

# EFFICIENCY IN THE EUROPEAN BANKING INDUSTRY: AN EXPLORATORY ANALYSIS TO RANK COUNTRIES

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## ABSTRACT

The introduction of the Euro in EMU is enhancing international competition between European banks, forcing banks to become more efficient. Which countries will be effected the most? The stochastic cost frontier approach is used to estimate the X-efficiency of the European banks, and a multiproduct translog cost function to compare cost levels. On average, Spanish, French and Italian banks appear to be less efficient than those in Germany, the Netherlands and the UK, while banks in Luxembourg, Belgium and Switzerland are the most efficient. Large differences in average X-inefficiencies and cost-levels between countries exist, Spain being around 40% above and Luxembourg about 35% below the European average. Large-scale consolidation and rationalisation of the banking industry are expected. Furthermore, the analysis provides evidence that X-efficiency estimates from single-country studies, as often found in the literature, can be very misleading.

**JEL-CLASSIFICATION:** F36, G21, G24, G34

**KEYWORDS:** banks, efficiency, international comparison, stochastic cost frontier approach, translog cost function, consolidation.

## 1. INTRODUCTION

Many forces of change have affected the competitive environment of the banking industry. This holds in particular for the European Union, where the adoption of the Second Banking Co-ordination Directive of 1992 as part of the single European market project has removed institutional obstacles for banks to operate in foreign markets in the EU. The establishment of the Economic and Monetary Union and the introduction of one single currency at the beginning of 1999 has also seriously effected the banking world. Large and transparent Euro capital markets have emerged. The comparative advantages of domestic banks on the domestic markets for bonds and equity in the field of underwriting and trading activities have diminished since the Euro has replaced national currencies. For similar reasons, fund management will no longer be the preserve of local financial institutions.

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<sup>\*</sup> The author is grateful to Job Swank and an unknown referee for valuable comment and to Miriam Holman-Rijken for excellent research assistance.

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These developments with respect to international integration will, together with national deregulation and entry of new types of competitors, further boost competition between banks in the countries involved. These issues have stirred up the interest in efficiency of banks. Under perfect competition or market conditions not far from that situation, less efficient banks will be driven from the market.<sup>1</sup> Eventually, the expected increase in competition is likely to lead to further consolidation and rationalisation in the European banking sectors. Less efficient banks are more likely to run the risk of being taken over. Large-scale rationalisation has grave effects on employment. 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.

In the last decade, the (in-)efficiency of the banking industry has been investigated extensively. In more recent years, the emphasis of this research area has shifted from scale and scope economies towards technical and allocative inefficiency. The managerial ability to decide on input and output in order to minimise cost or maximise revenues is referred to as X-inefficiency. The stochastic cost frontier approach seeks to measure this type of inefficiency as deviations of the costs from the so-called efficient frontier, which is the estimated level of costs under optimal behaviour.

This article applies the stochastic cost frontier approach to the European banking industry in an attempt to measure its efficiency.<sup>2</sup> The number of studies that evaluate the performance of European banks sink into insignificance beside the voluminous literature on US financial institutions. 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). Given the recent far-reaching structural changes in the environment of the European banking industry, this limited attention for Europe is striking. This may be explained in part by limited availability and unsatisfactory quality of data of the European banks and by particular problems of multicountry studies, among which, technical difficulties and the imperfect international comparability of the data.

The structure of this article is as follows. Section 2 discusses various definitions of efficiency and presents several often used simple ratios and index numbers for

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<sup>1</sup> Bikker and Haaf (2002) prove that banks in Europe indeed are operating under monopolistic competition, being not so far removed from perfect competition.

<sup>2</sup> See for instance the prominent survey on efficiency of financial institutions of Berger and Humphrey (1997) and the study of Molyneux *et al.* (1996).

European countries, which are used as a proxy for efficiency. Section 3 introduces the stochastic frontier model, deals with conceptual issues and elucidates basic choices concerning the specification. Section 4 presents the empirical results of Europe-wide and country-specific estimations. Section 5 reveals some restrictions of the stochastic cost frontier approach in a multicountry setting and presents an alternative measure for efficiency, based on the multiproduct translog cost function, which is also the basic component of the stochastic frontier model. Section 6 refines the estimates by taking the various bank categories into account and reconsiders the appropriateness of the frequently applied ratios and index numbers in the light of the refined estimates of efficiency. Section 7 summarises and concludes.

## 2. PROXIES FOR EFFICIENCY

Farrell (1957) distinguishes two components of the efficiency of a firm: *technical efficiency*, which reflects the ability of a firm to obtain maximum output from a given set of inputs, and *allocative efficiency*, which indicates the ability of a firm to use the inputs in optimal proportions, given their respective prices and the production technology. These two measures can be combined to provide a measure of total *economic efficiency*, or, when cost instead of production is considered, *cost efficiency*. The optimal or most efficient production, depending on various circumstances such as the scale of the firm in particular, is called efficient frontier. Errors, lags between the choice of the production plan and its implementation, human inertia, distorted communications and uncertainty cause deviations from the efficient frontier, called *X-inefficiency* (Leibenstein, 1966). For the sake of presentation, further on, we will often alternate efficiency and its complement inefficiency, and drop the prefix X where possible.

Efficiency cannot be observed directly. Therefore, efficiency is often estimated using related concepts, such as the cost income ratio or the interest rate margin. Table 1 presents a number of more or less well-known proxies of efficiency for nine European countries, investigated further in the remainder of this article, namely the largest seven EU countries: Belgium, France, Germany, Italy, the Netherlands, Spain and the UK, and two smaller countries with important banking sectors: Luxembourg and Switzerland. The first proxy is the ratio of operating (non-interest rate) expenses and gross income. The interpretation of this ratio is not unambiguous. As proxy of efficiency it is common to assume that a high ratio indicates high efficiency, (forced by) strong competition and (as a result) low average profit rates. This interpretation supposes that tariffs of bank services, such as interest margins, commissions and fees, are more or less fixed due to competition, and hence that, given the output level, revenues are more or less fixed.

An alternative view is that inefficiency causes relatively high cost, whereas profits may be seen, to some extent, as accidental or unrelated to cost. This view presumes that tariffs of bank services are not to a greater extent liable to competitive forces, but may be determined by, for instance, a markup on costs. As the interpretation of this ratio is not unambiguous, for the moment, we do not draw any conclusion from this ratio.

**TABLE 1. Country-specific ratios and indices related to efficiency (all banks, 1996)**

	Cost income ratio	Interest rate margin	Labour cost share	Labour intensity (balance sheet)	Labour intensity (inhab- itants) <sup>a</sup>	Intensity of bran- ches	Index of concen- tration <sup>b</sup>	Index of com- petition	Diffusion index
Belgium	0.66	1.21	0.60	59	76	17.7	55	0.92	-
France	0.70	1.08	0.54	73	69	4.5	41	0.91	efficient
Germany	0.64	1.79	0.59	101	87	5.3	16	0.86	inefficient
Italy	0.67	2.53	0.65	120	57	3.7	25	0.93	-
Luxembourg	0.47	0.67	0.50	22	491	8.1	22	0.92	-
Netherlands	0.67	1.73	0.54	75	75	4.4	75	0.66	efficient
Spain	0.62	2.55	0.61	162	62	9.4	44	0.56	inefficient
Switzerland	0.66	1.18	0.52	68	163	5.1	90	-	efficient
UK	0.62	2.07	0.55	156	71	2.1	28	0.72	inefficient
<i>Correlations</i>									
Cost inc. ratio	1	0.33	0.41	0.30	-0.90	-0.12	0.40	-0.06	
Int. rate margin		1	0.76	0.90	-0.64	-0.27	-0.21	-0.55	
Lab. cost share			1	0.57	-0.62	0.21	-0.31	-0.01	
Lab. int. (b.sh.)				1	-0.64	-0.32	-0.24	-0.62	
Lab. int. (inh.)					1	0.09	-0.18	0.32	
Int. of branches						1	0.13	0.16	
Concentration							1	-0.42	
Competition								1	

**Notes:**

Ratios and indices which are shaded lightly indicate countries where the banks are relatively efficient, whereas dark shading point to countries where the banks are relatively inefficient. Correlations with very light shading are expected to be negative, the others should be positive. Sources for the ratios and indices: OECD Bank Profitability; Financial Statements of Banks (1998). For Luxembourg and the UK: commercial banks, and for other countries: all banks; <sup>a</sup> IMF International Financial Statistics; <sup>b</sup> Total assets of the five largest banks as share of total (for Switzerland : 1995).

The second proxy is the ratio of net interest rate income and the balance sheet total. Low values of this ratio reflect high efficiency, strong competition and low profit rates. In Table 1, to allow easy identification, the three lowest interest rate margins, indicating the countries among the group of nine with the most efficient banks, are shaded lightly, and the three highest ratios, referring to the countries with the least efficient banks, are shaded darkly.<sup>3</sup> This interest rate margin ratio may be distorted by the composition of assets and liabilities, differences in the yield curve between

<sup>3</sup> This kind of shading in order to indicate countries with relatively efficient and inefficient banks is also applied to the other proxies of efficiency.

the countries considered, the relative size of equity capital and book-keeping operations, which enlarge or shorten the balance sheet. Other proxies are related to excessive use of labour or branch offices, indicating less developed types of production: labour cost as share of total operating expenses, the number of employees per 10.000 inhabitants, the ratio of the number of employees and balance sheet total, and the number of branches per 10.000 inhabitants. Actually, these indices are rather poor, as they reflect only a minor part of the determinants of efficiency. Finally, we present indices of concentration and competition, which are often assumed to be (positively) related to efficiency. For concentration, the relative balance sheet total of the largest five banks is used and for competition the so-called H-value of Panzar and Rosse as calculated by Bikker and Groeneveld (2000).<sup>4</sup>

The results in Table 1 are not very helpful in obtaining a unanimous ranking of the efficiency of the banking sectors in the nine countries considered. Virtually each country is indicated as efficient at least once, and each country but one is also referred to as inefficient at least once. There are at any rate two reasons for this unsatisfactory result. Firstly, all the employed ratios and indices are, at the best, remotely related to efficiency or reflect one of its many aspects; the majority of them does not *directly* measure efficiency. Secondly, many proxies are disturbed by measurement errors or special circumstances. For instance, banks in Luxembourg and Switzerland can attract foreign funds at lower cost, due to banking secrecy, the lack of tax on income from wealth for non-inhabitants and the stable currency, and employ a larger part of their countries' population. Another example is the index of concentration, which tends to be higher in smaller countries. The lower part of Table 1 presents correlations between the ratios and indices, which are expected to be negative in the (very) lightly shaded areas and positive elsewhere.<sup>5</sup> The low values confirm that the proxies do not coincide but (partly) diverge, whereas the wrong signs even point to opposite pattern. Apparently, at least most of the proxies are unreliable as indicator of efficiency.<sup>6</sup>

Disregarding these shortcomings, the final column of Table 1 presents a plain diffusion index, which just adds plusses (light shading) and minuses (dark shading) to obtain a total score. This indicator suggests that France, the Netherlands and Switzerland are rather efficient, whereas Germany, Spain and the UK are relatively inefficient. Based on direct (partial) observation or on in-depth knowledge of the

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<sup>4</sup> The H-value is the sum of input price elasticities of the total interest rate revenue. H is zero in the case of monopoly, 1 in the case of perfect competition and between these extreme values in the case of monopolistic competition.

<sup>5</sup> Under the assumption that the first interpretation of the cost income ratio would be correct.

<sup>6</sup> It is remarkable that the correlation between cost-income ratio and interest rate margin even has the wrong sign. This issue will be addressed in Section 6.

countries' banking sectors, a certain *communis opinio* states that banks in France, Germany and, in particular, Southern European countries, such as Italy and Spain, are on average less efficient than banks in the other Western European countries. More severe regulation, public policy and financial conservatism (Germany), strong direct interference by the government (France and Italy) and lagging economic development (Greece, Spain, Portugal) are mentioned to explain the diverging (alleged) level of efficiency.<sup>7</sup> We will further refer to this opinion as *expert view*, allowing for the fact that experts can also be completely wrong. In general, this view is not supported by any of the indirect proxies of efficiency of Table 1. From the preceding, it is obvious that there is a need for a much more convincing empirical assessment of the efficiency of the banking sectors in European countries.

### 3. THE STOCHASTIC FRONTIER APPROACH

This section seeks to measure the cost efficiency of banks in the nine European countries considered *directly*. Therefore, we use the stochastic cost frontier approach, which, in the last decade, has been applied often in the literature on efficiency of the banking industry. Stochastic cost frontier models enable us to calculate the degree of inefficiency for each individual bank in the sample and subsequently to draw general conclusions about X-inefficiencies for a country's banking industry as a whole. Where stochastic cost frontier functions have been applied to the US banking industry manifold, there is to the best of our knowledge only one multiple country applications to European banks (Allen and Rai, 1996).

Bank cost efficiency analysis is based on the assumption that the technology of an individual bank can be described by a production function, which links banking outputs to available input factors. Under certain conditions, a dual cost function can be derived from the bank's decision problem, with output levels and factor prices as arguments. Christensen *et al.* (1973) proposed the translog multiproduct cost function as a second-order Taylor expansion, usually around the mean, of a generic function with all variables appearing in logarithms. The translog cost function is a flexible functional form and is one of the most widely used functions for empirical assessment of efficiency.<sup>8</sup>

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<sup>7</sup> It would be interesting to relate these economic and institutional conditions to the degree of inefficiency as will be established in this article. However, firstly, it is difficult to measure these conditions and, secondly, it is hardly possible to do that in a way that allows comparison across these conditions, if at all.

<sup>8</sup> See for an overview, Berger and Humphrey (1997).

The first stochastic frontier function for production was independently proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977). Schmidt and Lovell (1979) presented its dual as a stochastic *cost* frontier function. The standard specification involves a model for cross-section data, which has an error term consisting of two components, one to account for random effects due to the model specification and another to account for cost (in)efficiencies. The model can be written in the following form:

$$c_{it} = \alpha + \sum_j \beta_j x_{ijt} + \sum_j \sum_k \gamma_{jk} x_{ijt} x_{ikt} + v_{it} + u_{it} \quad (1)$$

The dependent variable  $c_{it}$  is the logarithm of the cost of production of the  $i$ -th firm ( $i=1, \dots, N$ ) in year  $t$  ( $t=1, \dots, T$ ). The two sum terms constitute the multiproduct translog cost function: the independent variables, and their squares and cross-terms. The independent variables  $x_{ijt}$  are the logarithms of the output components (such as loans, saving accounts and demand deposits) and input prices (such as wages and the price level of capital) of the  $i$ -th firm in year  $t$ , and  $\beta_j$  and  $\gamma_{jk}$  are the companion unknown parameters. The last two terms form the random part of the stochastic frontier function: the  $v_{it}$ s are the specification errors of the multiproduct translog cost function, 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. As the traditional half-normal distribution may be too restrictive to draw reliable conclusions, we have used the more general truncated normal distribution  $N(\mu, \sigma_u^2)$ , with zero as truncation point, which provides a rich family of distributions, dependent on the parameters  $\mu$  and  $\sigma_u^2$ , and causes less technical problems than the gamma and exponential distributions.<sup>9</sup>

In applying the stochastic frontier model, the question may arise as to whether this model is a significant improvement of the relatively simple linear regression or translog cost function. The following test is available to address that issue. To simplify the calculation of the numerical maximum likelihood estimation procedure of the stochastic frontier model, Battese and Corra (1977) reparameterise the model:  $\sigma_v^2$  and  $\sigma_u^2$  are replaced by  $\sigma^2 = \sigma_v^2 + \sigma_u^2$  and  $\lambda = \sigma_u^2 / (\sigma_v^2 + \sigma_u^2)$ . The parameter  $\lambda$  can be employed to test whether a stochastic frontier function 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 (1) narrows down to the linear regression model.

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<sup>9</sup> See Coelli *et al.* (1998) for a more comprehensive discussion of this issue.

Finally, we will calculate cost efficiency of a bank relative to the cost frontier estimated by model (1). 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 all explanatory variables. Cost efficiency is defined as:<sup>10</sup>

$$EFF_{it} = E(C_{it} | u_{it} = 0, X) / E(C_{it} | u_{it}, X) = 1/\exp(u_{it}) \quad (2)$$

Expressed in words, efficiency is the ratio of the expected costs on the frontier (that is the case where the production would be completely efficient, or  $u_{it} = 0$ ) and the expected costs, conditional upon the observed degree of inefficiency.<sup>11</sup> Note that both nominator and denominator are conditional upon  $X$ , the given volume of output components and input prices.  $EFF_{it}$  ranges from 0 to 1. An alternative expression is 'inefficiency',  $INEFF_{it} = \exp(u_{it})$ , the inverse of  $EFF_{it}$ , which is bounded between 1 and  $\infty$ .

The appropriate definition of output in banking has been a topic of discussion in the cost efficiency literature. In the *intermediation approach*, banks attract deposits and other funds and transform these into loans and investment in securities, using labour and inputs, such as buildings, equipment, information technology and materials. Interest payments are seen as part of the bank's costs and the corresponding dual cost function does not include deposits as an input factor, but the interest rate paid on deposits. Examples of this view are Altunbas *et al.* (1994, 1995) and Barr *et al.* (1994). An alternative definition of output is taken by the *production approach*, which assumes banks to be providers of services related to loans and deposits. In this view, interest payments are not regarded as banking costs. As operating costs were shown to comprise the bulk of cost inefficiency at banks (Berger and Humphrey, 1991), the production approach has become the more common one; examples can be found in Swank (1996), Resti (1997) and Berger and DeYoung (1997). This article also applies the production approach.

Loans, savings accounts and demand deposits are distinguished as output factors. Although common in this kind of analysis, this is a rather rough approximation of bank production, as, for instance, the various kinds of loans are not distinguished. Euro credit activities generate low margins, but higher income/labour cost ratios than retail lending. However, data of a breakdown of loans into these various types is not available. Moreover, the translog multiproduct cost function should not contain too many variables. Investment in securities,<sup>12</sup> such as government bonds,

<sup>10</sup>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).

<sup>11</sup>Note that the  $E(C_{it} | u_{it}, X)$  differs from actual costs,  $C_{it}$ , due to  $v_{it}$ .

<sup>12</sup>Securities on the balance sheet consist mainly of (longer-term) investment.



are not distinguished, as they go at little costs. The number of branches has often also been included in the multiproduct cost function, as an indicator of additional service of a bank to its clients. As our data source did not include sufficient observations of the number of branches, we dropped this variable. Most bank services are related to traditional balance sheet items, such as loans and deposits, but to an increasing extent banks provide other services, for instance, 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. For the most part, this type of production cannot be related to balance sheet items, whereas other comprehensive information about the amount of these services produced is not reported. Instead of ignoring an increasing part of the banks' output, we have chosen to describe it in an approximate way and to take 'other (non-interest) income' as a proxy for this type of services (see also Resti, 1997).

A dual cost function also includes factor prices as arguments, such as wages and the price of physical capital. 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 may be rather unreliable, due to book-keeping tricks. Because of this the difference between, for instance, the 5th and 95th percentile of capital prices in our sample appears to be not less than a factor of 15.<sup>13</sup> Apart from these measurement problems, there is also some doubt with respect to content. For the whole approach to yield useable measures, it is necessary to assume competition in the input markets. For Europe, in particular with respect to the labour market, this may not be a reasonable assumption. Furthermore, there is the practical fact that wage rates are not available for the major part of the banks in our sample. For all these reasons, we did not including these input prices in the model (following Swank (1996), who, however, applied the stochastic cost frontier model for one country only, the Netherlands).<sup>14</sup>

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<sup>13</sup>All input prices - as well as outputs and costs - are made comparable across countries by expressing them in one currency, namely Deutsche Mark, using annual exchange rates.

<sup>14</sup>Anyway, results from additional calculations with a model including these input prices are in line with the outcome of this article.

#### 4. EUROPE-WIDE AND COUNTRY-SPECIFIC ESTIMATIONS

The choice of an adequate translog cost model is central in the specification of the stochastic frontier function. The translog cost model should link the complicated multiproduct output of the various types of banks (and, in principle, 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 preliminary calculations we have chosen for the output components loans, savings, demand deposits and other income. Berger and Mester (1997) have found that for the US functional form and choice of variables usually make 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 saving accounts, saving deposits and time deposits, and non-interest income consists mainly of commission and revenues from financial transactions. The model has been applied to data pertaining to the nine European countries, listed in Table 1. The sample of banks consists of all banking categories (such as listed in the lower part of Table 2), both in foreign and domestic hands, over 1989-1997, as far as included in the IBCA-Fitch database. Where banks are part of a bank holding company, we deal with consolidated figures only. Any bank-year combination for which at least one dependent or explanatory variable is missing, has been deleted from the sample. This also holds for zero values, which, of course, do not fit into a model with a logarithmic nature. This selection resulted in a sample of 3,085 banks and 14,751 bank-year observations. The second and fourth rows of Table 2 give the distribution of these numbers over the countries.

Table 2 presents an overview of a few country-specific characteristics of the European banks in our sample. For most countries considered, the bulk of banks occurring in the IBCA-Fitch database is included in our sample. However, for a substantial number of banks in Italy and the UK, the database does not record any relevant figures at all, or an incomplete set of data only. By far most of the banks excluded are of minor size. Given the high number of banks and the fact that all available banks are included, we assume that a few general conclusions can be drawn. The number of banks per inhabitant reflects some aspects of the national history of banking evolution in terms of mergers and acquisitions. In Germany, the number of banks is relatively high and, consequently, average bank size is low, reflecting a lagging position in the process of scaling up. For that reason, efficiency of the German banking industry could be lower than in a number of other

countries. In the Netherlands and the UK, the number of banks is relatively low<sup>15</sup> and average bank size is high, indicating lead positions in banking expansion and, possibly, in efficiency.

**TABLE 2. Country-specific characteristics of selected European banks (1989-97)**

	Bel- gium	Ger- many	France	Italy	Luxem- bourg	Nether- lands	Spain	UK	Switzer -land	Total
No. of banks in 94 IBCA		1,826	392	611	128	66	189	317	350	3,979
No. Banks in sample	66	1,661	359	320	89	43	135	115	297	3,085
Idem, per inhabitant	6.5	20.3	6.2	5.6	211.9	2.8	3.4	2.0	42.0	9.4
No. of observations	247	7,585	1,997	1,624	504	182	515	534	1,563	14,751
Balance sheet total <sup>a</sup>	19.9	6.7	19.9	9.5	8.0	40.2	18.9	39.3	3.9	10.8
Idem, per inhabitant <sup>b</sup>	129	136	122	53	1,700	111	65	77	162	101
<i>Shares in balance sheet total (in %)</i>										
Costs	1.5	1.4	1.9	2.7	0.6	2.0	2.5	2.3	2.2	1.9
Loans	30.0	43.8	43.5	50.4	24.1	48.9	47.1	54.7	58.7	45.9
Savings	50.5	32.3	37.3	20.8	31.0	24.7	38.4	26.1	29.8	32.1
Demand deposits	9.5	8.6	9.7	24.1	13.5	26.7	11.3	29.3	20.1	14.7
Other income	0.7	0.5	0.9	1.2	0.3	0.3	1.0	1.3	1.8	0.9
<i>Shares in number of observations (in %)</i>										
Commercial banks	63	9	66	25	92	77	57	67	56	
Co-operative banks	9	50	25	46	2	3	2	0	2	
Savings banks	10	39	6	25	2	4	36	3	10	
Investment banks	2	0	1	1	3	13	2	28	19	
M&I term credit <sup>c</sup>	16	0	1	2	1	0	2	0	0	
Real estate/mortg. <sup>d</sup>	1	1	1	0	0	2	2	2	2	
Spec. gov. credit <sup>e</sup>	0	1	0	2	0	0	0	0	10	

**Notes:**

<sup>a</sup> Averages, in billions of DM.

<sup>b</sup> Balance sheet total of all banks, divided by the number of inhabitants.

<sup>c</sup> Medium and long term credit institutions.

<sup>d</sup> Real estate and mortgage banks.

<sup>e</sup> Specialised government credit banks.

The number of banks is relatively low in Spain too, be it to a lesser degree. In Switzerland, the relative number of banks is high and in Luxembourg even extremely high. However, this is mainly due to the attractive characteristics of the banks in these countries, in particular for foreigners, as mentioned earlier. This phenomenon has resulted in many branches of foreign banks. For Luxembourg, its small population also effects the ratios. Apart from Luxembourg and Switzerland,

<sup>15</sup>As mentioned, for the UK this low number may also be due to under-recording in IBCA-Fitch.

the balance sheet total per inhabitant provides a rough indication of the development of the financial system. The figures report that Italy and Spain lag somewhat in that respect. For the UK, the - misleading - indication of 'underdevelopment' may be due to the above-mentioned under-recording of British banks in the IBCA-Fitch database.

Cost as share in the balance sheet total is an important indicator of efficiency, even though, of course, costs are explained in part by the output composition. The average cost level is high in Italy and Spain, in line with the 'expert view', mentioned in Section 2, but also in Switzerland and the UK, and low in Belgium and Germany and, in particular, Luxembourg. On the whole, the expert view is not confirmed. Loans as share of total assets range from 25 to 60%.<sup>16</sup> Savings and demand deposits vary from 40 to 60%. In all countries, most banks are of the universal 'commercial' or 'co-operative' type. In Germany and Italy, most banks, and in France many banks, are co-operative banks. This category is hardly found in the other countries.<sup>17</sup> In Germany, Italy and Spain, a substantial share of banks is of the traditional 'savings bank' type. Investment banks occur mainly in the Netherlands, the UK and Switzerland. Many of these differences between countries are due to regulatory reasons.

The first column of Table 3 presents estimates of efficiency for Europe as a whole, as well as for the individual countries considered. These estimates are based on a Europe-wide model which, apart from the intercept, consists of 14 explanatory variables: the four output categories and their cross terms (denoted by Eur-14). The stochastic frontier model appears to be a significant improvement of the linear regression model, as the null hypothesis  $\lambda = 0$  (or  $\sigma_u = 0$ ) is rejected conclusively, see the section above equation (2).<sup>18</sup> This holds also for all other variants of the stochastic frontier model, presented in the remainder of this article. The banks in France, Italy and Spain are indicated as the least efficient ones and those in Belgium, Luxembourg and Switzerland as the most efficient ones. This ranking of efficiency is rather plausible, that is, in line with the 'expert view'.

The estimate of the average level of efficiency is 0.381, which is seen as fairly low. This suggests that costs are at least twice as high as necessary, or that output could be more than doubled without increasing expenses. In general, this average level of efficiency is lower than found often in the literature (see below) and, for the

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<sup>16</sup>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.

<sup>17</sup>In the Netherlands, there is (only) one co-operative bank (Rabobank), but with large market shares.

<sup>18</sup>The value of the loglikelihood-test statistic, which has a mixed chi-square distribution (see Lee, 1993), is 11,039, while the critical value is 9.9.

moment, we conclude that our results may underestimate actual efficiency. One cause may be that we did not include input prices, which may have resulted in a more rigid estimation of the frontier. To investigate the average efficiency level further, we extend the Europe-wide model by eight dummy variables to account for country-specific differences (denoted by Eur-22)<sup>19</sup>.

**TABLE 3. Europe-wide and country-specific estimates of efficiency**

	<i>Europe-wide estimates</i>			<i>Country-specific estimates</i>				
	<i>Efficiency</i>			<i>tcf<sup>a</sup></i>	<i>sfm<sup>a</sup></i>			
	<i>Eur14</i>	<i>Eur22</i>	<i>Eur28</i>	$\sigma^2$	$\sigma^2$	$\sigma_u^2$	$\sigma_v^2$	<i>Efficiency</i>
Belgium	.431	.196	.237	.182	.834	.796	.038	.524
France	.261	.361	.377	.227	3.233	3.190	.043	.268
Germany	.424	.523	.562	.038	.235	.226	.008	.691
Italy	.273	.483	.505	.041	.120	.099	.021	.781
Luxembourg	.560	.344	.352	.298	1.266	1.193	.073	.436
Netherlands	.382	.408	.441	.186	.939	.916	.022	.498
Spain	.242	.341	.351	.095	.634	.604	.029	.533
Switzerland	.430	.393	.449	.111	.375	.321	.054	.659
UK	.297	.359	.416	.186	1.702	1.673	.029	.364
<i>Weighted avgs.</i>	.381	.460	.493					.615
	<i>Europe-wide estimates</i>							
Eur-14	.381			.151	1.607	1.578	.029	
Eur-22	.460			.134	1.183	1.155	.028	
Eur-28	.493			.131	1.015	.986	.028	

**Notes:**

Ratios and indices which are shaded lightly indicate countries where the banks are relatively efficient, whereas dark shading point to countries where the banks are relatively inefficient. <sup>a</sup> Tcf is short for translog cost function and sfm for stochastic frontier model.

These dummies allow the *level* of cost to diverge over the countries.<sup>20</sup> The inclusion of these dummies indeed raises the average efficiency from 0.381 to 0.460 (Column 2). The statistical description of the model in terms of  $\sigma$ , the estimated standard deviation of the random terms, indicates that inclusion of the country dummies is justified.<sup>21</sup> Adding dummy variables also for the various banking type categories further improves the results slightly, raising the average efficiency to 0.493 (Eur-28 in Column 3). The inclusion of country dummies has

<sup>19</sup>The FRONTIER programme used to estimate the models automatically includes an overall intercept (Coelli, 1996). Therefore, we cannot include dummy variables for all nine countries. The eight dummy variables indicate the difference between each of the corresponding eight countries and the ninth country (here: the Netherlands).

<sup>20</sup>An alternative is to allow all parameters to diverge over the countries, *i.e.* to apply a separate model for each country, see right-hand side of Table 3.

<sup>21</sup>In the stochastic frontier model,  $\sigma$  stands for  $(\sigma_u^2 + \sigma_v^2)^{0.5}$ , the standard deviation of the whole random term (both specification error and inefficiency term). A loglikelihood-ratio test makes clear that the restriction ‘no country dummies’ is rejected.

also caused a remarkable shift in the efficiency estimates of the countries, deviating from the expert view. Section 5 examines this rather alarming phenomenon further. Probably, all kinds of banks in nine European countries constitute a very heterogeneous group in terms of production processes. One may expect that, in general, the stochastic frontier approach is less adequate, the more heterogeneous the group of banks is (see Mester, 1996). Where circumstances and bank characteristics vary so widely, it is no surprise that the frontier deviates so much from the mass of the banks. Or, in other words, the estimated frontier of such a heterogeneous collection of banks may not be adequate for the majority of the banks.<sup>22</sup> In order to be able to assess the effect of Europe-wide comparison, the stochastic frontier model is also applied to the individual countries considered. The last columns of Table 3 present the results of this country-specific estimation. The heterogeneity of the banks in the various countries is illustrated by the standard deviation of the random term in the stochastic frontier model  $\sigma$  and of its components, efficiency  $\sigma_u$  and specification error  $\sigma_v$ , which all diverge severely over the countries. This indicates that the chosen model is better suited to describe the cost structure of banks from some countries, such as Germany, and less for others, such as France, or that the collection of banks is more homogeneous in Germany than in France. In line with expectations, the estimates of the efficiency level are higher for most countries, the weighted average being 0.615 instead of 0.493.<sup>23</sup> The average efficiencies of the various countries range from 0.268 for France to 0.781 for Italy.

On the whole, the estimated levels of efficiency are fairly low compared to what has been found in the literature. For the US, Berger and Humphrey (1997) in their survey report average efficiencies typically to be around 0.80 or even higher, but substantially lower levels of even 0.48 have also been observed (Evanoff and Israilevich, 1991, Cebenoyan *et al.*, 1993, Berger, Hancock and Humphrey, 1993). Wagenvoort and Schure (1999) find also efficiency levels for European countries of around 0.80, but values as low as 0.30 too (for Greece). Most estimates for European countries in Pastor *et al.* (1997) are much lower, ranging from 0.5 to 0.8.<sup>24</sup>

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<sup>22</sup>So, there is a trade-off between the advantage of Europe-wide estimation, which allows the efficiency of banks to be compared with the Europe-wide best-practice frontier, and the disadvantage of the heterogeneity of such a broad collection of banks, which may prohibit the estimation of an adequate translog cost function.

<sup>23</sup>The efficiency of each country is weighted by the number of banks in the sample.

<sup>24</sup>Most single-country estimates are somewhat higher. For German banks, Altunbas, Evans and Molyneux (1994) estimate an efficiency level of 0.76, for Italian banks, efficiency estimates range from 0.70 (Resti, 1997) to 0.87 (Altunbas, Molyneux and Di Salvo, 1994), and for British banks an even higher level of efficiency of around 0.90 was found (Altunbas, Maude and Molyneux, 1995).

The ranking of the countries in the alternative approaches, respectively inclusion of country dummies and country-specific estimates, raises serious doubts about the reliability of these estimates. In particular, the low efficiency of banks in France and the UK, and the relatively high efficiencies of banks in Germany and Italy are unexpected. The next section examines this issue further.

## 5. AN ALTERNATIVE ESTIMATE OF COST EFFICIENCY

In the previous section, a remarkable shift in the countries' levels of efficiency estimates was observed when country dummies were included in the Europe-wide model. The classification of the efficiency of Belgian banks fell from high to low and the status of Italian banks rose from low to high (Table 3). The ranking of most other countries also changed. This is due to the following technical intricacy of a stochastic frontier model with country dummies. Equation (1) extended with country dummies reads as:

$$c_{it} = \alpha + \sum_j \beta_j x_{ijt} + \sum_j \sum_k \gamma_{jk} x_{ijt} x_{ikt} + \sum_r \delta_r D_r + v_{it} + u_{it} \quad (3)$$

Dummy coefficient  $\delta_r$  measures the deviation of the level of costs of country  $r$  from the Europe-wide cost level.<sup>25</sup> The OLS estimate of  $\delta_r$  is based on the group averages of the variables (countries seen as groups):

$$\begin{aligned} \hat{\delta}_r &= (1/N_r) \sum_{i,t \in \{R\}} (c_{it} - \hat{\alpha} - \sum_j \hat{\beta}_j x_{ijt} - \sum_j \sum_k \hat{\gamma}_{jk} x_{ijt} x_{ikt}) \\ &= (1/N_r) \sum_{i,t \in \{R\}} [(\alpha - \hat{\alpha}) + \sum_j (\beta_j - \hat{\beta}_j) x_{ijt} + \sum_j \sum_k (\gamma_{jk} - \hat{\gamma}_{jk}) x_{ijt} x_{ikt} \\ &\quad + v_{it} + u_{it}] \end{aligned} \quad (4)$$

Estimates are denoted by hats. The summation is over all bank-year combinations of banks from country  $r$ , denoted by the set  $\{R\}$ , which contains  $N_r$  observations. In panel data analysis, equation (3) is denoted as *fixed-effects model* and equation (4) is called *between group estimator*, as this estimator is based on variance between observations of banks of country  $r$  only. All other coefficients of equation (3) are based on the *within group (or country) variance* of equation (5):

$$\bar{c}_{it} = \sum_j \beta_j \bar{x}_{ijt} + \sum_j \sum_k \gamma_{jk} \bar{x}_{ijt} \bar{x}_{ikt} + \bar{u}_{it} + \bar{v}_{it} \quad (5)$$

<sup>25</sup>Or, actually, from the Dutch cost level, as in the empirical application  $\delta_{\text{Netherlands}}$  is omitted to avoid indeterminacy of the country dummies. (If all countries would be included, there would be a linear relationship between these countries and the constant).

where  $\bar{c}$  denotes 'c in deviation from the respective country mean'. Country specific variance is swept away. Note that, via  $c_{it}$ , the average level of X-inefficiency of country  $r$ , which we seek to measure, is one of the determinants of the dummy coefficient of this country and that the average level of X-efficiency of country  $r$  cannot be distinguished separately. In the stochastic frontier approach, the coefficients are not estimated by OLS, but by a numerical procedure, which takes account of the complicated (truncated normal) distribution of  $u_{it}$ . The split up of variance in between and within group variance, as expressed above, applies to the estimates of the translog cost model parameters and the specification error  $v_{it}$ , but not necessarily to the random term  $u_{it}$ , which represents the X-inefficiency. Its truncated-normal-distributed character prohibits a plain and clear view on the effects of the introduction of country dummies on the estimates of X-inefficiency. Nevertheless, it is likely that the measurement of the two concepts, the country's relative cost level and its X-inefficiency, are mixed up in the stochastic frontier model. This is illustrated empirically by the results of Table 3: if dummies are introduced, the estimates of the countries' average X-inefficiency shift from a plausible ranking to a less convincing ordering.

The ranking of the countries' X-efficiency levels in Table 3, based on country-specific estimation, shows a strong similarity to the ranking of the Europe-wide estimation, based on a model with country dummies. This is remarkable as in the Europe-wide model one frontier is estimated (for all countries), whereas in the country-specific application nine frontiers are estimated, one for each country. This similarity is probably due to the fact that the country-specific model's intercept is estimated just like a dummy coefficient in a Europe-wide application. Expressed in other words, the effect of country dummies is identical to shifts in the countries' frontiers from the European one. Anyhow, the lack of uniqueness of the estimated country-specific frontier, different from the Europe-wide one, prohibits a true international comparison of efficiency.

This leads us to the following conclusions. Firstly, efficiencies based on estimation of a stochastic frontier model in a multicountry setting, which includes country dummies, are not adequate for comparison between countries, due to interference between country dummies and average efficiencies. Secondly, efficiency estimates from stochastic frontier models for single countries can be very misleading, as country-specific frontiers may deviate strongly from a Europe-wide one. For that reason, single-country studies tend to overestimate efficiency. In particular the



second conclusion has important consequences, as most of the literature on efficiency is based on single-country studies.<sup>26</sup>

The above analysis indicates that the dummy coefficients in the multiproduct cost function, which constitutes the stochastic frontier model, not only measure differences in the cost level of banks in the various countries in producing identical combinations of financial services, but also reflect differences in average X-efficiency levels. This suggests that these dummy coefficient estimates provide a straightforward alternative measure of differences in efficiency between the countries. Straightforward, because this alternative is less sophisticated than the X-inefficiency measure of the stochastic frontier model, and because the closely related concepts of deviations in cost level and X-inefficiency are taken together. On the other hand, the cost-function based efficiency estimates are much more precise and tailored than the various rough and sometimes ambiguous proxies presented in Table 1.

Table 4 presents this alternative: coefficients of country dummies, estimated using a Europe-wide model. The classification of the countries in the categories 'more efficient' (light shading), 'medium efficient' (blank) and 'less efficient' (dark shading) is identical, whether we apply the stochastic frontier model (sfm) or the translog cost function (tcf), or whether we do (Eur-28) or do not (Eur-22) add dummies for types of specialisation. Probably, the estimates of the former model (Eur-28) are more accurate, as that model takes the effects of banking specialisation into account. The classification we find here, corresponds to a certain extent with the 'expert view' mentioned earlier: lower efficiency in Italy and Spain, and, thereafter, France, and higher efficiency in the other countries. The high levels of significance of the dummy coefficients indicate that the estimates are rather robust.

For comparison, the last column of Table 4 shows the X-efficiency levels as found earlier with the Europe-wide stochastic frontier model without dummy variables (Eur-14). There is a remarkable close correspondence between its ranking and the ranking according to the dummy coefficients. This confirms the appropriateness of our alternative measure to proxy differences in the countries' X-efficiency. To assess its qualities further, Table 4 also presents (for Eur-28) the *effects* of the dummy coefficients on costs, actually the exponent of the dummy coefficients (transforming logarithms back to their natural form), in deviation from their geometric mean. According to the translog cost function, the cost level in Spain and Italy is, respectively, 29 and 24% higher than on average and in Luxembourg

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<sup>26</sup>This problem may be less seriously for studies of the US, given its vast size, but appears to be disastrous for studies of countries as large as Germany and Italy.

34% lower (controlled for the structure of the banks through the output components). The differences in cost efficiency according to the sfm are substantially larger than according to the tcf, too large to be plausible. Here, again, it appears to be impossible to estimate country dummy coefficients and X-efficiency in the sfm simultaneously, as explained in the beginning of this section. Therefore, we will further restrict ourselves to estimates based on the plain multiproduct translog cost function.

**TABLE 4. Efficiency estimated by coefficients of country dummies**

	Eur-22		Eur-28				Eur-14	
	sfm	tcf	sfm	tcf	sfm	tcf	sfm	tcf
	<i>Dummy coefficients<sup>a</sup></i>						<i>Effects</i>	
Belgium	-1.251 (18.3)	-.298 (7.8)	-.901 (16.5)	-.209 (5.5)	.40	.89	.431	1.22
France	.302 (8.1)	.049 (1.7)	.365 (9.3)	.101 (3.4)	1.43	1.21	.261	.74
Germany	.199 (5.4)	-.146 (5.1)	.271 (7.5)	-.097 (3.3)	1.30	.99	.424	1.20
Italy	.569 (14.8)	.066 (2.2)	.656 (16.8)	.130 (4.2)	1.91	1.24	.273	.77
Luxembourg	-.620 (13.8)	-.544 (16.7)	-.581 (13.1)	-.510 (15.8)	.55	.66	.560	1.58
Netherlands	0	0	0	0	.99	1.09	.382	1.08
Spain	.309 (7.1)	.134 (4.1)	.535 (11.9)	.171 (5.2)	1.69	1.29	.242	.68
Switzerland	-.158 (4.1)	-.297 (9.7)	-.221 (5.7)	-.272 (8.9)	.79	.83	.430	1.22
UK	.164 (3.8)	-.083 (2.5)	-.047 (1.0)	-.100 (3.1)	.95	.99	.297	.84
<i>Geometric mean</i>					1.00	1.00		1.00
<i>[St. dev.]</i>					[.51]	[.21]		[.30]
Commercial			0	0				
Co-operative			-.082 (4.9)	-.042 (4.3)				
Savings			.200 (12.8)	.025 (2.4)				
Investment			.671 (18.5)	.191 (10.3)				
M & L term			-.699 (12.9)	-.345 (9.4)				
Real Estate			.284 (8.9)	.115 (3.9)				
Spec. Gov.			.183 (4.6)	-.139 (5.6)				

**Notes:**

<sup>a</sup> t-values between parenthesis. Ratios and indices which are shaded lightly indicate countries where the banks are relatively efficient, whereas dark shading point to countries where the banks are relatively inefficient. Unshaded countries take an intermediate position.

The last column of Table 4 gives an *index* of the effects of X-efficiency, defined as percentage deviations from its geometric mean. High efficiency corresponds to low costs. The correlation of this index with the alternative measure, the effects of tcf dummy coefficients (the third last column of Table 4), is at 0.924 very high.<sup>27</sup> This proves that two differing measures of efficiency produce fairly coinciding results, and raises confidence in these approaches. The level of the X-efficiency estimates from the EUR-14 model may be too low, their values constitute a reliable ranking of the efficiency of the banking sectors of the countries involved.

<sup>27</sup> Measured in absolute terms. The correlation with the effects of sfm dummy coefficients is at 0.776 much lower. Also the standard deviation of the index of efficiencies (0.30) is closer to that of the effects of dummy coefficients of the tcf (0.21) than to that of the sfm (0.51).

Finally, Table 4 also shows the coefficients of the categories of specialisation. Their high t-values indicate that the average cost levels diverge strongly between the categories. The costs of investment, savings and real estate & mortgage banks are significantly and sometimes substantially higher than those of commercial banks, whereas the costs of co-operative banks and medium & long term credit institutions are, respectively, slightly and considerably lower. Apparently, in terms of cost levels, the various categories taken together do not form a homogeneous group.

## 6. CATEGORY-SPECIFIC ESTIMATES

The production process and the influence of important but omitted determinants, such as other output components or (other) input prices, may diverge substantially between banks of various kinds of specialisation, on the one hand, and between these banks and banks with a broad supply of financial services, on the other. We expect the diversity of banking activities to be the major origin for the heterogeneity of our bank sample. Therefore, in this section we seek to further refine the estimation results by estimating efficiency for separate categories.

**TABLE 5. Specialisation-specific characteristics of European banks**

	commer- cial	co- operative	savings	invest- ment	m&l credit	term real & mortg.	estate specialised gov. credit	all banks
number of banks	909	1,174	772	114	31	39	46	3,085
no. of observations	4,685	5,080	3,887	536	113	181	269	14,751
balance sheet total <sup>a</sup>	19,752	4,990	4,209	6,149	27,551	25,590	51,682	10,792
	<i>shares in balance sheet total (in %):</i>							
costs	2.1	1.8	2.3	2.0	0.5	1.0	0.7	1.9
loans	46.6	49.2	46.9	29.9	51.8	59.7	31.3	45.9
savings	30.1	35.4	54.1	26.0	25.5	17.4	21.3	32.1
demand deposits	16.3	13.6	14.2	8.9	1.9	28.6	6.2	14.7
other income	1.0	0.7	0.7	1.7	0.4	0.3	0.3	0.9

Note:

<sup>a</sup> Averages, in millions of DM.

Table 5 presents specialisation-specific characteristics of the European banks in our sample. Commercial, co-operative and savings banks dominate the sample in terms of numbers of banks or observations. On average, the balance sheet total of commercial banks is four times as large as those of co-operative and savings banks, but smaller than those of some more specialised banks. The shares in the balance sheet total of the four output components considered reflect some of the different

activities of the various types of banks. This is illustrated by funding, which diverges over the categories by size and composition. The share of other income, consisting of commission and revenues from financial transactions, is large compared to that of costs for investment banks and medium & long-term credit institutions and much smaller for the others. Cost shares diverge over the categories, but at least in part, they are explained by the composition of output.

The first row of Table 6 presents the average X-efficiencies for the seven bank categories, based on the Europe-wide stochastic frontier model. The weighted average of these efficiency estimates for separate categories is at 0.622 higher than the efficiency estimate based on a model wherein all categories are taken together (0.493; see Table 3), and also slightly higher than the average over the country-specific estimates (0.615). This holds, in particular, for banking categories with more similar activities, such as savings banks, which have an average efficiency of 0.847, and much less for the largest category, commercial banks, which includes banks with activities, which may diverge strongly.<sup>28</sup> This outcome underlines that splitting the sample in more homogenous groups (*i.e.* in categories) improves the estimates of efficiency, resulting in more plausible - that is higher - efficiency levels. On the other hand, some categories, in particular commercial banks, remain rather heterogeneous, hampering - to a certain degree - further progress in estimating efficiency more accurately. This also illustrates that restricting the analyses to one category of banks, *e.g.* commercial banks, instead of investigating all banks together, may not be very helpful.

The lower part of Table 6 presents the country dummy estimates for the various bank categories. To avoid the distortion, caused by simultaneous estimation of country dummy coefficients and X-efficiency, as identified in Section 5, the estimation is based on the translog cost function. The ranking of the countries in terms of average cost level, such as found for all banks, appear to hold also for most of the bank categories. Apart from the small subset 'real estate & mortgage banks', where the ranking deviates completely from that of other categories, there are only a few minor deviations from the overall ranking, due in part, to the small number of banks for some combinations of country and category. This picture of a consistent ranking is confirmed by the averages of the dummy coefficients in the last but one column, which are weighted by the corresponding number of observations to take the importance of the categories into account<sup>29</sup>.

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<sup>28</sup>Also the large value of the translog cost function error term ( $\sigma_v^2$ ) for commercial banks suggests that the banks of this category are more heterogeneous, as the model is less able to explain their costs.

<sup>29</sup>The dummy coefficients measure the countries' average cost levels as deviation from the level in the Netherlands. To take account of that, for the calculation of the averages, the dummy coefficients are taken as deviations from their means (per category, over the countries).

**TABLE 6. Europe-wide efficiency estimates for separate bank categories**

	all banks	com- mercial	coopera tive	savings	invest- ment	m&l term cr.	real estate	spec. gov. cr.	weighted avgs	effects
<i>stochastic frontier model</i>										
X-efficiency	.493	.312	.735	.847	.525	.407	.887	.711	.622	
$\sigma^2$	1.183	2.708	.164	.202	.071	2.984	.072	.245	.979	
$\sigma_v^2$	.028	.055	.009	.010	.003	.028	.050	.039	.025	
<i>translog cost function</i>										
$\sigma^2$	.131	.281	.032	.024	.105	.163	.064	.085		
<i>coefficients of country dummies</i>										
Belgium	-.209	-.211	-.115	.325	-1.420	-.822	1.916	-	-0.195	0.82
France	.101	.034	.071	.595	-.351	.921	.925	-.112	0.160	1.17
Germany	-.097	-.095	-.172	.514	-.797	-.190	1.002	.138	0.020	1.02
Italy	.130	.177	-.011	.850	-.285	.742	-.072	-.325	0.241	1.27
Luxembourg	-.510	-.541	-.476	-.105	-.070	-1.519	1.348	-	-0.418	0.66
Netherlands	0	0	0	0	0	-	0	-	0.105	1.11
Spain	.171	.150	.090	.825	-.234	-.317	-	-	0.281	1.33
Switzerland	-.272	-.267	-.554	.119	-.578	0	.485	0	-0.159	0.85
UK	-.100	-.119	-	.641	-.502	-	1.676	-	0.003	1.00

**Notes:**

Ratios and indices which are shaded lightly indicate countries where the banks are relatively efficient, whereas dark shading point to countries where the banks are relatively inefficient.

The last column transforms these outcomes to 'effects' on the cost level.<sup>30</sup> The banking industry in Spain appears to be the least efficient, with a level of costs that is 33% above the average. Banks in Italy and France are also rather inefficient, having costs which are, respectively, 27% and 17% higher than on average. Banks in Germany, the Netherlands and the UK take a medium position in the ranking, whereas banks in Switzerland, Belgium, and in particular Luxembourg are the more efficient ones at cost levels of, respectively, 15%, 18% and 34% below the average. It should be noted that for Luxembourg and Switzerland, this in part does not reflect efficiency, but the special circumstances mentioned earlier, which, for banks of these countries, makes it easier and, so, cheaper to attract funds. The results reveal that differences in cost levels between European countries are very large and suggest that merging and restructuring activity, as observed in recent years, are most likely to continue or even to speed up. Although efficiency gain is only one among the many incentives for mergers, there is empirical evidence that, in particular, banks with weak management have more change to become take-over prey, see *e.g.* Dermine (1999).<sup>31</sup>

<sup>30</sup>For instance, for Spain, the exponent of 0.281 is 1.325.

<sup>31</sup>The literature makes clear that there is hardly any evidence that efficiency increases after a merger. An exception is the acquisition of an inefficient bank (with weak management) by an efficient bank (with strong management). More mergers are expected for this reason, but also as a consequence of increased competition: some banks will merge, as they are too weak to survive, whereas others will do so as they still believe that a merge will reduce cost (and inefficiency). Note that merging banks often mention efficiency gain as a major incentive.

Table 7 provides an overview of the results: *average* effects of the dummy coefficients in the bank-specific models (from Table 6), effects of the dummy coefficients in the Europe-wide model, and the index of X-efficiency of the stochastic cost frontier model (both from Table 4). For the sake of comparison, the inverse of the latter is shown as index of X-inefficiency. The three measures are highly correlated, as is shown at the bottom of the Table, whereas the ranking of countries in terms of cost efficiency is almost identical. The similarity between the results of the various approaches is striking and raises some confidence with regard to the robustness of the results.<sup>32</sup> On average, the banks in Spain, Italy and France are the less efficient ones and those in Luxembourg, Belgium and Switzerland are more efficient. The 'effects' of the bank-specific model best indicate differences in cost levels, whereas the index of X-efficiency provides a ranking of the frontier-type of X-efficiencies. This index suggests that the range of average X-inefficiencies is even wider than the range of average cost levels: from 46% above the European average (Spain) to 37% below this average (Luxembourg).

**TABLE 7. Comparison of various estimates of inefficiency**

	Effects of dummies of bank-category specific models, averages (tcf)	Effects of dummies of Europe-wide model (tcf)	Index of X-inef- ficiency (scf)
Belgium	0.82	0.89	0.82
France	1.17	1.21	1.35
Germany	1.02	0.99	0.83
Italy	1.27	1.24	1.29
Luxembourg	0.66	0.66	0.63
Netherlands	1.11	1.09	0.93
Spain	1.33	1.29	1.46
Switzerland	0.85	0.83	0.82
UK	1.00	0.99	1.19
	<i>correlations</i>		
Bank-category specific models	1	0.99	0.91
Europe-wide model		1	0.92
Index of X-inefficiency			1

Finally, we compare these more sophisticated indices of efficiency with the easy ratios and indices listed in Table 1, which are often used as a proxy of efficiency. None of these ratios provides a ranking that comes close to the ranking we have found in Table 7. Table 8 presents correlations between these simple ratios and the more sophisticated estimates of efficiency. The correlations in the shaded areas are expected to be negative, whereas the other correlations should be positive.<sup>33</sup> The

<sup>32</sup>Various alternative specifications and estimations, including splitting the sample over the time period, also provides similar results.

<sup>33</sup>There is no *a priori* expectation for the cost income ratio.

often-used cost income ratio appears to be positively correlated, indicating that the second interpretation of this ratio with respect to its relationship with efficiency, mentioned in Section 2, is most probably correct. The interest rate margin is the best proxy of differences in cost levels, based on its correlation of 0.80 with effects of the bank-specific model. With a correlation coefficient of 0.72, the labour intensity index related to the balance sheet total is second best. In reversed order, these ratios are also the best proxies of our index of X-efficiencies (correlations are 0.76 and 0.69 for, respectively, labour intensity and interest rate margin). On the whole, the interest rate margin seems to be the best proxy but, nevertheless, with serious shortcomings, as it gravely overestimates efficiency in France and underestimates efficiency in the UK. In theory, efficiency and competition are closely related. In particular, competition is seen as a condition that forces banks to become efficient. Actually, at the moment, efficiency and competition appear to be rather limited connected phenomena, given the low correlations of around 0.40 between our measures of efficiency and the index of competition. These results underline that none of the popular simple proxies is appropriate, and that there is a need for direct measures of efficiency as proposed in this article.

**TABLE 8. Correlations between simple ratios and more sophisticated efficiency estimates**

	<i>Ratios:</i>	cost	interest	labour	labour	labour	intensity	index of	index
<i>Sophisticated estimates</i>	income	rate	cost	intensity	intensity	branches	concentration	of com-	petition
	ratio	margin	share	(bal.sheet)	(inhab.)				
Effects dummies of bank spec. Model	0.57	0.80	0.63	0.72	-0.72	-0.34	-0.09	-0.47	
Index of X-inefficiency	0.46	0.68	0.50	0.75	-0.62	-0.28	-0.16	-0.39	

## 7. SUMMARY AND CONCLUSIONS

National deregulation, international integration, entry of new types of competitors and, in particular, the introduction of the Euro have seriously affected the competitive environment of the European banking industry. These new developments force banks to become more efficient to avoid being driven from the market. Assessment of the efficiency of the European banking industry and differences in efficiency between countries is of vital importance for public policy with respect to the viability of the banking industry in the near future. As efficiency cannot be observed directly, a number of ratios or index numbers are commonly used as a rough estimate. Rankings of countries based on such proxies diverge strongly. Apparently, the value of most or all of these ratios and indices as a yardstick of efficiency is fairly poor.

This article applies the stochastic cost frontier approach to measure X-inefficiency, paying particular attention to the differences in efficiency between the banks of the countries considered. Europe-wide estimation allows the efficiency of banks to be compared to the Europe-wide best-practice frontier. However, institutional and market conditions and bank characteristics vary so widely that the mass of the banks deviates much from the frontier, running the risk that inefficiency is overestimated (compared to other, single-country studies). Country-specific analyses allow the estimation of more homogenous groups of banks, but diminish the international comparability. Actually, there is strong evidence that efficiency estimates from single-country studies, as often found in the literature, may be very misleading. Two approaches are taken in solving the trade-off problem encountered. Firstly, we conducted Europe-wide estimation of X-inefficiency separately for each of the various categories of banks in order to reduce the problem of heterogeneity. Secondly, employing a translog cost function, we propose a more straightforward alternative measure of inefficiency, based on dummy coefficient estimates that reflect differences in average cost levels between countries.

The estimates of these two inefficiency measurement approaches are highly correlated and provide a virtually identical ranking of countries with respect to the inefficiency of their banking industries. This similarity raises confidence with regard to the robustness of the results of the two approaches. On average, Spanish banks appear to be the least efficient ones, followed by banks in France and Italy, whereas banks in Luxembourg are most efficient, followed by banks in Belgium and Switzerland. Of course, for banks in Luxembourg and Switzerland, this not only reflects efficiency but also favourable conditions, stemming from bank secrecy and tax regime. On average, banks in Germany, the Netherlands and the UK take a medium position. Cost levels in Spanish banks are estimated to be 33% above the European average and X-inefficiency even 46%. Costs in banks in Luxembourg are 34% below the European average and X-inefficiency 37%. These results can be split up into category-specific efficiency estimates per country.

Of course, the results should be presented with a ample prudence, as they may have been affected by, among other things, the heterogeneous nature of the selected banks and their environment, the estimation techniques that are used and the exclusion of input prices. Nevertheless, the overall outcome indicates that differences in average cost-levels and X-inefficiency between EU countries are huge; the average inefficiency is probably higher than the 20%, found often in the literature for the US. In particular in the countries where banks are less efficient, large-scale consolidation and rationalisation of the banking industry will be unavoidable and also is necessary in order to improve its soundness.



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