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DO ENVIRONMENTAL VARIABLES AFFECT THE PERFORMANCE AND TECHNICAL EFFICIENCY OF THE EUROPEAN BANKING SYSTEMS?

A PARAMETRIC ANALYSIS USING THE STOCHASTIC FRONTIER APPROACH

L. CAVALLO – S.P.S. ROSSI

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L. CAVALLO[*] – S.P.S. ROSSI[**]

Abstract
The aim of this paper is to compare the efficiency of the European banking systems in view of the constitution of the European Monetary Union. Since competition among banks will be stronger, it is relevant to identify the most efficient banking system which can play a role in that market. We follow a parametric approach based on the estimation of a stochastic cost frontier. This methodology allows us to measure the X-inefficiency and to model it as a function of environmental variables which may influence the firm efficiency. Through this analysis it is possible to identify the most efficient banking systems and to focus on the determinants of deviations from cost minimising. The analysis evidences significant efficiency gaps among the performances of banks belonging to different countries and different institutional types.
In particular, we find the Mittle-European model to be the one operating closer to the efficient frontier. This may be a signal that the universal banking system, permitting a more functional integration between commercial and investment activities, allows, more than separated banks, for production plans closer to the optimal frontier.
Our analysis suggests that, at the beginning of the European Monetary Union, national barriers and regulatory frameworks are still responsible for deviation from the efficient frontiers.

JEL Classification: G21

Keywords: Stochastic cost frontier, productivity, technical efficiency, cost efficiency, banking systems.

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DO ENVIRONMENTAL VARIABLES AFFECT THE PERFORMANCE AND TECHNICAL EFFICIENCY OF THE EUROPEAN BANKING SYSTEMS? A PARAMETRIC ANALYSIS USING THE STOCHASTIC FRONTIER APPROACH

1. *Introduzione*

The aim of this paper is to evaluate the performance of European banks in order to compare the efficiency of the different banking systems and to analyse the determinants of any deviation from cost minimising. As the European Monetary Union brings banks into closer competition only the most efficient can reach a leader position in the common market, while banks which perform poorly will be forced either to leave the market or to merge with more efficient banks.

Researches concerned with the measurement of firms' efficiency have mainly developed into two different streams: non-parametric frontier analysis, and parametric frontier analysis. The first approach, well known as Data Envelopment Analysis (DEA), is a linear programming technique which approximates an efficient frontier in a non-parametric way. The second approach is based on the econometric estimation of a cost or production frontier.

The parametric approach by imposing an approximate form of the frontier can incur in the problem of confounding the measured efficiency with the specification error. On that respect, the DEA has the advantage of not requiring the explicit specification of the functional form of the frontier. However, in contrast with the parametric approach, this method does not allow for a random error, incurring in the risk of confounding the random deviations with deviations from the efficient frontier.

The empirical studies have used these two different techniques alternatively, emphasising the weakness and strengths of each approach. Recently some authors have showed that the results obtained are not significantly different when the two techniques are applied on the same data (Ferrier and Lovell, 1990, and Resti ,1997). In this study we follow the econometric approach based on the estimate of a stochastic cost frontier.

Despite of the extensive academic contributes analysing the efficiency of specific banking systems, only few studies compare banking performances across countries. This is mainly due to the difficulties in constructing homogeneous samples, in obtaining information about regulatory structure of each banking systems, and other data limitations.

Moreover, the few studies dealing with international comparisons generally use the non-parametric approach (Berg, Førsund, Hjalmarson and Suominen

(1993), Fecher and Pestieau (1997) and Pastor, Pérez and Quesada, (1977), Dietsch and Lozano Vivas (1998)).

A stochastic frontier approach is used by Allen and Rai (1996) to compare banks in fifteen countries. In this paper, we use the same approach to analyse the bank cost efficiency in six European countries (France, Germany, Italy, Netherlands, Spain, and UK). Our sample covers a set of countries smaller than the one used by Allen and Rai, but it presents a significantly wider number of observations for each country. This allows to obtain a more detailed representation of the banking system of each country and to compare the different banking models. The countries selected are in fact representative of three different banking models: the Mittle-European one (Germany and Netherlands), which operates at a lower level of cost obtaining a moderate level of profitability . The Anglo-Saxon model (UK), with higher level of cost and profitability. The Latin model (France, Italy and Spain), which operates at level of cost higher than the Mittle-European one, and at level of profitability lower than the Anglo-Saxon model (Parrillo, 1998).

2. *Stochastic cost frontier*

The two primary stochastic frontier model specifications are an error components specification with time-varying efficiencies permitted (Battese and Coelli, 1992), and a model specification in which the firm effects are directly influenced by a number of variables (Battese and Coelli, 1995).

In the basic stochastic econometric frontier model, the deviation of a firm's observed cost from the frontier may be explained by an error term which can be split in two components, one referring to random noise V_i, and the other to technical or allocative inefficiency U_i.

The cost function can be expressed as follows:

$$\ln C_{it} = \ln C(y_{it}, w_{it}, \Theta) + (V_{it} + U_{it}) \qquad i=1,...,N, \quad t=1,\dots,T \qquad (1)$$

where

C_{it} is the (logarithm of the) observed cost of the i-th firm at time t;

y_{it} is the vector of the output for the i-th firm at time t;

w_{it} is the vector of input prices for the i-th firm at time t;

Θ is the vector of unknown parameters;

the V_{it} are random variables which are assumed to be iid $N(0,\sigma_V^2)$, and independent of the U_{it} which are non-negative random variables assumed to account for the cost of inefficiency in production, defining how far the firm operates above the cost frontier. U_{it} in a cost function accounts for both technical and allocative inefficiencies. Under the assumption of allocative efficiency, it is possible to interpret U_{it} as closely related to the cost of technical inefficiency.

$U_{it} = (U_i \exp(-\eta(t-T)))$, where η is a parameter to be estimated which captures the time-variance of inefficiency;

The most common distributional assumption for U_i is a truncated normal (usually half-normal) or gamma distribution. Under the assumption of truncated normal distribution the inefficiency are assumed to be *iid* as truncation at zero of the $|N(\mu, \sigma_U^2)|$. In the case of the half normal distribution $\mu = 0$. The main criticism to this assumption is that it presumes that most firms are operating near full efficiency, with higher degrees of inefficiency being increasingly unlikely (Berger 1993).

In the Battese and Coelli (1995) specification, the inefficiency effect, U_{it} can be expressed as an explicit function of a vector of variables z_{it} which may influence the firm's efficiency:

$$U_{it} = z_{it}\delta + W_{it} \tag{2}$$

the term W_{it} is the truncation of normal distribution with zero mean and variance σ^2. Note that this model overcomes the shortcoming of the half normal distribution assumption because in this case the term of truncation is $-z_{it}\delta$, where $U_{it} \sim N(z_{it}\delta, \sigma_u^2)$, and then $W_{it} \geq -z_{it}\delta$.

In the special case when T=1 and z_{it} contains only a constant term, then the model can be reduced to the Stevenson's (1980) specification where δ_0 correspond to the μ parameter of the more general model.

The stochastic frontier and the model for the inefficiency effects are simultaneously estimated using the maximum likelihood method. The likelihood function is expressed in terms of variance parameters $\sigma^2 = \sigma_u^2 + \sigma_v^2$, and $\gamma = \sigma_u^2 / \sigma^2$.

The measure of cost efficiency is defined as:

$$EFF_{it} = E(C_{it} | U_{it}, X_{it}) / E(C_{it} | U_{it}=0, X_{it}) \tag{3}$$

where X_{it} are the regression parameters.

It will take a value between 1 and infinity and it corresponds to $\exp(U_{it})$. Values closer to one indicate a higher level of efficiency.

3. *Methodological issues*

3.1. *Definitions of a bank cost function*

The most recent literature on the banking efficiency concentrates on the comparison between the profit and cost efficiency (Berger and Mester, 1997). The duality theory postulates that it is equivalent to minimise cost or maximise profit. Distinction on these two specifications arises only when some assumptions do not hold, in particular when market are not perfect. In this paper we follow the cost function approach assuming that the European Union integration and the more competitive environment introduced by the II European Directive for Banking Industry make markets closer to perfect competition.

In modelling the cost function of banks, characterised to be financial and multiproduct firms, we incur into two main issues widely debated in the empirical literature. The first concerns the identification of the *inputs* and *outputs* of financial firms. Here the discussion concentrates particularly on the role of deposits, considering that they present both input and output characteristics. The second regards how input and output have to be measured, whether in physical or monetary units.

The literature faces those issues according to two different approaches: the production (or value added) approach and the *intermediation* (or asset) approach. The first underlines the role of financial institutions as provider of services for account holders. The second considers financial institutions mainly as mediator of funds between savers and investors. Under the production approach input and output should be properly measured by data on physical quantities. However, since those data are not always available some studies use monetary stocks taken from the income statement. Under the *intermediation approach* it would be appropriate to use services flow data. Sometimes, the stock of financial value in the accounts is used instead, based on the assumption that flows are proportional to those stocks.

Regarding the role of deposits there is a longstanding controversy: the production approach argues that deposits should be considered as output because they are associated with liquidity, safekeeping and payments services provided to depositors and therefore they involve the creation of value added. Moreover, customers incur an opportunity cost; if this cost is thought as the fee for the services provided by the bank, these services (and then the deposits) should be thought as an output of the financial institution. The *intermediation approach* underlines instead that deposits should count as an input since they constitute the row material to be transformed in loans and investible funds[1].

Despite the fact that neither of the two approaches is exhaustive in capturing the dual roles of financial institutions, each of them presents some advantages. While the production approach is probably more adequate to evaluate the efficiency of branches of financial institutions, whose main role is to process customers documents and who have little influence on the overall bank policy, the *intermediation* approach may be better for evaluating entire financial institutions.

Moreover, considering that the profit maximisation process needs the minimisation of the total costs, which, differently from the production costs includes also the interest payments, the *intermediation* approach seems to be more appropriate in frontier efficiency analysis.

[1] For a good review of the literature on the argument see Berger and Humphrey (1997).

The two approaches suggest different solutions regarding which input and output has to be included in the analysis. Under the assumption that the role of financial institutions is to provide services (deposits included) for account holders, the production approach considers as inputs only physical entities, such as labour and capital. The *intermediation* approach argues that also the funds raised and their cost should be included as inputs in the analysis.

Some efficiency studies use both approaches and compare the results obtained (Hunter and Timme, 1995, Favero and Papi,1995).

Other works (Berger and Humphrey ,1991, Bauer, Berger and Humphrey,1993) propose a dual approach which allows both the input and output characteristics of deposits to be considered. According to this approach the interests paid on deposits are input, while the quantities of deposits are considered as an output, under the assumption that they can approximate the amount of services provided to the customers.

In order to compare the different approaches, we tested the relative specifications with the Davidson McKinnon J-test (1993)[2]

Since results from this test do not allow us to discriminate among the three models (none of the model has been significantly rejected), we decide to use the latter approach, which although not free from criticism, seems to be a good attempt to capture the double role of deposits.

3.2. Data and variable description

All data used in this study came from *Bankscope*, a financial database distributed by Bureau van Dijk and IBCA. Data are presented in balance sheet and income statement form. Our sample includes 1992-1997 data for banks in six European countries (Italy, France, Germany, UK, Spain, and Netherlands).

Banks are divided into three sub-groups: large, medium and small. In order to classify banks according to their size we selected banks belonging to the tenth, the sixth and the second decile of the distribution of the asset size.

Following the dual approach deposits are included in our analysis, both as an output that as an input accounting the costs of deposits as an input, and their stock value as an output.

[2] Davidson and MacKinnon (1993) proposed a method (J-test) of choosing between two non-nested models. The test is based on the idea that if one model is the correct one, then the fitted values from the other model should not have explanatory power when estimating that model. In order to run this test on the panel regression, we tested for fixed and random effect models using the Hausman test (1978), rejecting the fixed effect hypothesis. All the results are available upon request.

Table 1 - Descriptive statistics by country and by dimension for the period 1992-97

		Italy	Spain	Netherlands	Germany	France	U.K.	Total
Small	Obs.	250	113	45	163	228	89	888
	T.A	53941.27	45948.33	123844.2	126976.5	104068.1	146259.7	91995.79
Medium	Obs.	281	84	52	211	192	75	895
	T.A	4180.453	4120.47	2809.56	3011.673	5145.982	3680.016	3984.823
Large	Obs.	231	36	61	180	189	36	733
	T.A	580.7299	1492.222	1031.709	1127.797	1573.26	1065.348	1077.087
Commercial Banks	Obs.	292	84	119	134	244	131	1004
	T.A	35940.82	37505.16	27549.65	71968.04	49960.26	72270.04	48032.83
Cooperatives	Obs.	199	5	6	83	218		511
	T.A	6218.726	3503.104	172463.5	43962.69	28605.57		23825.32
Saving and Loans	Obs.	184	114		229	43	6	576
	T.A	4979.547	12962.04		2210.359	29760.94	44722.97	7722.465
Investment banks	Obs.		6	6		6	16	34
	T.A		6116.444	2388.077		36660.13	4307.98	9997.517
Real Estate and Mortgage Banks	Obs.	6	6	6	43		6	67
	T.A	336.4232	17514.12	4062.487	19963.11		166542.7	29688.78
Non-banking institutions	Obs		6	5		62	6	79
	T.A.		29206	502.4086		16074.83	2481.044	15054.1
Medium and Long term credit banks	Obs.	29		6	5	12		52
	T.A	24577.72		17748.63	37834.75	58372.32		32863.22
Banks Holding	Obs.	11	12	10		18	35	86
	T.A	114288.2	52446.72	132112.3		137419.7	71790.87	95277.77
Specialised Governmental Credit Institutions	Obs.	41			60	6		107
	T.A	4237.722			111487.5	152705.2		72703.07
Total	Obs.	762	233	158	554	609	200	2516
	T.A	19414.93	24000.01	36595.06	38872.98	41072.07	66657.32	34200.39

T.A. represents the average total assets expressed in million of US dollar.

We identify three output variables: loans, deposits and financial investments. The loans variable includes all forms of performing loans. The deposits variable accounts for all funds raised from retail customers and can be thought as a proxy of the amount of services produced. The financial investment variable is constructed as the total value of short-term investments, trading securities, equity investments, and public sector securities.

Labour, capital and deposits are the input variables considered in the analysis.

The total costs associated with those inputs are, respectively: total personnel expenses, non-staff expenses, and total interest on deposits. The labour price is obtained by dividing staff expenses by total number of employees. When the last variable is not available it has been estimated by dividing the total staff expenses by the average value of the unitary labour cost for the same bank or for banks belonging to the same country and the same size class. The price of capital is obtained by dividing cost of capital by fixed assets net of depreciation. In order to adjust the book value of fixed capital to account for distortions[3], we use an adjusted value, computed as the fitted value of a translog estimation, where fixed asset is regressed on a constant term, the amount of deposits, the amount of loans and the number of employees[4]. In the few cases where the gap between fitted and book value of capital asset was higher than 50% we decided to use the last value. The appropriateness of using these fitted values in the model has been tested with the Davidson McKinnon J-test (1993)[5]. Finally, interest costs are computed by dividing total interest expenses by the total amount of deposits.

Table 2 -Variable used and their definition

Variable	Variable Name	Description
Output		
y1	Loans	All forms of performing loans
y2	Deposits	Deposit with retail customers
y3	Financial Investments	short-term investments, trading securities, public sector securities, equity investments
Input prices		
w	Price of labour	Personnel expenses/Total number of employees
k	Price of capital	Non-personnel expenses/ Adjusted value of net fixed assets
d	Price of deposits	Interest paid on deposits/Deposits
Total cost		
TC	Operating costs + interest expenses	Personnel expenses+non personnel expenses+interests paid on deposits

The environmental variables (z) used in the technical inefficiency specification (2) include: dummies accounting for the firm's dimension, bank organisational type dummies and bank balance indicators.

All variables used are expressed in monetary values at 1997 prices. This choice, mainly due to the lack of data on physical quantities, can affect the

[3] We must take into account the fact that fixed capital may have been recorded in different periods, and revalued due to tax laws or mergers.

[4] A similar method is used in Resti (1997, pag. 226), where the number of branch rather than the number of employees is used as a proxy for physical capital. Our choice is due to the lack of information about the number of branches. The regressions are estimated separately for banks belonging to different countries and having different size dimension (small, medium and large). Results are available upon request.

[5] Results from this test are available upon request.

results, since it is not necessary true that, for example, an equal monetary amount corresponds to an equal production of bank services. The error associated to this approximation is partially compensated by the high correlation generally existent between the stock of funds and the physical quantities[6].

4. *The model*

In our analysis we use both the primary stochastic frontier model (Battese and Coelli, 1992), and the model in which the inefficiency term is expressed as a function of a number of explanatory variables (Battese and Coelli, 1995). In both cases we specify the cost function as translog stochastic frontier. The translog specification is one of the most used functional forms in the empirical literature on the efficiency. In fact, it presents the well-known advantages of being a flexible form and of including, as a particular case, the Cobb-Douglas specification.

The s-*th* firm total cost can be written as follows:

$$\ln(TC)_s = [\alpha_0 + \sum_{i=1}^{3}\alpha_i \cdot \ln y_{is} + \sum_{k=1}^{2}\beta_k \cdot \ln x_{ks} + \tfrac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3}\alpha_{ij} \cdot \ln y_{is} \cdot \ln y_{js} + \tfrac{1}{2}\sum_{k=1}^{2}\sum_{h=1}^{2}\beta_{kh} \cdot \ln x_{ks} \cdot \ln x_{hs} + \sum_{i=1}^{3}\sum_{k=1}^{2}\delta_{ik} \cdot \ln y_{is} \cdot \ln x_{ks}] + V_{st} + U_{st} \quad (4)$$

where:

TC = total cost

y_i is the i-*th* output

x_i is the price of the k-*th* input.

In estimating the equation, we impose:

1) the symmetry conditions $\alpha_{ij} = \alpha_{ji} \quad \forall\ i, j\ (i, j = 1, \ldots\ldots\ldots.\ n)$

$$\beta_{ij} = \beta_{ji} \quad \forall\ i, j\ (i, j = 1, \ldots\ldots\ldots.\ m)$$

2) the linear homogeneity conditions by normalising total cost (TC), price of labour (*w*) and price of deposits (d) by the price of capital (*k*).

In the first part of the analysis we estimate a common cost frontier on the full longitudinal sample, using the basic Battese Coelli (1992) model. We allow for time-varying inefficiencies (the term η is not restricted to be zero).

[6] See Humphrey (1990).

The estimation of a common frontier is the most used method to compare the performances of banking belonging to different countries. From the estimation of the model we obtain the values of inefficiency for each firm included in the sample. Using these values we compute the average cost efficiency for each country by firm's dimension and banking organizational type. This makes a comparison of the firm's efficiency levels across countries possible.

However, this approach does not allow to distinguish whether the differences in inefficiency are due to environmental conditions or difference in the technology used[7].

Therefore, we re-estimate the common frontier on a more homogeneous subsample to check whether results are significantly different. This subsample includes only the traditional banking institutions (commercial banks, cooperatives and saving & loans). Such institutions providing the same activities and financial services are likely more comparable than other financial firms.

However, since it is still reasonable to expect differences both in the cost functional form and in the technical inefficiency structure of the six European countries considered in our sample, in the second part of the analysis we run the regression for each country separately. By doing so we use the second model (Battese Coelli, 1995) where the technical inefficiency is specified as:

$$U_{st} = \delta_0 + \sum_{i=1}^{n-1} \delta_i dSize_i + \sum_{s=1}^{l-1} \delta_s dOT_{si} + \sum_{b=1}^{p} \delta_b BalI_b + \delta_t Trend + W_{it} \qquad (5)$$

$dSize_i$ are 3 dummies accounting for the firm's dimension (small, medium, large) i = 1,..n, n=3;

dOT_s are 9 banking organizational type dummies (Commercial banks, Saving and Loans, Cooperative banks, Real Estate & Mortgage Banks, Medium & Long Term Credit Banks, Investment banks, Non-banking credit institutions, Specialised Governmental Credit Institutions, Bank Holding & Holding Companies) s=1, ... l, l=9;

$dBalI_b$ are bank specific balance indicators (b = 1, ...p, p=13) accounting for: *size* (lnTA: log of total Asset); *portfolio composition*: liquidity (total securities investments over total asset); asset items (total asset items over total assets); liabilities (total liabilities over total assets); liability composition (consumer deposits over total liabilities); *performance*: ROA (net income over total asset); Non-interest income (non-interest income over total assets); Net-interest income (net-interest income over operating

[7] To account for those effects, Dietsch and Lozano Vivas (1998) impose cross-equation equality restriction on the parameters of each country's cost frontier in order to obtain results which are not influenced by the country's technology. They add country-specific environmental variables to the cost function specification to measure the impact of those variables on the differences in country inefficiencies.

income); personnel expenses over operating costs; Non interest expenses (cost to income ratio); *inter-banking relationships*; *capitalisation* (bank's capital plus reserves over Total asset); *fiscal load* (Tax over gross income).

We also add a trend variable (*Trend*) to capture the pattern of the inefficiency throughout the six year period.

5. *Empirical findings*

5.1. *Common frontier analysis*

The models are estimated using the computer program Frontier 4.1 (Coelli 1996). As explained above, we first run our model on the full longitudinal sample using the Battese Coelli (1992) specification. Results, presented in table 3, show the appropriateness of the translog specification used in the analysis. Most of the second order terms parameter estimates of the cost function are significant. In addition the high value of the estimation of the γ parameter, reflecting the importance of the inefficiency effects, strongly supports the opportunity of using the stochastic frontier production function rather the standard OLS method. The negative value for η indicates a decreasing trend in the efficiency over the period considered.

By decomposing the inefficiency values obtained from this first estimate on the overall panel, we can derive information about the level of banking efficiency by country, by dimension, and by bank organizational type. Through this analysis we have a first insight about the efficiency of the banking systems. Results of the estimated efficiency levels are presented in table 4a.

Overall results evidence the presence of inefficiency in the banking system: the mean value of the full sample is sensibly higher than unity (1.71) indicating that on average, banks are operating far from the efficient frontier. Looking at values by countries we can compare the performance of each banking system. Among the countries selected Germany presents the most efficient banking system, followed by France and Netherlands. In deed difference in mean tests performed in table 4b indicate that the level of inefficiency in France and Netherlands are not statistically different. The worst performance is instead played by the United Kingdom banks, which show a mean value of efficiency equal to 2.03. This result apparently quite surprisingly is maybe consistent with the characteristics of the Anglo-Saxon banking model, which works with higher level of cost to achieve a higher level of profitability. Higher total costs make most likely firms to deviate from the optimal frontier. Despite the fact that all the efficiency estimates are highly significant[8], high values of the

[8] All the inefficiency levels are significant at 99%. T-test results are available from the authors upon request.

standard deviation suggest a wide difference in the distribution of inefficiency levels for the British and Dutch banks.

Table 3 - Parameters of the cost function specified on the full sample

Variables	Parameter	Panel	
		coefficient	t-ratio
	b_0	1.254	10.890
ln y1	b_1	0.750	14.061
ln y2	b_2	-0.083	-1.404
ln y3	b_3	0.051	3.432
ln dk	b_4	0.902	34.845
ln wk	b_5	0.016	0.559
$(\ln y1)^2/2$	b_6	0.261	6.929
ln y1.ln y2	b_7	-0.247	-6.422
ln y1.ln y3	b_8	0.003	0.556
$(\ln y2)^2/2$	b_9	0.270	6.664
ln y2.ln y3	b_{10}	-0.010	-1.665
$(\ln y3)^2/2$	b_{11}	0.001	0.714
$(\ln wk)^2/2$	b_{12}	0.177	19.557
ln dk.ln wk	b_{13}	-0.214	-31.423
$(\ln dk)^2/2$	b_{14}	0.238	40.991
ln y1.ln wk	b_{15}	-0.200	-9.796
ln y1.ln dk	b_{16}	0.246	13.448
ln y2.ln wk	b_{17}	0.208	10.306
Ln y2.ln dk	b_{18}	-0.250	-13.834
Ln y3.ln wk	b_{19}	-0.011	-3.653
ln y3.ln dk	b_{20}	0.011	3.779
	σ^2	0.041	25.072
	γ	0.932	346.066
	μ	0.392	15.412
	η	-0.016	-7.918

The table reports magnitude and t-statistics of the maximum likelihood translog estimate (eq. 4) where $\sigma^2 = \sigma_u^2 + \sigma_v^2$; $\gamma = \sigma_u^2 / \sigma^2$; μ is the truncation of a normal density functions, η indicates the time-variance of inefficiency: $U_{it} = U_i \exp(-\eta(t - T))$

Table 4a - Statistics on efficiency estimates by country, by size and by banking organizational type.

	All sample	**Italy**	**Spain**	**Netherlands**	**Germany**	**France**	**Uk**
Full sample							
All sample	1.71	1.77	***1.84***	***1.68***	***1.52***	***1.66***	***2.03***
	(.56)	***(.26)***	***(.22)***	***(1.31)***	***(.25)***	***(.34)***	***(1.22)***
			Size				
Large	1.79	1.89	1.89	2.6	1.43	***1.58***	2.19
	(.62)	(.19)	(.24)	(2.12)	(.34)	***(.30)***	(.35)
Medium	1.75	1.84	1.83	1.28	1.57	1.71	2.17
	(.63)	(.29)	(.21)	(.11)	(.18)	(.32)	(1.89)
Small	1.57	1.57	1.75	1.35	1.52	1.70	1.35
	(.30)	(.17)	(.09)	(.51)	(.18)	(.40)	(.13)
			Banking organizational type				
Comm	1.75	1.89	1.91	1.45	1.50	1.65	2.10
	(.64)	(.18)	(.16)	(.45)	(.38)	(.39)	(1.46)
Coop	1.70	1.72	1.22	1.91	1.51	1.76	
	(.27)	(.29)	(.007)	(.03)	(.16)	(.24)	
S&L	1.76	1.83	1.88	-	1.63	1.67	2.54
	(.20)	(.18)	(.17)	-	(.09)	(.09)	(.07)
			Other intermediary and non banking institutions				
Investment banks	1.45	-	1.85	1.37	-	1.40	1.35
	(.21)	-	(.03)	(.01)	-	(.01)	(.14)
Real Estate & Mortgage banks	1.35	-	1.38	1.33	1.26	-	1.65
	(.21)	-	(.01)	(.01)	(.17)	-	(.02)
Non-banking institutions	1.45	1.71	1.27	1.08	-	1.45	1.91
	(.38)	(.02)	(.01)	(.004)	-	(.39)	(.04)
Holdings	2.32	2.02	1.85	5.3	-	1.65	2.07
	(1.58)	(.04)	(.13)	(3.3)	-	(.36)	(.49)
Med & Long Term	1.25	1.35	-	1.23	1.14	1.07	-
	(.13)	(.07)	-	(.008)	(.004)	(.04)	-
Specialized Govern. Credit Institutions	1.33	1.27	-	-	1.36	1.44	-
	(.09)	(.06)	-	-	(.09)	(.01)	-

			Three-sectors subsample				
All sample	1.74	1.82	***1.87***	***1.47***	***1.57***	***1.70***	***2.12***
	(.47)	***(.23)***	***(.19)***	***(.45)***	***(.24)***	***(.32)***	***(1.43)***
			Size				
Large	1.85	1.93	1.97	1.96	1.61	***1.64***	2.20
	(.30)	(.13)	(.15)	(.16)	(.41)	***(.26)***	(.30)
Medium	1.78	1.95	1.81	1.26	1.58	1.71	2.51
	(.66)	(.17)	(.22)	(.12)	(.18)	(.32)	(2.32)
Small	1.59	1.57	1.74	1.37	1.54	1.75	1.36
	(.29)	(.16)	(.09)	(.53)	(.17)	(.36)	(.14)

Table reports the inefficiency mean value, expressed in percentage, and standard deviation (in parenthesis).
The measure of cost efficiency is defined as:

$$EFF_{it} = E(C_{it}|\ U_{it}, X_{it})/E(C_{it}|\ U_{it} = 0, X_{it})$$

where: C_{it} is the total cost, U_{it} is the inefficiency term, and X_{it} are the regression parameters. It will take a value between 1 and infinite. Values closer to one indicate a higher level of efficiency.

The efficiency values by bank's size measured on the full sample show a significant difference between small and large banks the better efficiency performance being played by the small financial institutions. The analysis by country confirms this evidence for the Italian, the Spanish, the British and the Dutch banking system. Actually for the last country the medium banks have a level of inefficiency lower than small banks, but the difference between these two means is not significant (see table 4c). On the contrary the largest banking institutions appear to be the most efficient ones in Germany and France.

Table 4a also reports efficiency levels for different bank organisational types, separating banks operating in the more traditional activities (commercial, cooperative and saving & loans) from the other banking institutions.

Among traditional banks, globally the best performance seems to be played by the cooperative banks. Looking at the analysis by country these banks however result to be the more efficient only in Italy and Spain, while in the other countries the best performance seems to be played by the commercial banks.

For the other banking institutions the analysis evidences the poor performance of the holding banks. The very high level of inefficiency (5.3) for Dutch holding banks should actually be interpreted with caution, considering the few observations (only two banks) available for this banking type. However this value does not drastically affect the other results, as shown in the last rows of table 4a, where we present the model estimates on a subsample which includes only the three traditional bank types. Results obtained on this subsample generally confirm the evidence presented before. The only noteworthy change regards the ranking of the three most efficient banking systems. Taking into account only banks belonging to this more homogenous sample the best performance results to be played by Netherlands closely followed by Germany and France. British banks confirm their poor performance. Using this subsample small institutions result to be the most efficient ones also for Germany, leaving France banking system the only exception where large banks are still the most efficient institutions.

Table 4b - Difference in mean among inefficiency levels by country

	Italy	**Spain**	**Netherlands**	**Germany**	**France**	**Uk**
			Full sample			
Italy		-7	9*	25	11	-26
		(-3.72)	(1.74)	(17.50)	(6.79)	(-5.44)
Spain			16*	32	18	-19
			(1.83)	(16.97)	(7.50)	(-2.33)
Netherlands				16	2**	-35
				(2.71)	(0.34)	(-2.61)
Germany					-14	-51
					(-7.93)	(-9.32)
France						-37
						(-6.74)
Uk						
			Three-sectors subsample			
Italy		-5	35	25	12	-30
		(-2.82)	(13.03)	(7.51)	(7.49)	(-5.14)
Spain			40	30	17	-25
			(11.16)	(15.71)	(7.08)	(-2.46)
Netherlands				-10	-23	-65
				(-3.31)	(-6.59)	(-4.87)
Germany					-13	-55
					(-7.01)	(-7.79)
France						-42
						(-6.07)
Uk						

The table reports the difference between the mean inefficiency level of the country indicated in the first column and the country indicated in the first row. In parenthesis we report the value of the difference in mean test, computed as :

$$t = (\mu_1 - \mu_2)\sqrt{\frac{N_1 N_2 g}{N_1 + N_2}} \Big/ \sqrt{(N_1 - 1)\sigma_1^2 + (N_2 - 1)\sigma_2^2}$$

where $g = N_1 + N_2 - 2$ defines the number of degrees of freedom, μ_i is the mean of the *i-th* group, N_i is the number of observations in the *i-th* group and σ_i^2 is the variance of the *i-th* group. Under standard assumption, the test has a t-distribution.

Starred values are only significant at 90%; two-starred values are not statistically significant; all other values are significant at 99%.

Table 4c - Difference in mean among inefficiency levels of different dimensional class of banks (by country)

	All countries	Italy	Spain	Netherlands	Germany	France	Uk
	Full sample						
Large-medium	4**	5	6*	132	-14	-13	2
	(1.35)	(2.32)	(1.83)	(4.49)	(-5.12)	(-4.29)	(0.10)
Medium-small	18	27	8	-7**	5	1**	82
	(7.10)	(12.49)	(2.20)	(-0.97)	(2.74)	(0.27)	(2.59)
Large-small	32	32	14	125	-9	-12	84
	(8.79)	(19.41)	(3.42)	(4.44)	(-3.10)	(-3.50)	(13.99)
	Three-sectors subsample						
Large-medium	7	-2**	16	70	3	-7	-31**
	(2.49)	(-1.40)	(5.58)	(20.78)	(0.84)	(-2.22)	(-1.03)
Medium-small	19	38	7*	-11**	4	-4**	115
	(6.904)	(24.48)	(1.83)	(-1.29)	(2.19)	(-1.08)	(2.71)
Large-small	36	36	23	59	7	-11	84
	(16.01)	(-25.91)	(8.62)	(5.84)	(1.89)	-(3.19)	(14.53)

The table reports the difference between the mean inefficiency level of the size classes indicated in the first column. In parenthesis we report the value of the difference in mean test, computed as :

$$t = (\mu_1 - \mu_2)\sqrt{\frac{N_1 N_2 g}{N_1 + N_2}} \Big/ \sqrt{(N_1 - 1)\sigma_1^2 + (N_2 - 1)\sigma_2^2}$$

where $g = N_1 + N_2 - 2$ defines the number of degrees of freedom, μ_i is the mean of the *i-th* group, N_i is the number of observations in the *i-th* group and σ_i^2 is the variance of the *i-th* group. Under standard assumption, the test has a t-distribution.
Starred values are only significant at 90%; two -starred values are not significant; all other values are significant at 99%.

Table 4a also shows that the banking institutions presenting the best performances are the Medium & Long term banks, the Real Estate & Mortgage Banks, and, quite surprisingly, the Specialised Governmental Credit Institutions. In France and in the United Kingdom Investments banks are among the most efficient institutions.

In our analysis we also compare the level of efficiency of the three different banking models. Table 5 reports those estimates. As expected the Mittle-European model seems to be the most efficient banking system, followed by the Latin and Anglo-Saxon model. Moreover for all the three banking models small institutions result to be the most efficient ones. Both results are strongly confirmed when we use the more homogenous sample including only the most traditional banking institutions.

Table 5a – Efficiency levels across different banking models

	Latin		Mittle-European		Anglosaxon	
	Mean (st.dev)	*Obs.*	*Mean (st.dev)*	*Obs.*	*Mean (st.dev)*	*Obs.*
Full sample						
All sample	1.74 (.30)	1604	1.55 (.65)	712	***2.03*** ***(1.22)***	200
Size						
Large	1.77 (.29)	591	1.69 (.13)	208	2.19 (.35)	89
Medium	1.79 (.30)	557	1.52 (.20)	263	2.17 (1.89)	75
Small	1.63 (.29)	456	1.48 (.31)	241	1.35 (.13)	36
Banking organizational type						
Comm	1.79 (.30)	620	1.47 (.41)	104	2.10 (1.46)	131
Coop	1.73 (.27)	422	1.53 (.19)	241		0
S&L	1.83 (.18)	341	1.63 (.09)	226	2.54 (.07)	6
Other intermediary and non banking institutions						
Investment banks	1.63 (.23)	12	1.37 (.01)	6	1.35 (.14)	16
Real Estate & Mortgage banks	1.54 (.17)	12	1.26 (.16)	49	1.65 (.02)	6
Non-banking institutions	1.43 (.37)	68	1.08 (.004)	5	1.91 (.04)	6
Holdings	1.81 (.28)	41	5.3 (3.34)	10	2.07 (.49)	35
Med & Long Term	1.27 (.14)	41	1.19 (.04)	11		0
Specialized Govern. Credit Institutions	1.30 (.08)	47	1.36 (.09)	60		0

Three-sectors subsample

	Latin		Mittle-European		Anglosaxon	
	Mean (st.dev)	*Obs.*	*Mean (st.dev)*	*Obs.*	*Mean (st.dev)*	*Obs.*
All sample	1.78 (.27)	1383	1.55 (.30)	571	***2.12*** ***(1.43)***	137
Size						
Large	1.84 (.24)	484	1.71 (.39)	104	2.20 (.30)	60
Medium	1.84 (.26)	483	1.52 (.21)	241	2.51 (2.32)	47
Small	1.66 (.27)	416	1.49 (.31)	226	1.36 (.14)	30

Table 5b - Difference in mean among inefficiency levels by banking model and by dimension

	Latin-Mittleuropean	Mittleuropean-Anglo	Latin-Anglo
Full sample	19	-48	-29
	(9.62)	(-7.40)	(-7.82)
Three-sectors subsample	23	-57	-34
	(16.56)	(-8.77)	(7.59)
	Latin	**Mittle-European**	**Anglosaxon**
	Full sample		
Large-medium	-2**	17	2**
	(-1.14)	(10.61)	(0.09)
Medium-small	16	4*	82
	(8.57)	(1.73)	(2.59)
Large-small	14	21	84
	(7.74)	(9.10)	(13.98)
	Three-sectors subsample		
Large-medium	0**	19	-31**
	(0)	(5.85)	(-1.02)
Medium-small	18	3**	115
	(10.16)	(1.23)	(2.70)
Large-small	18	22	84
	(10.58)	(5.50)	(14.53)

The first part of the table reports the difference between the mean inefficiency level of the bank models indicated in the first row. The second part of the table reports the difference between the mean inefficiency level of the size classes (in which each banking model has been divided) indicated in the first column. In parenthesis we report the value of the difference in mean test, computed as :

$$t = (\mu_1 - \mu_2)\sqrt{\frac{N_1 N_2 g}{N_1 + N_2}} \Big/ \sqrt{(N_1 - 1)\sigma_1^2 + (N_2 - 1)\sigma_2^2}$$

where $g = N_1 + N_2 - 2$ defines the number of degrees of freedom, μ_i is the mean of the *i-th* group, N_i is the number of observations in the *i-th* group and σ_i^2 is the variance of the *i-th* group. Under standard assumption, the test has a t-distribution.
Starred values are only significant at 90%; two -starred values are not significant; all other values are significant at 99%.

The results of the panel estimation give a first evidence of wide differences in the inefficiency level by country and by sector. We recall that these results are obtained by comparing the performances of banking belonging to different countries with respect to a common frontier. As evidenced above this approach does not allow to account for differences in inefficiency due to environmental conditions and differences in the technology used.

5.2. Analysis by country

To capture differences both in the cost functional form and in the technical inefficiency structure of the six European countries considered in our sample, we perform the regressions for each country separately. This analysis does not aim to directly compare the results obtained for each country (since we are not allowed to relate different cost frontiers) but to identify the inefficiency determinants and the characteristics of each banking system. For that purpose we use the Battese and Coelli model (1995) which allows to specify the variables affecting technical inefficiency.

The estimates are obtained by the following simultaneous estimations of the equations 4 and 5 described above:

$$\begin{cases} \ln(TC)_s = [\alpha_0 + \sum_{i=1}^{3}\alpha_i \cdot \ln y_{is} + \sum_{k=1}^{2}\beta_k \cdot \ln x_{ks} + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3}\alpha_{ij} \cdot \ln y_{is} \cdot \ln y_{js} + \frac{1}{2}\sum_{k=1}^{2}\sum_{h=1}^{2}\beta_{kh} \cdot \ln x_{ks} \cdot \ln x_{hs} + \sum_{i=1}^{3}\sum_{k=1}^{2}\delta_{ik} \cdot \ln y_{is} \cdot \ln x_{ks}] + V_{st} + U_{st} \\ U_{st} = \delta_0 + \sum_{i=1}^{n-1}\delta_i dSize_i + \sum_{s=1}^{l-1}\delta_s dIT_{si} + \sum_{b=1}^{p}\delta_b BallI_b + W_{it} \end{cases}$$

In table 6 we report only the most significant coefficients of the inefficiency equation, while full estimation results are available from the authors upon request.

In our regressions information on the effect that firm's size can have on the efficiency level are obtained by the *lnTA*, and the three dummies *Dsmall*, *Dmedium* and *Dlarge*. While the *lnTA* capture the existence of a correlation between the bank total asset and the cost efficiency, the dimension dummies account for the impact that banks belonging to different size class can have on the inefficiency levels.

Compared to the omitted variable *Dmedium*, the dummy *Dsmall* presents a significant and negative sign, in the case of Italy, Spain and UK, supporting the results obtained from the common frontier analysis that small banks perform closer to the efficient frontier. These results are apparently in contradiction with the negative sign of the *lnTA* coefficient indicating an apparent decline in the cost inefficiency as bank total asset grows for almost all countries. In deed this coefficient aims to capture the influence of the total asset dimension on the efficiency of banks independently from the class dimension to which the firm belongs. Therefore we could expect to find a negative relation between total asset and inefficiency cost inside the most efficient small size group[9].

[9] Even though the criteria used to build the dimension group could generate a problem of collinearity between dSize dummies and *lnTA,* looking at the correlation matrix of the coefficients we can exclude the existence of such a problem in our analysis.

Table 6 – The determinants of inefficiency by country

Variables	France	Germany	Italy	Netherlands	Spain	UK
			Size			
LnTA	0.066	-0.024	0.011	-0.065	-0.084	-0.115
	(1.214)	(-2.075)	(1.13)	(-2.218)	(-7.255)	(-3.141)
Dsmall	0.035	0.001	-0.053	-0.001	-0.049	-0.492
	(0.45)	(0.03)	(-3.157)	(-0.021)	(-2.117)	(-3.693)
Dlarge	-0.087	0.157	-0.002	0.14	0.043	0.03
	(-1.097)	(3.102)	(-0.108)	(1.453)	(1.934)	(0.215)
			Institutional type			
Comm	0.01	-0.078	0.017	0.611	-0.103	-0.051
	(0.218)	(-2.356)	(0.443)	(7.956)	(-1.758)	(-0.41)
Coop	-0.044	-0.089	-0.008	0.063	-0.197	0
	(-0.877)	(-2.852)	(-0.211)	(0.529)	(-4.798)	0
S&L	0.017	-0.031	-0.004	0	-0.096	0.122
	(0.298)	(-0.978)	(-0.099)	0	(-1.918)	(0.767)
Invbanks	-0.545	0	0	0.558	-0.14	-0.512
	(-0.455)	0	0	(4.044)	(-2.02)	(-2.677)
Real Estate and Mortgage Banks	0		0	0.743	-0.214	-1.013
	0		0	(4.069)	(-3.938)	(-2.813)
Holdings	-0.035	0	0.034	0.538	-0.092	-0.024
	(-0.446)	0	(0.73)	(5.268)	(-1.426)	(-0.163)
Med&long	-0.01	-0.447	-0.156	0.186	0	0
	(-0.082)	(-8.21)	(-3.585)	(1.42)	0	0
Specialised Governamental Credit Institutions	-0.113	-0.158	-0.307	0	0	0
	(-0.464)	(-4.494)	(-7.399)	0	0	0
			Trend			
	0.008	0.018	0.011	0.01	0.008	-0.005
	(1.566)	(6.05)	(5.063)	(0.889)	(2.299)	(-0.531)
			Portfolio composition			
Liquidity[a]	-0.003	0.001	-0.001	0.003	-0.002	0.011
	(-2.055)	(0.588)	(-2.566)	(0.976)	(-2.476)	(3.716)
Asset items [b]	0.001	0.001	0.001	0.002	0.003	0.007
	(1.197)	(1.52)	(2.106)	(1.526)	(4.275)	(3.926)
Liabilities[c]	0.001	0.005	-0.002	-0.001	0.001	-0.008
	(0.831)	(7.346)	(-3.991)	(-0.348)	(1.297)	(-3.627)
Asset items composition[d]	0.002	0.004	0.002	-0.001	0	0.004
	(3.006)	(7.135)	(9.58)	(-0.862)	(0.837)	(2.748)

Follows table 6

Variables	France	Germany	Italy	Netherlands	Spain	UK
			Performance			
ROA	-0.001	-0.053	-0.028	-0.026	0.003	0.113
	(-0.042)	(-2.162)	(-8.334)	(-0.767)	(0.583)	(2.915)
Non interest income[e]	0.022	0.142	0.052	8.937	0.149	0.097
	(1.117)	(8.923)	(11.032)	(7.439)	(6.296)	(6.81)
Interest income[f]	0	0.001	-0.001	0.001	0.006	-0.002
	(3.206)	(1.965)	(-5.225)	(0.854)	(6.915)	(-1.004)
Non interest expenses[g]	0	0.001	0.001	0.007	0.004	0.004
	(2.218)	(11.255)	(7.328)	(3.805)	(7.1)	(5.232)
			Capitalization			
Capital plus reserves/TA	0.004	0.015	0.007	0.007	0.001	-0.03
	(0.627)	(3.26)	(7.241)	(0.912)	(0.174)	(-3.893)
			Trend			
	0.008	0.018	0.011	0.01	0.008	-0.005
	(1.566)	(6.05)	(5.063)	(0.889)	(2.299)	(-0.531)
			Goodness of fit indicators[h]			
σ^2	0.027	0.0042	0.003	0.008	0.001	0.013
	(11.435)	(15.442)	(18.184)	(6.181)	(9.303)	(5.754)
γ	0.29	0.999	0.301	0.876	0.773	0.823
	(4.741)	(1089.557)	(14.928)	(63.936)	(21.025)	(18.875)
Log-likelihood	259	869	115	218	467	195
N. of cross-sections	105	99	136	100	85	84

Table 6 reports magnitude and t-statistics of the most significant coefficients of the inefficiency equation (d_{j5}, j=0,…, 24) obtained by the simultaneous estimation of the following system performed separately for each country:

$$\begin{cases} \ln C_{it} = \ln C(y_{it}, w_{it}, \Theta) + (V_{it} + U_{it}) \\ U_{st} = \delta_0 + \sum_{i=1}^{n-1} \delta_i dSize_i + \sum_{s=1}^{l-1} \delta_s dIT_{si} + \sum_{b=1}^{p} \delta_b BalI_b + W_{it} \end{cases}$$

[a] Securities/TA
[b] Total asset items/TA
[c] Total liabilities/TA
[d] Custumer Dep/Total liabilities
[e] Non interest Income /TA
[f] Net Interest Income/Operating Income
[g] Cost to Income Ratio
[h] $\sigma^2 = \sigma_\upsilon^2 + \sigma_\varpi^2$; $\gamma = \sigma_\upsilon^2 / \sigma^2$

Looking at the banking organisational type indicators, we can observe a wide difference across countries. All the coefficients have to be interpreted with respect to the omitted dummy, that is the non-banking institutions for all countries with the exception of Germany, where instead the omitted dummy is Real Estate & Mortgage Banks (being the data on non-banking institutions not available). With few exceptions, country analysis results are consistent with the general results presented in table 4a. In particular, in Italy and in Germany Medium & Long Term Banks and Specialised Governmental Credit Institutions appear to be the less inefficient institutions. Real Estate & Mortgage Banks have a positive effect on the technical inefficiency in Spain and UK. Investment banks show a negative sign in UK.

With respect to the general results Commercial banks in Spain and Commercial and Cooperatives banks in Germany seem to present higher levels of efficiency.

The main *caveat* of those results is represented by the lack of homogeneity of the data set used: for example, not all the institutional types are present in the country analysed[10]. At the same time, since we are interested in capturing the characteristics of each country's banking system, we prefer to choose asymmetric country samples. By standardising the sample across countries (selecting only common banking types, or the same number of banks having the same dimension) we would gain in homogeneity and comparability of the results, but we would lose important information about the specific country features.

Looking at the specific bank balance indicators, we can have more insights about the determinants of inefficiency.

The coefficient Liquidity (securities activity as a fraction of total asset) shows a significant and negative sign for Italy, Spain, France and positive for UK. In order to correctly interpret this result, we should refer to the composition of the security variable which indifferently include short-term investments, trading securities, public sector securities, equity investments. Those activities are different for the countries analysed, and particularly for UK (which is traditionally designated as a *separated banking* country). Probably, the more complex structure of the security activity in UK makes this activity more cost absorbing than in other countries. On the contrary, in Italy, in Spain, and in France being engaged in greater amounts of security trade have a negative impact on cost efficiency.

The coefficient of Asset items is significantly positive for Italy, Spain and UK (for the others countries the coefficient is not significant). This positive sign suggests that banks engaged in higher lending activity tend to be less

[10] The use of different technical efficiency specification due to the presence of different institutional type does not significantly change the results obtained on the other parameters. Results are available from the authors upon request.

efficient[11]. A plausible explanation is that these banks are particularly exposed to credit risk and therefore face higher costs inefficiencies connected with the monitoring and collection of debts activities.

The possibility to access to a stable base of deposits, measured by the Liabilities, seems to have a positive impact on efficiency for Italy and UK, as evidenced by the negative sign of the coefficient. On contrary the Liabilities coefficient presents a positive sign for Germany.

It is interesting to note that the customer component of deposits (Liabilities composition) generally have a positive sign, indicating that the positive impact on efficiency is mainly due to inter-banking deposits.

The coefficient on the ROAA is significantly negative for Germany and Italy indicating that for these countries higher profitability is related to greater efficiency. On the contrary, the significantly positive sign of the same coefficient for UK indicates that the Anglo-Saxon model realizes higher level of profitability at the expenses not only of higher level of total cost but also of larger distance between the cost and the efficient frontier. This suggests that for this country room exists for further improving profitability by reducing the inefficiency gap.

The significant positive sign of the non interest expenses coefficient in all country regressions, confirms the hypothesis that firms with higher total costs are most likely to deviate from the optimal frontier.

A noteworthy result of the analysis is the impact of the non-interest income on the technical inefficiency, which is positive and highly significant (with the exception of France) for all countries. This result may be an useful contribute to the discussion about the way banks should approach the more competitive market promoted by the European Union. The non-interest income is the standard alternative to the reduction in the operating costs proposed to face the sharp reduction of the main bank's profit source, the interest income. Our results highlight how this alternative cannot be efficiently outperformed without a preliminary reduction of the operating costs and particularly of the gap between total costs and the efficient frontier.

The capitalisation indicator shows a positive and significant sign for Germany and Italy. The capital requirement constitutes a relevant constraint for banks, reducing flexibility in the cost structure. Only for Germany, Spain and Italy we can observe an increase in the inefficiency over time, which shows an increase over the six year period.

6. *Conclusion*

In this paper we have analysed the performance of European banks in view of the constitution of the European Monetary Union. As the European

[11] Mester (1993) finds the same result for S&L but not for Mutuals; on the contrary, Allen & Rai (1996) find a negative sign for the same coefficient.

Monetary Union brings banks into closer competition only the most efficient can reach a leader position in the common market, while the weakest banks, by loosing their market share, will be induced to leave the market or to merge with the more efficient firms.

The analysis, based on an international database of financial institutions, is focused on the determinants of any deviation from cost minimising.

The results indicate the appropriateness of the specifications used to model both the cost function and the technical inefficiency. All the qualitative and quantitative variables are significant components in explaining the cost inefficiency. The estimation of the model over the period 1992-97 shows that there is space for all banks to improve the efficiency of the productive process by reducing deviations from the optimal frontier. The analysis also evidences the existence of significant efficiency gaps among the performances of banks belonging to different countries and different institutional types. This suggests that, at the beginning of the European Monetary Union, national barriers and regulatory frameworks are still responsible for a suboptimal performance of financial institutions. Among countries, results suggest that the German banks perform better than banks belonging to the other countries, followed by France and Netherlands. On the contrary the UK financial institutions show the less efficient performance.

From these result we may infer that the universal banking system, permitting a more functional integration between commercial and investment activities, more than separated banking system allows for production plans closer to the optimal frontier. Although this result needs further and more direct investigation, it contributes to support the tendency of banking systems to move towards more integrated and multifunctional structures.

Beyond these differences, the analysis allows us to point out some common insights. Useful suggestions can be drawn by looking at the determinants of inefficiency. A common result is the negative relationship between the cost to income ratio and the non-interest income on one side and the cost inefficiency on the other. This suggests that in order to efficiently approach the increasing European competition, banks should first act on operating costs and produce closer to the efficient frontier. Only after this adjustment, they may concentrate on the development of income sources other than interest rate. Also the capital requirement negatively affects cost efficiency. This constraint, even more strict as a consequence of the II European Directive for Banking Industry, reduces flexibility in the cost structure. Moreover, results evidence that banks engaged in higher lending activity and more exposed to credit risk, tend to be less efficient. This suggests the opportunity for these banks to improve the management of the credit risk by enhancing their monitoring and collection of debt activities, by developing more accurate measure of risk, and by a wider use of credit derivatives.

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