roughly equal split between applications of non-parametric and parametric techniques. *Non-parametric* approaches 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, they may be measured as inefficiency, raising the inefficiency estimate. An even 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 regarding the distribution of the inefficiency term, but supposes that the error term for each bank over

[7] 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.

time is zero. Hence, the average predicted error of a bank is its estimated inefficiency. This assumption is quite strong and does not allow identification shifts over time. Finally, the thick frontier method does not compare single banks with the best-practice banks on the frontier, but produces an inefficiency measure for the whole sample. The 25th percentile of the bank cost distribution is taken as the "thick" frontier and the range between the 25th and 75th percentile as inefficiency. This approach avoids the influence of outliers, but, on the other hand, assumes that all errors of the 25th percentile reflect only specification errors and not inefficiency. All approaches have their pros and cons. All in all, the stochastic frontier approach, which has been applied widely, is selected as – in principle – being the least biased 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 critical.

The stochastic cost frontier (SCF) model elaborates on the TCF, splitting the error term into two components, one to account for random effects due to the model specification and another to account for X-inefficiencies:

$$c_{it} = \alpha + \Sigma_j \beta_j x_{ijt} + \Sigma_j \Sigma_k \gamma_{jk} x_{ijt} x_{ikt} + v_{it} + u_{it} \tag{2}$$

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 distributed and to be independent from the $v_{it}s$. Coelli et al. (1998) discuss various distributions for u_{it}. In what follows, the more general truncated normal distribution $N(\mu, \sigma_v^2)$, with zero as the truncation point, has been applied, which provides a rich family of distributions, based on the ranges of parameters μ and σ_v^2, and causes fewer technical problems than some of the alternative 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 major part of this article; depend on time in a structural way ($u_{it} = u_i f(t)$), as in Section VI.; 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 is the matrix containing the explanatory variables. Cost efficiency is defined as:[8]

$$EFF_{it} = E(C_{it}|u_{it} = 0, X)/E(C_{it}|u_{it}, X) = 1/\exp(u_{it}) \quad (3)$$

In other words, efficiency is the ratio of expected costs on the frontier (where the production would be completely efficient, or $u_{it} = 0$) and expected costs, conditional upon the observed degree of inefficiency.[9] Numerator and denominator are both conditional upon X, the given level of output components and input prices. Values of EFF_{it} range from 0 to 1. The inverse of EFF_{it} is inefficiency, $INEFF_{it} = \exp(u_{it})$, which is bounded between 1 and ∞.

The SCF model encompasses the TCF, in cases where 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 σ_v^2 and σ_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 λ parameter can be employed to test whether a SCF model is essential at all. Acceptance of the null hypothesis $\lambda = 0$ would imply 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).

III. 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 closely as possible to total operating costs, excluding interest rate income. There is, of course, the trade-off between the advantage of having more output factors, allowing a higher degree of accuracy in explaining costs, on the one hand, and the possible disadvantage of increased 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 for other services. For the US, in any case, 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

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[8] 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).

[9] Note that the $E(C_{it}|u_{it}, X)$ differs from actual costs, C_{it}, due to v_{it}.

accounts, savings is made up of savings accounts, savings 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 approximations, as interbank differences in labour productivity and average working time are ignored,[10] while price of capital should be interpreted broadly, as "other non-interest expenditure" includes also 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.

To estimate inefficiency, the model has been applied to data on banks in the fifteen countries, which are at present Member States of the European Union, plus Switzerland, where many prominent banks are domiciled. Austria is not represented in the sample, as data on demand deposits were lacking. The sample of banks consists of all banking categories, such as enumerated in the lower part of Table A.1 in Appendix I, both in foreign and domestic hands, over the years 1990–1997, in as far as they are included in the IBCA-Fitch database. All value series are expressed in one currency, namely Deutsche Mark. 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.[11] In particular, the absence of data on (one of) the two input prices reduced the sample. This selection resulted in a sample of 2,563 banks and 6,358 bank-year observations. Table A.1 gives the distribution of these numbers over the countries as well as other country-specific characteristics of the selected European banks.

Reliable and simple indicators of efficiency are very hard to find. The cost-income ratio, the interest-rate margin, the labour-cost share and many other indices or ratios, which are often used, fail as efficiency indicators, as was proven by Bikker (2001a).[12] Table A.1 provides useful in-

10 An alternative would have been to correct the wage rate for national differences in labour productivity and average working time.

11 Zero values do not fit into a model of a logarithmic nature.

12 For instance, the often used cost income ratio is ambiguous. It is common to assume that a high ratio indicates efficiency, strong competition and low profits. An alternative view is that *in*efficiency causes higher costs and hence a higher ratio. Empirical analysis supports the latter view. However, the correlation with X-inefficiency is low, lower than with most of the other proxies, see *Bikker* (2001a).

formation on the national banking systems, but none of the shown ratios stand up as an all-embracing indicator of inefficiency. In order to have a reference for the discussion on the empirical results in later sections, we here present a certain *communis opinio* on the ranking of the inefficiency of 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 local government in the *Länder*, which reduces competition, financial conservatism, a low level of consolidation and extended network of branches (Germany), strong direct interference by the government (France and Italy) and lagging economic development (Greece, Spain, Portugal).[13] Banks in the UK are often seen as more advanced and exposed to 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 established popular opinions may now be obsolete. 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 article seeks to provide just such a yardstick.

1. Model Specification and Econometric Issues

The specification of the translog cost function, which also constitutes the core of the SCF model, requires a number of choices. As mentioned above, loans, savings, demand deposits and other income (as a proxy for other services) have been chosen as output components. Some alternative choices are discussed here in order to further justify the model used in the rest of this article. Table 1 presents the statistics that have helped to

[13] This *communis opinio* is partly based on the (disqualified) simple proxies of efficiency as mentioned above, for instance, higher interest rate margins and labour cost shares in Italy and Spain and lower ones in Luxembourg ands Switzerland, higher labour intensity per inhabitant in Germany, lower concentration in Germany and Italy (see Table 1 in *Bikker*, 2001a). Elsewhere the expert-view ranking is not in line with these proxies (e.g. high interest rate margin in the UK, special positions of Luxembourg and Switzerland).

select one of the various models considered, *viz.* the logarithms of the likelihood ($\ln \boldsymbol{L}$) for, respectively, the SCF model and the TCF, ditto per observation ($\ln \boldsymbol{L}/n$)[14] and the corresponding standard deviations. For the SCF model, the latter includes both the specification error and the inefficiency term. Note that the more expanded models encompass the elementary ones.

Table 1

Specifications of the SCF and TCF models

	No input prices	Wages	Capital prices		Wages and capital prices			
				corrected		corrected		
							incl. loans/assets restrict.	
columns	1	2	3	4	5	6	7	8
n	6358	6358	6358	6358	6358	6358	6350	6350
Stochastic cost frontier (SCF)								
$\ln \boldsymbol{L}$	–626.1	–504.2	–516.1	–455.4	–425.8	–331.8	97.5	88.9
$\ln \boldsymbol{L}/n$	–0.098	–0.079	–0.081	–0.072	–0.067	–0.052	0.015	0.014
σ^2	0.289	0.300	0.280	0.269	0.288	0.287	0.260	0.261
Translog cost function (TCF)								
$\ln \boldsymbol{L}$	–2130	–2039	–1952	–1967	–1896	–1868	–1330	–1373
$\ln \boldsymbol{L}/n$	–0.335	–0.321	–0.307	–0.309	–0.298	–0.294	–0.209	–0.216
σ^2	0.115	0.112	0.109	0.109	0.107	0.106	0.090	0.091

According to economic theory, the models considered should include input prices. Data concerning wage rate and price of capital are available, but the quality of the observed prices may be somewhat poor. Both variables are rough approximations, as interbank differences in labour productivity and average working time are ignored, and the price of capital is proxied as the ratio of "other non-interest expenditure" and the

[14] 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 statistically correct comparison, but in this case the difference can practically be disregarded.

balance sheet item "premises and fixed assets" (PFA), whereas the latter may be rather unreliable, due to book-keeping 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. By far, the best result is obtained, when both input prices are included.

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):

$$\ln PFA = \alpha_0 + \alpha_1 \ln C + \alpha_2 \ln TA + \alpha_3 (\ln C)^2 + \alpha_4 (\ln TA)^2 + \alpha_5 \ln C \ln TA + \varepsilon \quad (\bar{R}^2 = 0.84) \tag{4}$$

This correction brings the book-keeping 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 close-to-zero values of *PFA*, which has a major effect on the respective ratio.[15] The correction leads to a significant increase in the logarithm of the likelihood of both models. In the remainder of this article we therefore use corrected instead of original capital price data.

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 grant loans to more risky borrowers, will also incur additional monitoring costs, for instance, by employing more skilled labour or using advanced information technology to manage these risks (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 banks. Inclusion of this risk measure indeed improves the models tremendously in terms of increase of the logarithm of the likelihood.[16] Hence, this risk variable is maintained in the remainder of this article.

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 gen-

[15] 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.

[16] The sample reduces by 8 to 6350 observations and by 5 to 2558 banks, due to missing observations of the variable L/A.

erality – that the index j in equation (1) is 1 and 2, respectively, for wages and capital prices:

$$(5) \qquad \beta_1 + \beta_2 = 1, \gamma_{11} + \gamma_{12} = \gamma_{21} + \gamma_{22} = 0, \text{ and } \gamma_{k,1} + \gamma_{k,2} = 0 \text{ for } k = 3, \ldots, 7$$

The index k refers to output components and other explanatory variables, such as the risk variable. The first restriction stems from cost exhaustion, reflecting 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. This is reflected in the second and third sets of restrictions in (5). 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.[17] However, it is well known that restrictions tend to be rejected as the sample size increases. This holds in particular in this case, where the inaccuracy of the data prevents exact fulfilment of the restrictions. Henceforth, based on economic theory as well as on the 'nearby fulfilment' of the restrictions, both price homogeneity and cost exhaustion have been imposed. This is equivalent to rewriting cost and prices using one of the prices as a numerary. By this method, the number of parameters is reduced from 35 to 27. For this reason, the model in the far-left column of Table 1 is selected for the next analysis.

IV. Measurement of Efficiency

As a first step to assessing banking efficiency in Europe and to establish efficiency differences across countries, the SCF model was applied to all banks. For each country, the level of efficiency was calculated as an average across its banks (Table 2). For Finland, Ireland and Sweden, these numbers may be less reliable, as they are based on less than 20 observations, and, as a matter of fact, on even fewer banks. In the following discussions we will therefore ignore the outcomes for these three

[17] 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 χ^2 distribution, see *Lee* (1993).

countries and to indicate this, their results in Tables 2 and 3 have been shaded.

At the end of Section II., a test was 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, $\sigma_u^2 = 0$ or no inefficiency, is rejected at a higher level of significance. Hence, efficiency differences are of great importance in explaining cost differences between banks.

The average efficiency in Europe is estimated at 69%. This implies that 31% of costs could be avoided by improving efficiency. This loss is high compared to many other studies, which indicate a loss of around 20% (Berger and Humphrey, 1997, Altunbas et al., 2000). As a matter of fact, the range of estimates in the literature is wide. The use of a single model for banks in such a large number of countries may lead to an overestimation of inefficiency, as the differences across countries may contribute to the heterogeneity of the sample, see Mester (1996).

These first results indicate that banks from Germany, Luxembourg, Switzerland and Portugal are amongst the most efficient ones, whereas, on average, banks in Greece, Belgium, Spain and France are least efficient. Banks from the UK, the Netherlands, Italy and Denmark take up intermediate positions in these respects.[18] Part of the results coincides with the *common opinion* expectations described above. Banks in Greece, Spain and France are often mentioned as being less efficient. Higher efficiency of banks in Luxembourg and Switzerland is in line with expectations, due to special circumstances including bank secrecy, zero tax rates for foreigners and a stable currency in their country, which makes it easier to attract (foreign) investment cheaply.[19]

Not all results are in keeping with common belief (not that the latter is necessarily true). Germany is commonly reputed to be probably less efficient, but the efficiency estimates in Table 2 suggest otherwise. For that matter, the favourable efficiency assessment for Germany is also supported by the low cost share in Table A.1 in Appendix I. Probably, the German efficiency estimate is strongly affected by the composition of the

[18] Denmark takes up an intermediate position according to the standard SCF model. The extended SCF indicates a lower X-efficiency, which may be due to the skew distributions of the banking types (almost all Danish banks in the sample are 'commercial') or to some irregularity.

[19] Moreover, international banks may have branches in these countries, particularly in Luxembourg, while costs may mainly weigh down on the parent bank in its home country, see also the low cost share of banks from Luxembourg in Table A.1 in Appendix I.

Table 2

European-wide estimates of X-efficiency using the SCF model

Countries	Number of observations	Standard SCF	Ranking	Extended SCF	Ranking
Belgium	44	0.521	14	0.484	14
Denmark	57	0.597	9	0.543	13
Finland	13	0.690	5	0.677	5
France	964	0.568	12	0.552	12
Germany	2,983	0.740	2	0.755	1
Greece	40	0.500	15	0.395	15
Ireland	20	0.798	1	0.697	4
Italy	1,221	0.578	11	0.601	10
Luxembourg	177	0.738	3	0.717	2
Netherlands	164	0.641	8	0.623	8
Portugal	67	0.685	6	0.649	6
Spain	105	0.548	13	0.577	11
Sweden	17	0.590	10	0.617	9
Switzerland	299	0.731	4	0.705	3
UK	187	0.666	7	0.649	6
Weighted Averages		*0.690*		*0.696*	
λ		0.909		0.916	
σ^2_{mle}		0.260		0.261	
σ^2_{ols}		0.090		0.086	
R^2		0.965		0.966	

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

German banking sample in terms of categories, where savings and cooperative banks outnumber the commercial banks more commonly found elsewhere. This matter will be investigated in greater detail in Section V.[20]

[20] 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 ex-

Actually, due to the low level of consolidation and the size of Germany, the German banks dominate the Europe-wide sample numerically. The question may arise whether this German overrepresentation in any way affects the results of Table 2. To find this out, we analysed three alternative samples with a strongly reduced number of German observations (or banks). 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 by more than three quarters, see Table A.1 in Bikker (2001 b). German banks continue to rank 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 to see Portugal among the more efficient countries. However, the liberalisation of the Portuguese banking system during 1987 and 1992 prompting increased competition 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 in explaining costs. However, this does not imply that this method is best able to explain differences in cost efficiency across countries. For that reason, the next section presents an alternative approach.

1. Differences in Cost Levels Across Europe

The preceding section considered *X-efficiency*, that is the managerial ability to decide on input and output quantities in order to minimise cost. This section looks at *differences in cost levels*, controlled for types of activities and input prices, which 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 mutually independent features of (in)efficiency. In practice, they may overlap in part. Differences between countries are measured by adding country dummies to equation (1).

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planatory variables), affected neither the ranking nor the leading position of Germany, see left columns of Table 2.

The left-hand side of Table 3 presents the estimates of the relative cost levels of the countries considered. The 97% goodness of fit 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" now being taken 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, in line with what is observed directly (severe regulation, interference by government, financial conservatism, etc.). With an 8th position, the cost-based ranking of the Belgian banks is less humble than according to the X-efficiency ranking (11th). Apparently managerial performance in Belgium may be relatively weak, whereas the institutional or economic conditions with regard to costs are not far from the average level in Europe.

The right-hand side of Table 3 repeats the analysis for a model, which takes the various banking categories into account by 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 section 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 – more 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 show 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, 2001a), and would not allow comparisons across countries. Therefore, in the next section, heterogeneity is reduced by examination of, respectively, separate size-classes and separate bank type categories.

Table 3

European-wide estimates of cost effects using a translog cost model

Countries	Standard TCF				Extended TCF			
	Dummy coeff.[a]		Cost effects[b]	Ranking	Dummy coeff.[a]		Cost effects	Ranking
Belgium	0.093	(1.6)	1.15	11	0.156	(2.7)	1.16	13
Denmark	0.088	(2.0)	1.14	10	0.135	(3.1)	1.13	10
Finland	–0.214	(2.6)	0.84	4	–0.146	(1.8)	0.86	4
France	0.114	(4.4)	1.17	12	0.154	(5.9)	1.16	12
Germany	–0.048	(1.9)	1.00	7	–0.019	(0.7)	0.97	8
Greece	0.234	(3.9)	1.32	15	0.386	(6.4)	1.46	15
Ireland	–0.299	(4.4)	0.77	2	–0.173	(2.5)	0.83	3
Italy	0.114	(4.4)	1.17	12	0.149	(5.5)	1.15	11
Luxembourg	–0.240	(6.7)	0.82	3	–0.209	(6.0)	0.80	2
Netherlands	0		1.04	9	0		0.99	9
Portugal	–0.124	(2.8)	0.92	5	–0.080	(1.9)	0.91	6
Spain	0.172	(4.5)	1.24	14	0.203	(5.3)	1.21	14
Sweden	–0.039	(0.5)	1.00	7	–0.048	(0.6)	0.94	7
Switzerland	–0.337	(10.1)	0.75	1	–0.254	(7.4)	0.77	1
UK	–0.116	(3.6)	0.93	6	–0.117	(3.7)	0.88	5
Bank type categories[c]								
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}	.0797				.0767			
Adjusted R^2	0.969				0.970			

[a] t-values between parenthesis; [b] Geometric mean for "cost effects" is set at 1; [c] For explanation: see footnotes b–d in Table A.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.

V. Efficiency for Various Bank Sizes and Categories

In order to obtain more homogeneous samples, the SCF model has been applied to bank-sizes and bank category classes. A simultaneous analysis of sizes and categories is impossible, as we can not split the sample in both bank size and bank type classes – the resulting samples would simply be too small.[21] Both types of refined analyses are similar in nature but different in direction. Hence, for the sake of presentation, we treat one refinement – the bank category one – here and the other – the bank size case – in Appendix II. The main conclusion of the bank size analysis is that differences in efficiency between size classes are 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 complex and therefore more difficult to manage, it is quite conceivable that the effects of differences in the quality of management increase with the size of the bank.[22] For an alternative explanation, refined assessments of national inefficiencies and the affect on these estimates of ignoring bank sizes, we refer to Appendix II.

The assumption of one frontier for all bank type categories may cause overestimation of inefficiency. Therefore, the remainder of this section aims at reducing heterogeneity by applying the SCF model to separate bank categories.[23] Efficiency estimates appear to vary strongly across categories (Table 4). Cooperative banks form a category of mainly small and less complex banks,[24] where the estimated inefficiencies are small, on average only 16%. Saving banks have limited inefficiencies too, 20% on average. Although these banks are often rather large, their structure is still less complex. Increasing inefficiency is found in investment banks, "other categories" (taken together because the samples of the three other categories are too small for a separate SCF model to be estimated) and commercial banks, respectively. Probably, commercial banks are more complex than other banks, as is also indicated by the lower model fit (or the higher σ_v^2).[25] Apart from that, this category may also still be too heterogeneous, causing overestimation of inefficiency.

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21 See Table A.3 in Appendix II.

22 For a growing bank, the scale economies following from our estimates (not shown here) would, in part, be offset by a certain loss of efficiency.

23 It is sometimes difficult to classify large and complex universal banks into single categories, particularly as we do not have data on their separate business units. Large banks are relatively often labelled as commercial bank, see Table A.3 in Appendix II.

24 See Table A.3.

Table 4: **Mean X-efficiency by country and by bank categories (1990–1997)**

	Commercial			Cooperative			Savings			Investment			Other categor.[a]			Weighted[b]	
	Effic.	#[c]	*rank*	*Effic.*	#	*rank*	*Effic.*	#	*rank*	*Effic.*	#	*rank*	*Effic.*	#	*rank*	*Effic.*	*rank*[d]
Belgium	0.252	14	13	0.916	1	2	0.372	1	14				0.710	2	3	0.347	13
Denmark	0.278	20	11				0.830	1	2							0.305	12
Finland	0.336	4	8	0.895	1	4	0.688	1	8				0.034	1	13	0.423	9
France	0.330	166	9	0.762	68	7	0.759	21	6	0.559	2	7	0.536	8	7	0.483	10
Germany	0.388	113	6	0.855	799	5	0.825	560	3	0.685	1	5	0.387	30	8	0.799	5
Greece	0.265	13	12										0.189	2	12	0.255	15
Ireland	0.519	6	2				0.666	1	9	0.740	1	3	0.339	2	9	0.520	4
Italy	0.244	66	14	0.794	164	6	0.583	63	11	0.486	3	9	0.580	15	6	0.621	11
Luxembourg	0.548	67	1	0.701	2	9	0.987	1	1	0.749	3	2	0.961	1	2	0.572	1
Netherlands	0.444	32	3	0.656	1	10	0.802	1	5	0.524	6	8	0.965	1	1	0.482	3
Portugal	0.323	18	10	0.903	1	3	0.704	3	7	0.783	4	1	0.279	1	10	0.453	8
Spain	0.223	9	15	0.718	3	8	0.664	19	10	0.359	1	10	0.645	2	4	0.542	14
Sweden	0.361	7	7				0.508	1	12							0.379	7
Switzerland	0.442	86	4	0.982	3	1	0.821	12	4	0.701	33	4	0.584	16	5	0.557	2
UK	0.415	52	5				0.465	1	13	0.651	19	6	0.222	2	11	0.471	6
Total[e]	*0.375*	*673*		*0.839*	*1043*		*0.793*	*686*		*0.666*	*73*		*0.487*	*83*		*0.688*	
λ	0.983			0.819			0.965			0.966			0.995				
σ^2_{mle}	1.477			0.061			0.087			0.306			1.067				
σ^2_v	0.025			0.011			0.003			0.010			0.005				
σ^2_{ols}	0.166			0.027			0.017			0.076			0.137				
R^2	0.958			0.985			0.985			0.961			0.942				
Cost levels[f]	–			+1%			+7%			+19%			–17%				

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; [f] See Table 3; *Explanatory note:* Shading refers to countries with a limited number of banks for that category.

Note that the observed inefficiency differences across the various categories deviate distinctly from the cost level differences as estimated above (see last row in Table 4). For instance, savings banks are efficient, but have higher costs than other bank type categories, whereas commercial banks are inefficient but deal with an average cost level. Here it is clear that efficiency and costs measure different phenomena.

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 this reason, we do not investigate the country effects in Table 4 in detail, but only draw general conclusions. The last two columns present, respectively, the weighted average of efficiencies and the 'ranking of the weighted average of rankings', both over the five categories. In principle, these weighted efficiencies are more precise than the results in Table 2, as they are based on more refined estimates (where each class has its own implied frontier).

An important issue is that, if the size distribution of banks over the classes within each country is not uniform, a certain systematic distortion may occur, due to the correlation between inefficiency and bank category. The *weighted rankings* aim at avoiding this type of distortion. 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 2 or Table 4, second column from right). However, within these categories – and among other categories – the German banks are not the most efficient ones.[26] After correction for this category effect, the German efficiency appears to be just slightly above average (see last column in Table 4). A similar bias has occurred for Italy and Spain where, respectively, 73% and 64% of the banks are cooperative and savings banks.[27] A big ranking shift in the reverse direction occurs

[25] As management problems increase with size, it is relevant to observe that commercial banks and 'other banks' are overrepresented in the (two) large bank size classes.

[26] Actually, this is not so clear as regards the cooperative and savings banks, where the numbers of banks in the other countries are too low to obtain reliable results, but for commercial banks and other categories it is clear.

for the Dutch banks, 78% of which are 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 4) instead of 8th (as in Table 2).[28]

We conclude that the separate bank-type category efficiency estimates for the countries considered are more accurate, because they use more homogeneous samples. More importantly, the weighted ranking, despite its artificial nature, is able to reveal systematic distortion in countries where there is an unusual concentration of certain bank type categories, as in Germany. We regard this yardstick as the most 'reliable' measure of X-efficiency ranking across countries.

VI. Changes in Efficiency and Cost Differences Over Time

It is plausible, especially in Europe, that the degree of banks' inefficiency is not constant over the years but falls off gradually over time, either thanks to managers' increased knowledge and experience, 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:

$$(6) \qquad c_{it} = \alpha + \Sigma_j \beta_j x_{ijt} + \Sigma_j \Sigma_k \gamma_{jk} x_{ijt} x_{ikt} + v_{it} + u_i \exp(-\eta(t - T))$$

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 η 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 the application of this panel data model, it is not necessary to have observations of the full panel set at one's disposal.

The third column of Table 5 presents estimation results of the time-dependent version of the employed stochastic frontier model. The time-trend coefficient appears to be positive, indicating a decrease in inefficiency, as expected, and in fact highly significant. The same pattern

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[27] However, the corrected rankings of these countries are not substantially lower than in Table 2. The correction compensates the shift due to the category specific estimates in Table 4 (last column but one).

[28] We do not find similar systematic distortions in the application of the translog cost function model for the various bank type categories (*Bikker*, 2001 b).

Table 5

Changes in efficiency and cost level over time

	Number of banks	SCF	TCF	
Time trend (η)		0.0229 (7.5)		
Linear time trend			–1.837 (6.0)	
		Efficiency	*year dummies*	*cost effect (%)*
1990	31	0.563	–	–
1991	52	0.543	–0.010	–1.0
1992	220	0.563	–0.040	–3.9
1993	364	0.564	–0.117	–11.0
1994	515	0.590	–0.030	–3.0
1995	1126	0.653	–0.069	–6.7
1996	2135	0.733	–0.105	–10.0
1997	1907	0.739	–0.133	–12.5

emerges if 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 the results are therefore less reliable, a continuous and strong improvement of efficiency over time shows up. Actually, this improvement is truly remarkable: between 1990 and 1997, average inefficiency in Europe has fallen by no less than 43%. This is somewhat more than observed by Altunbas et al. (2000).

Similar results can 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 highly significant. When, alternatively, year-dummies are introduced, a similar trend of lower costs over time emerges, be it less regular over the years. The average cost level in 1997 appears to be 12.5% below that in 1990 (last column). Average costs have 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 practice 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, liberalisa-

tion and globalisation, and the prospect of the single currency in the Economic and Monetary Union in 1999, has, in some way or another, favourably affected competition and efficiency in the European banking industry.

The question arises whether the structural changes over time have been similar for all countries. Or, in other words, whether the ranking of countries in terms of efficiency has been affected.[29] In principle, this could be investigated by re-estimation of the models for shorter periods, or even single years. However, as the number of observations for the earlier years is rather low, particularly where the analysis aims at establishing efficiency levels for individual countries, the possibilities for estimating more detailed changes over time are limited. In order to keep the number of observations per country at a sufficient level, the sample has been split into (only) two shorter periods, 1990–1995 and 1996–1997. The results for efficiency levels are presented in Table 6. Both the statistical distortion observed in Section V. and the limited number of observations for some countries, might reduce the clear view on developments over time for some countries. Therefore, below, only some of the most remarkable developments are mentioned.

In line with earlier observations, average efficiency appears to improve over time, inefficiency dropping by one quarter in the latter period. Greece, the most lagging country in both periods, has shown the largest improvement, be it not in ranking. Spanish banks improved their position in terms of efficiency too, even in terms of ranking. The average efficiency of the Dutch banks deteriorated over time, both in ranking and in absolute value. However, since a few large banks dominate the Dutch banking market, the average over 37 banks considered incorporates many small banks, which may make this overall result less representative. The rank position of the French banks took a turn for the worse.

VII. Summary and Conclusions

This article assesses cost efficiency of the European banking industry, examines efficiency and cost level differences across European countries and provides sensitivity analyses with respect to bank size, bank type category and developments over time. As is well known, the *level* of cost inefficiency depends, in part, on the methodology applied. Using the stochastic cost frontier approach, we observe that X-inefficiency in Europe

[29] For the cost level difference analysis, see *Bikker* (2001b).

Table 6

Europe-wide estimates of X-efficiency for two sub-periods

	1990–1995			1996–1997			1990–1997	
	Efficiency	*Rank*	*# banks*	*Efficiency*	*Rank*	*# banks*	*Efficiency*	*Rank*
Belgium	0.515	14	6	0.650	10	23	0.484	14
Denmark	0.564	11	15	0.601	13	21	0.543	13
Finland	0.557	12	1	0.746	3	7	0.677	5
France	0.576	10	256	0.601	14	111	0.552	12
Germany	0.728	1	399	0.773	1	1490	0.755	1
Greece	0.352	15	10	0.578	15	15	0.395	15
Ireland	0.685	2	3	0.723	5	10	0.697	4
Italy	0.638	7	267	0.652	8	306	0.601	10
Luxembourg	0.629	8	41	0.647	11	73	0.717	2
Netherlands	0.643	5	37	0.604	12	36	0.623	8
Portugal	0.640	6	15	0.723	4	27	0.649	6
Spain	0.542	13	22	0.651	9	33	0.577	11
Sweden	0.665	4	5	0.718	6	7	0.617	9
Switzerland	0.666	3	57	0.772	2	145	0.705	3
UK	0.623	9	49	0.691	7	73	0.649	6
Total[a]	*0.650*		*1183*	*0.734*		*2377*	*0.696*	
λ	0.910			0.907			0.916	
σ^2_{mle}	0.359			0.207			0.261	
σ^2_v	0.032			0.019			0.022	
σ^2_{ols}	0.118			0.078			0.086	
R^2	0.961			0.965			0.966	

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

is rather high at 30% on average, generally higher than the 20% often found in the literature. However, most studies analyse only a single country, thereby seriously underestimating inefficiency, as they ignore foreign best-practice 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 is owing at least in part to their privileged position as tax haven for foreign investors and, hence, less to managerial ability. Most German banks belong to the very efficient categories of cooperative and savings banks. However, compared to

their banking category peers, the efficiency of German banks is only just above the European average. Banks in Denmark, the Netherlands, Portugal and the UK rank among the more efficient ones, whereas banks in Belgium, France, Greece and Italy are typically less efficient. Most Spanish banks are large banks, which make up a class of rather inefficient institutions. However, compared to their peers, the efficiency of Spanish banks is just about the European average.

Apart from X-efficiency, a related but distinct 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 in Germany, the Netherlands, Portugal and the UK. Of course, many banks in the former two 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 as much as 25% and 35% higher, respectively. This points up the vast differences that exist in institutional and economic conditions among European banks.

Estimated inefficiency appears to be proportional to 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. On average, the inefficiency of cooperative and savings banks is relatively small, at 15% and 20%, respectively, whereas commercial banks typically have two or three times higher inefficiencies. Inefficiencies and cost levels show different patterns with respect to categories, as savings and investment banks face 10% and 20% higher costs, respectively, than cooperative and commercial banks, whereas some specialised bank types operate 30% more economically. Differences over time also appear to be vast. Inefficiencies in 1997 were nearly 45% lower than in 1990, whereas the cost level has also fallen by more than 10%. Apparently, deregulation, liberalisation and ongoing financial and monetary integration in the EU have increased competitive pressures and forced 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 preparation for increased foreign competition is, for at least part of the banks, only in its early stages.

Banks with poor management and high inefficiency, amply present in numbers, are an easy prey for hunting institutions with better-performing management looking for take-over game. Especially in countries where banks are less efficient, large-scale consolidation and rationalisation of the banking industry will be unavoidable and even necessary in order to improve the banking system's soundness and survival prospects.

Appendix I

Country-specific Characteristics of European Banks

Table A.1 presents an overview of a few country-specific characteristics of the European banks in our sample. 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.[30] 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 and general conclusions, except for Finland, Ireland and Sweden, where the sample is too small.

Cost as a share in the balance sheet total is an indicator of efficiency, even though, of course, costs are explained in part by output composition and input prices. The average cost level is high in Greece, Italy, Portugal and Spain, which are 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, Germany and, in particular, Luxembourg. Most banks in Luxembourg are branches of foreign banks with relatively low costs. Loans as a 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.[31] In Germany and Italy a

[30] In *Bikker* (2001a), 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.

[31] In the Netherlands, there is only one cooperative bank (Rabobank), but with a large market share.

substantial share of banks is of the traditional 'savings bank' type; in Spain, in terms of numbers, it is even the 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.

The lower part of Table A.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* in the sample as a percentage of the OECD number, excluding of the non-cooperative banks. Apart for Finland, Ireland and Sweden, as mentioned earlier, the volume of the sample used is substantial in terms of the number of banks – on average, half of the total is included. The last row gives the *balance-sheet total* of IBCA sample as a percentage 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 sample, due to lack of data. Hence, our sample contains a larger share of the bigger banks. Apparently, larger banks publish more data and provide the data set employed in this article more frequently. 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 A.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.[32] This phenomenon has prompted many foreign banks to establish branches in these countries.

The number of banks, whether or not per capita, is at times said to reflect certain 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 limited average size, reflecting a lagging position in the scaling up process. For that reason – and several others – efficiency in part of the German banking industry is often seen as lower than in countries where mergers and acquisitions have already reduced

[32] For Luxembourg, its small population also affects the per capita ratios.

Table A.1

Country-specific characteristics of selected European banks

	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	Switzerland	UK	Total
IBCA, 1990-97																
number of banks	94	99	12	392	1,826	22	48	611	128	66	42	189	22	350	317	*4,218*
no. of banks sample	23	21	7	265	1,503	15	10	311	74	41	27	34	8	150	74	*2,563*
no. of observations	44	57	13	964	2,983	40	20	1,221	177	164	67	105	17	299	187	*6,358*
balance sheet total[a]	0.77	0.32	0.21	3.14	8.13	0.08	0.13	2.26	0.61	1.60	0.35	0.95	0.60	0.53	3.45	23.14
	shares in balance sheet total (in %)															
costs	1.2	2.0	2.1	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*
loans	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	*47.0*
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	*16.4*
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*
	shares in number of observations (in %)															
commercial	66	95	62	69	7	85	55	24	92	78	69	36	88	57	70	*32*
cooperative	16	0	15	23	48	0	0	46	2	4	4	8	0	2	0	*35*
savings	2	5	15	5	43	0	10	26	1	1	13	52	12	7	1	*27*
investment	0	0	0	1	0	0	10	1	3	15	9	2	0	22	27	*3*
m&l term credit [b]	11	0	0	2	0	15	25	2	2	0	0	1	0	0	0	*1*
real estate/mortg.[c]	5	0	0	1	1	0	0	0	0	2	4	1	0	2	2	*1*
spec. gov. credit [d]	0	0	8	0	1	0	0	2	0	0	0	0	0	10	0	*1*

	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	Switzerland	UK	Total
OECD, 1997[e]																
number of banks	131	92	348	567	3,111	51	52	935	215	169	237	307	124	360	468	*7,167*
id. per capita[f]	13	17	68	10	38	5	14	16	512	11	24	8	14	51	8	*19*
#, excl. coop. banks	131	92	54	440	691	44	52	283	215	169	67	210	124	360	468	*3,400*
id. per capita[f]	13	17	11	8	8	4	14	5	512	11	7	5	14	51	8	*9*
id., sample as %[j]	17	23	11	45	102	34	19	52	33	24	39	15	6	41	16	*45*
no. of inhabitants[g]	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[h]	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[i]	140	64	43	73	97	22	110	54	2529	125	43	40	55	304	124	*88*
id. sample as %[k]	54	96	93	74	103	35	34	73	57	82	82	60	123	25	48	*71*

[a] Balance sheet total of all banks in the sample of 1997, in trillions of Deutsche Mark; [b] Medium and long term credit institutions; [c] Real estate and mortgage banks; [d] Specialised government credit banks; [e] Source: OECD, 1999, Bank profitability: financial statements of banks; [f] Number of banks, divided by the number of inhabitants, per million; [g] In millions; [h] Balance sheet total of all banks, in trillions of Deutsche Mark; [i] In thousands; [j] Number of non cooperative banks of IBCA sample as a % of the OECD number; [k] Balance sheet total of IBCA sample as a % of OECD balance sheet total.

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.

Appendix II

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-size classes, where the volume of total assets was used to split the all-bank sample. The small-bank class runs up to 500 million US$ in total assets, the large-bank class contains banks with 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 A.2. Of course, the split in size classes reduces the available number of banks in each cell.[33] 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 A.2 in detail, but only draw general conclusions.

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 complex and therefore more difficult to manage it is no surprise that differences between strong and weak management increase with bank size. An alternative explanation could be that small banks are more similar to one another, whereas large banks constitute a less homogeneous class, where the assumption of one common underlying frontier may cause overestimation of inefficiency (Mester 1996). Remarkably, however, the results indicate that the trans-

[33] In general, the number of observations is 2 or 3 times larger than the number of banks.

Table A.2: **Mean X-efficiency by country and by bank-size class**

Total assets[a]	Class 1 <500			Class 2 500–<1250			Class 3 1250–<5000			Class 4 5000+			Weighted[b]		
	Efficiency	# of banks	Ranking	Efficiency	# of banks	Ranking	Efficiency	# of banks	Ranking	Efficiency	# of banks	Ranking	Efficiency	Ranking[c]	Ranking[d]
Belgium	0.88	3	1	0.51	2	13	0.26	3	14	0.35	10	9	0.44	11	11
Denmark	0.57	6	10	0.57	8	11	0.51	5	9	0.24	6	14	0.48	10	14
Finland				0.62	2	8	0.73	1	1	0.27	4	13	0.44	13	13
France	0.64	65	7	0.59	63	10	0.44	93	13	0.37	100	7	0.49	8	12
Germany	0.80	599	2	0.78	468	4	0.70	375	2	0.52	104	3	0.75	1	2
Greece	0.57	4	11	0.50	7	14	0.20	4	15	0.17	5	15	0.37	15	15
Ireland				0.79	2	2	0.69	6	3	0.53	3	2	0.67	4	1
Italy	0.71	125	5	0.61	78	9	0.48	92	12	0.33	60	10	0.56	6	9
Luxembourg	0.67	10	6	0.73	23	6	0.63	25	6	0.65	27	1	0.67	3	3
Netherlands	0.63	14	8	0.83	6	1	0.63	12	5	0.45	18	5	0.59	5	5
Portugal	0.57	2	9	0.79	5	3	0.58	10	8	0.31	14	11	0.49	9	10
Spain				0.56	2	12	0.48	8	11	0.40	27	6	0.43	14	6
Sweden	0.50	1	12				0.64	2	4	0.36	6	8	0.44	12	7
Switzerland	0.77	65	3	0.72	42	7	0.61	33	7	0.46	23	4	0.68	2	4
UK	0.76	21	4	0.74	17	5	0.50	20	10	0.28	30	12	0.53	7	8
Total [e]	*0.77*	*915*		*0.73*	*725*		*0.61*	*689*		*0.42*	*437*		*0.66*		
No. of observations	1910			1664			1581			1195					
σ^2_{mle}	0.138			0.196			0.474			1.459					
λ	0.888			0.912			0.979			0.994					
σ^2_v	0.015			0.017			0.010			0.009					
σ^2_{ols}	0.052			0.065			0.077			0.113					
R^2	0.874			0.787			0.825			0.941					

[a] Millions of Deutsche Mark; [b] Weighted average over the four size classes; [c] Ranking of previous column; [d] Ranking of weighted average of rankings over the four size classes; [e] For efficiencies: weighted average over the countries; *Explanatory note:* Shading refers to countries with a limited number of banks in the respective class. The total number of banks is 2766, which is higher than the sample total 2558. This is due to the fact that over the years some banks fall in different size classes (and are counted twice).

log cost function itself fits better for the larger banks (see, in Table A.2, the lower values for σ_v^2 for the last two classes), in spite of the relatively more 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 distribution of banks over size and category classes in Table A.3 also does not indicate similarity within bank size classes, as each class contains banks in various categories.

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 A.2 present, 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 2, 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 occur, 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 2, 14th in Table A.2). 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, although based on a much smaller sample.[34]

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.

[34] We do not find similar systematic distortions in the application of the translog cost function model for the various bank size classes (*Bikker*, 2001 b).

Table A.3

Distribution of banks over size and categories classes

Total assets	Commercial	Cooperative	Savings	Investment	Others	All banks
0–500	193	606	86	29	1	915
500–1,250	189	289	214	19	14	725
1,250–5,000	191	134	325	18	21	689
5,000+	205	62	99	21	50	437
Total	778	1,091	724	87	86	2,766

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Summary

Efficiency and Cost Differences Across Countries in a Unified European Banking Market

This article seeks to discover the level and spread of bank efficiency in the EU, which in the light of the current and expected increase in competition in Europe is of vital importance for welfare-related public policy toward market structure and conduct. In particular, this study focuses on differences across countries, variously sized banks (reflecting distinct market segments), various banking categories and over time. Two related but diverging dimensions of efficiency are considered: X-efficiency, measuring managerial ability, and cost level differences, reflecting national economic and institutional conditions with respect to supervisory rules, government interference, customer preferences and level of development. On average, cost levels of banks in Luxembourg appear to be 20% below the European average and cost levels in Spain and Greece are 30% higher. The X-inefficiency results are similar, be it that the spread is somewhat smaller. Large banks

are twice as inefficient as small banks; apparently, shortcomings in managerial ability reveal themselves more readily 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 forced European banks to operate more economically. The analysis provides evidence that X-efficiency estimates in single-country studies, often found in the literature, can be highly 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 – has only just begun. (JEL F36, G21, G34)

Zusammenfassung

Effizienz und Kostendifferenzen im Ländervergleich auf einem geeinten europäischen Bankenmarkt

In diesem Beitrag werden Niveau und Streuung der Effizienz von Banken in der EU untersucht. Bankeffizienz ist im Lichte des derzeitigen sowie des zu erwartenden stärkeren Wettbewerbs in Europa für eine auf das Sozialleistungssystem bezogene staatliche Politik auf dem Weg zu marktwirtschaftlich geprägten Strukturen und Verhaltensweisen von besonderer Bedeutung. Die vorliegende Untersuchung vergleicht insbesondere Länder, unterschiedlich dimensionierte Banken (die Ausdruck bestehender unterschiedlicher Marktsegmente sind), verschiedene Bankenkategorien und deren Entwicklung über die Zeit. Es werden zwei Effizienzen geprüft, die zwar aufeinander bezogen sind, jedoch unterschiedliche Dimensionen haben: (i) X-Effizienz sowie Managementfähigkeiten und (ii) Unterschiede im Kostenniveau. Letztere spiegeln die volkswirtschaftlichen und institutionellen Regeln wider, die für die staatliche Aufsicht, die Einflußnahme des Staates, für Kundenvorlieben und für das Entwicklungsniveau gelten. Im Durchschnitt scheint das Kostenniveau der luxemburgischen Banken 20 % unter dem europäischen Durchschnitt zu liegen und das Kostenniveau in Spanien und Griechenland 30 % darüber. Die X-Ineffizienzergebnisse sind ähnlich, möglicherweise auf Grund der ein wenig geringeren Streuung. Große Banken sind doppelt so ineffizient wie kleine. Offenbar manifestieren sich Defizite in Managementfähigkeiten bei großen Finanzinstituten schneller. Die Ineffizienzen im Jahre 1997 waren fast 45 % geringer als im Jahr 1990. Offenbar haben Deregulierung, Liberalisierung und kontinuierliche finanzielle und monetäre Integration in der EU den Wettbewerbsdruck im Zeitablauf erhöht und die europäischen Banken dazu gezwungen, wirtschaftlicher zu arbeiten. Diese Untersuchung liefert Beweise dafür, daß Schätzungen der X-Effizienz in auf ein einziges Land bezogenen Studien, die man häufig in der Fachliteratur antrifft, sehr leicht irreführend sein können. Die breite Streuung bei den Ineffizienzen und Kostenhöhen läßt erkennen, daß der Prozeß von Scaling-Up und Rationalisierung mit dem Ziel, ausländischem Wettbewerb zu begegnen, für zumindest einen Teil der Banken gerade erst begonnen hat.

Résumé

Les différences d'efficience et de coûts dans les pays d'un marché bancaire européen unifié

Cet article essaie de cerner le niveau et les écarts dans l'efficience des banques dans l'Union européenne. Lorsqu'on considère l'accélération actuelle et à venir de la concurrence en Europe, connaître ces éléments est d'une importance vitale pour définir la politique sociale qui touche à la structure et aux comportements des marchés. En particulier, la présente étude se concentre sur les divergences d'un pays à l'autre, les différences de taille entre les banques (reflétant des segments de marché distincts), les diverses catégories de banque et les heures supplémentaires. Deux aspects de l'efficience, qui sont corrélés mais divergents, sont examinés: l'efficience X, qui mesure la compétence managériale, et les écarts dans les niveaux des coûts. Ce dernier élément reflète les différences dans les conditions économiques nationales et institutionnelles en matière de réglementation de supervision, d'interférence des gouvernements, de préférences des consommateurs et de niveau de développement. En moyenne, les niveaux de coûts des banques au Luxembourg sont de 20 % inférieurs à la moyenne européenne, alors que ceux en Espagne et en Grèce sont supérieurs de 30 %. Pour l'efficience X, les résultats sont comparables, même si les écarts sont plus petits. Les grandes banques sont deux fois moins efficientes que les petites. Apparemment, le manque de compétence du management est plus rapidement visible dans les plus grandes institutions financières. En 1997, le manque d'efficience était inférieur de 45 % comparé à 1990. De toute évidence, les heures supplémentaires, la déréglementation, la libéralisation et l'intégration financière et monétaire en cours au sein de l'Union européenne ont accru les pressions compétitives et ont obligé les banques européennes à opérer de façon plus économique. L'analyse prouve que les estimations de l'efficience X dans les études sur un seul pays, ce qui se trouve souvent dans la littérature, peuvent fortement induire en erreur. Les écarts importants constatés dans les niveaux d'efficience, comme ceux dans les niveaux des coûts, sont révélateurs du fait que le processus d'agrandissement d'échelle et de rationalisation, nécessaire pour faire face à une concurrence étrangère plus vive, vient seulement de démarrer, du moins pour une partie des banques.