ITALIAN MUTUAL BANKS:
Performance, Efficiency and Mergers and Acquisitions

Foreword by Roberto Di Salvo

Two papers by

Juan Sergio Lopez,
Alessandra Appennini, and
Stefania P.R. Rossi

and

Roberto Di Salvo,
Maria Carmela Mazzilis,
and Andrea Guidi

Société Universitaire Européenne de Recherches Financières
Vienna 2002

CIP

Italian Mutual Banks: Performance, Efficiency and Mergers and Acquisitions
(Two papers)
Juan Sergio Lopez, Alessandra Appennini, and
Stefania P. R. Rossi

JEL Classification: G21
Keywords: bank efficiency, cooperative banks, mutual banks, DEA, stochastic cost frontier.

Roberto Di Salvo, Maria Carmela Mazzilis,
and Andrea Guidi

JEL Classification is: G21 G28

Keywords: banks, mergers

Vienna: SUERF (*SUERF Studies:* 15)

ISBN 3-902109-07-6

Contents

Italian Mutual Banks: Performance, Efficiency and Mergers and ,Acquisitions

Foreword[1]

The Italian co-operative credit banks (CCB) are endowed with a strong local attitude, small size, autonomy-based governance and mutual principles. They play an important role in financing households, craftsmen and small enterprises. Nowadays, about 500 CCBs account for 3000 branches (10.5 % of the total number of branches in Italy) and market shares ranging from 5% of total bank loans to 7% of deposits. So far, they have thrived benefiting from their deep knowledge of local economies and from structural regulation that hampered competition in the banking industry. Besides, they have benefited from network externalities, since scale economies have mainly been exploited through outsourcing strategies within a three-tiered organisation.

Nevertheless, both the deregulatory process and technological development are making contestable even local and isolated markets, putting pressure on the performance of these financial institutions.

Generally speaking, local/mutual banks still maintain their traditional comparative advantages due to their capacity to lower the effects of asymmetric information. However, increasing competition implies that they have also to cope with slimmer profit margins which entail lowering costs and broadening the sources of revenues. Since CCBs largely represent the segment of small, local and mutual banks still operating in Italy, their ability to face this new business environment may affect a non negligible part of the Italian economy.

The two papers presented in the SUERF Study deal with two aspects related to the long term economic viability of mutual banks: economic efficiency and the search for optimal scale or dimension. The first paper uses up-to-date mathematics and statistical tools to investigate the cost efficiency of a panel

---

[1]. The two papers that follow were presented at the Conference “Efficiency and competition in the co-operative banking industry in Europe: key-issues for further development” held in Rome on 21-22 June 2001.

of 450 CCBs over the period 1995-99. This study is completed with an analysis of possible determinants of the efficiency scores. The second paper analyses the effect of mergers and acquisitions (M&A) between Italian mutual banks on their efficiency and economic performance. The paper's aim is to test the hypothesis whether the M&A wave over the past ten years has increased the efficiency level of mutual banks, both in terms of overall performance and productive efficiency.

The analysis refers to 94 CCBs which have been involved in M&As over the period 1995-1998 and is carried out on both merged and non-merged banks, either before concentration or in the subsequent years.

The empirical tests show significant results as Italian mutual banks turn out to be increasing their cost efficiency over time and the concentration wave in the 1990s has been successful in re-designing the structure of the co-operative banking industry.

These results have also relevant policy implications: internal growth may be successful in reducing inefficiency due to extremely small size, while M&As are likely to be helpful for both preventing bank defaults and improving market positioning. Indeed, the search for more efficiency is expected to be more properly fulfilled through network integration policies rather than by increasing the size of any single bank.

Roberto Di Salvo

Head of the Research Center
Credito cooperativo – Federcasse
Via M. D'Azeglio, 33
00184 Rome – Italy
email: rdisalvo@federcasse.bcc.it

Are Italian mutual banks efficient?
Evidence from two different cost frontier techniques

Juan Sergio Lopez, Alessandra Appennini
Research Department,
Federazione Italiana delle Banche di Credito Cooperativo, BCC-CRA
Via Massimo D'Azeglio 33, 00184 Rome
Jlopez@federcasse.bcc.it
Aappennini@federcasse.bcc.it

Stefania P. S. Rossi[2]
Department of Economics
Università degli Studi di Napoli "Parthenope"
Via Medina 40, 80133 Naples
Rossiste@cds.unina.it

Abstract

The aim of this paper is to analyze the efficiency of co-operative banks in Italy. The increasing competition induced by the ongoing process of liberalization in Europe has been affecting also these small financial institutions that used to operate in a more protected environment. Based on a panel of about 450 banks covering the period 1995-99, we employ two different techniques: non-parametric frontier analysis, and parametric frontier analysis. By means of this analysis it is possible to compare the results obtained using these two methodologies and analyze the determinants of bank inefficiency.

JEL Classification: G21
Keywords: bank efficiency, cooperative banks, mutual banks, DEA, stochastic cost frontier.
Corresponding author: Juan Sergio Lopez

[2] The Italian version of this paper will be published in the Proceedings of the Conference "Competition and Efficiency of Cooperative Banks in Europe; Key-issues for Further Development" held in Rome on 21-22 June 2001, *Cooperazione di Credito*, n. 173-174, January-March 2002.

The Authors are grateful to Francesco Cesarini and the Advisory Board of the Review *Cooperazione di Credito* for their support and useful comments. A special thank is addressed to Allen Berger for his comments on a previous version. The Authors also wish to thank David T. Llewellyn, who participated at the Conference and outlined this issue within a broader perspective, and Robert DeYoung for his comments and encouragement for further research. The usual disclaim applies. Although this paper is the result of a joint effort, sections 1, 3, Annex 1 and Annex 2 are written by Lopez and Appennini; sections 2, 4, and Annex 3 are written by Rossi.

Introduction

After decades of steadily growing business and improving economic performance, Italy's mutual banks (*banche di credito cooperativo*) are increasingly feeling the heat of competition; although they continue to record earning growth, in the last few years they have underperformed the more dynamic segments of the banking system. Without entering into the details of the developments that are altering the environment in which mutual banks operate, two aspects have a crucial bearing on any analysis of mutual banks' performance: efficiency in the use of productive factors and attainment of optimal size. This is especially so now that local markets are infinitely more contestable following the liberalization of branching and the rise of aggressive, specialized intermediaries. Peripheral location and integration into the local economy remain important but are no longer sufficient to guarantee high profitability and growth. Cost efficiency and scale efficiency can be two important operational factors on which to act in order to maintain and increase market shares in a more competitive environment. Against this background, the measurement of efficiency is an essential step for formulating a strategy of competitive repositioning.

1. Efficiency estimates: methodological aspects

1.1 Methodologies to measure efficiency

The literature concerning the problem of measuring efficiency in the field of applied economics can be divided into two principal strands: the approaches that use parametric statistical methods and those that use non-parametric methods.

Non-parametric methods, known as data envelopment analysis (DEA), apply linear programming techniques to construct an efficient production frontier. Since they do not require explicit specification of the production function, they are particularly suitable for analyzing the efficiency of non-profit institutions and, more generally, of multi-input, multi-output organizations. However, DEA does not allow random errors (for example, data observation errors) to be taken into account, with the risk of confusing random deviations with deviations from the efficient frontier. Parametric methods do not involve this risk, but by imposing the specification of a production frontier they can confuse specification error with the measure of efficiency. A comparison of the two methodologies has been carried out in Ferrier and Lovell (1990) and Resti (1997) which find that efficiency scores obtained with the two methods are comparable and consistent, whereas an extensive study by Bauer et al. (1998) reaches opposite conclusions.

The choice of non-parametric methods, or DEA, appears to be particularly appropriate in the case of mutual banks in light of the following considerations:

- Although mutual banks must satisfy the constraint of economic viability, they are characterized by an objective function not reducible simply to profit maximization (Fried et al. 1993, Di Salvo and Galassi 1997, Cardilli and Di Battista 1997). As mentioned above, non-parametric techniques of efficiency analysis are particularly well-suited to analyzing such organizations inasmuch as they do not require a prior definition of the production function (and hence the cost function). In fact, the first applications of DEA in the field of economics concerned non-profit institutions, such as schools and hospitals, for which the definition of profit and the production function proved most problematic.
- The assumption of technological homogeneity of the units is absolutely unavoidable when a DEA methodology is applied. This assumption is more plausible in the case of mutual banks than in that of sets embracing commercial banks of widely different sizes and specialization. As noted by Hunter (1997), many studies of the US market reach the conclusion that large and small institutions operate on different cost functions and may therefore be considered as operating in different industries. The other necessary assumption for applying DEA is that of the independence of the decision-making units. It too is satisfied by the institutional structure of mutual banks.

Although applying a non-parametric method is justified by the type of bank considered, the observation by Bauer et al. (1998) that in order to be useful for policy and regulatory purposes the two methods should produce at least some consistent results remains cogent. Hence, in our study we accompany the use of DEA with estimation of a parametric frontier. The results reached by means of the former method will be compared with those yielded by the latter. Given the technological homogeneity of the banks in question and notwithstanding the pronounced differences between the two methods used, it is reasonable to expect the result to be homogeneous to some degree.

1.2 The concept of efficiency

It is appropriate to clarify the notion of efficiency of a production unit. According to Koopmans (1951), a decision-making unit producing a vector of output **y** using a vector of input **x** is technically efficient if:

- an increase of one unit of output necessarily implies a reduction of one unit of another output or an increase in the use of at least one input;
- a reduction of one unit of input requires an increase of another input or a reduction of one output.

In particular, the concept of efficiency underlying the DEA model is that of Debreu (1951) and Farrel (1957) and is based on the radial measure of the possible proportional reduction (expansion) in inputs (outputs) compatible with a given vector of output (input). The radial measure (which is not the only possible measure) has the advantage of allowing immediate economic interpretation of efficiency scores by indicating the possible percentage reduction in the utilization of inputs if efficient production were to obtain. In short, the DEA method identifies as efficient those decision-making units for which there exists no other unit or linear combination of units that can produce a given output with equal or smaller input (or produce equal or the greater output with a given input). The efficient frontier is thus constructed by the linear combination that connects the efficient units, forming a convex set of production possibilities.

The DEA method produces technical efficiency scores ranging from 0 (maximum inefficiency) to 1 (maximum efficiency). By inserting the prices of the productive factors it is also possible to estimate cost efficiency, given by the product of technical efficiency (net of the effect of prices) and allocative efficiency.

Figure 1 illustrates a simplified situation in which an output is produced using two inputs[3]. There are five production units with different input/output ratios.

---

[3] The example is taken from Coelli 1996.

The frontier is the piecewise line AA'. The efficient units are the number 2 and 5 whereas the number 1, 3 and 4 are inside the frontier. The segment that radially projects the productive unit on the efficient frontier (1-1', 3-3' and 4-4') measures the technical inefficiency. If factor prices are known, the straight line BB' is obtained and the allocative inefficiency can be measured (segments 1'-1'', 3'-3'' and 4'-4'').

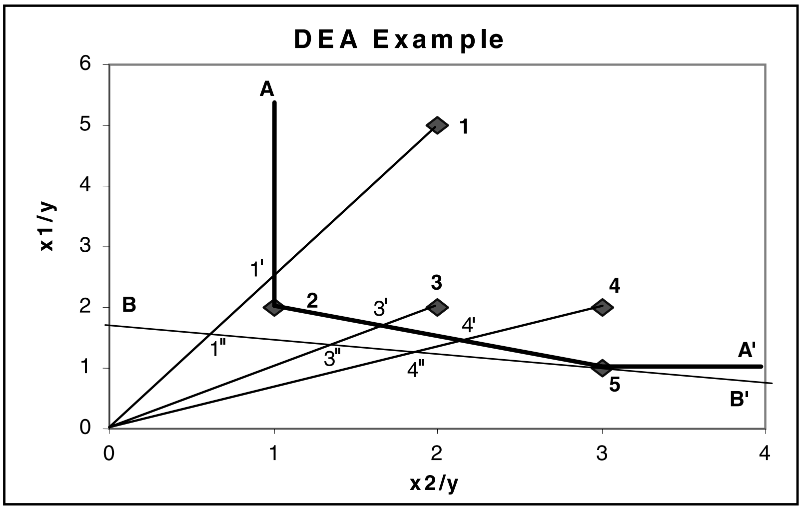


FIGURE 1

1.3 Structure of the paper

Like part of the recent literature, our study is divided into two parts. In the first part we calculate the efficiency score of each individual decision-making unit by applying linear programming techniques and test for the existence of economies of scale. In the second part, we try to "explain" the efficiency scores obtained in the light of environmental and/or operational variables (statistical analysis). From the methodological point of view, we apply a tobit panel regression (Destefanis and Pavone 1996, Casu and Molyneux 2000).

An alternative would be to use variables that already incorporate operational and environmental aspects. For example, Siems and Barr (1998) employ variables that reflect the economic result of the bank (net-interest income and income from services) as outputs. Prometeia (1999) also defines an efficient frontier on the basis of income variables. However, these approaches tend to equate the concept of profitability with that of efficiency, thereby possibly obscuring elements that can be brought out by non-parametric models. For example, where banks that operate in environments of markedly different competitiveness are compared on the basis of profitability alone, the outcome can be that units whose profitability depends on the particular configuration of their market will be defined as efficient, thus possibly concealing inefficiencies in the production process of banks with good profitability. This situation can be significant for institutions such as mutual banks, which operate in markets where the relatively dominant position they used to enjoy is increasingly threatened by the proliferation of bank branches.

2. Defining the model

2.1 Defining banking output

The application of non-parametric methods for the calculation of efficiency in the banking sector has made considerable headway in the past few years. Research in this field has shown that the DEA and free disposal hull (FDH) methods are well-suited to a typically multi-input, multi-output industry such as banking. On the other hand, there is no consensus on the definition of bank output and the variables representing it (Colwell and Davis 1992, Resti 1994 and 1997). In addition, available data are abundant but of a type not entirely adequate to the requisites of the methodology. Accordingly, conducting a DEA or FDH study preliminarily requires:

- a clear definition of the inputs and outputs of banking output (Annex 1-A);
- an evaluation of the adequacy of the database, with explicit discussion of the motivations and implications of the use of proxies (Annex 1-B).

With regard to the first issue, an appreciable variety of models based on different definitions of the output of banking services can be found in the literature. In empirical applications the discussion centres on two main issues: whether deposits should be included in input or output and whether output should be measured in physical or monetary units.

The lack of consensus on a general model makes it advisable for researchers to adopt a pragmatic approach based on theoretical and methodological considerations, the objective of their particular study and the database available. It should also be stressed that the choice of a given approach will not only be reflected in the selection of input and output variables but will also affect the final results (Favero and Papi 1995, Hunter and Timme 1995, Resti 1997).

In this paper we adopt a model compatible with the user cost theory and the value added approach.

2.2 Defining the cost function

The model selected specifies three output variables, three input variables and the related input prices:

Output variables
- Customer loans
- Customer deposits
- Income from services

Input variables:
- Number of staff
- Branches
- Other administrative costs (including fees and commissions payable)

Input prices:
- Labour costs/Number of staff
- Depreciation plus premises and fixed asset expenses /Branches
- Other administrative costs/Total assets

The data we use are drawn from the archive of company accounts and (for premises and fixed asset expenses) the archive of supervisory returns, both of which are managed by Federcasse.

2.3 Variables affecting efficiency

As mentioned earlier, after estimating the efficiency scores a second-level analysis is performed in order to identify the variables that influence the level of efficiency found.

Technical efficiency is modelled according to the following schema:

$$E_{st} = \delta_0 + \delta_1 Comp + \sum_{b=1}^{p} \delta_{bs} BalI_{bs} + \sum_{i=1}^{n-1} \delta_{is} dArea_{is} + \sum_{k=1}^{n-1} \delta_{ks} dSize_{ks} + W_{st} \qquad (1)$$

where:

Comp is an index of concentration (used as a proxy of an index of competition) calculated using the following formula[4]:

[4] The index is taken from Rigon (1996).

$$Comp = \sum_{j=1}^{K} \frac{SP_{ij}}{\sum_{i=1}^{N} SP_{ij}} \frac{SP_{ij}}{\sum_{j=1}^{K} SP_{ij}} \qquad (2)$$

I = 1,.....,N are the branches of banks operating in the area; J = 1,.....,K are the towns of the area.

In practice, the index is the sum of the bank's market share in each town, weighted by the bank's share in the total number of branches.

$BalI_{bs}$ are balance sheet and income indicators:

a) Non interest income (the share of gross income deriving from fees and commissions and from profit on financial operations), which approximates the degree of diversification of the bank's output. It is taken to be the natural alternative to a reduction banks' primary source of income, i.e. net interest income. Income diversification should be a sign that the bank is sensitive to market signals and able to adapt to the shifting conditions of the market.

b) Value added per employee (Vap). We expect a positive correlation between Vap and bank efficiency.

c) Ratio of loans to deposits as a proxy of the bank's market orientation. We expect that banks that are more active in the market need to be more efficient in order to withstand competition.

d) Bad debts over total customer loans is a measure of the risk the bank runs in the course of carrying on business. A negative sign or an insignificant value would indicate that efficiency is not achieved by reducing screening and monitoring activity (and the related costs).

$dArea_{is}$ are 4 dummies, included in order to test the effect of the macro regions considered (North-West, North-East, Centre and South), i = 1,..n, n=4;

$dSize_{ks}$ are 3 dummies, included in order to test the effect of the different bank size (small, medium, large), k=1,..n, n=3.

All the monetary variables are deflated to 1995 values. The sample consists of 449 mutual banks present throughout the period of time considered (1995-1999).

3. Empirical findings

3.1 DEA efficiency scores[5]

As shown in Table 1, cost efficiency – the product of technical efficiency and allocative efficiency – averages below 70 per cent and exhibits a slightly rising trend, which comes to a halt in 1999. Variability is rather high (from a minimum of 40 per cent to 100 per cent).

Table 1 – Efficiency scores obtained with the DEA method

All banks (%)

	Constant returns to scale			Variable returns to scale		
	Technical	Allocative	Total	Technical	Allocative	Total
1995	58.8	86.2	50.3	70.1	87.6	60.6
1996	63.0	90.2	56.7	71.1	89.2	62.7
1997	64.9	90.2	58.3	73.8	90.3	66.3
1998	65.2	89.4	58.2	74.0	91.4	67.2
1999	64.0	91.5	58.6	72.1	93.4	67.0

Total efficiency is the product of technical efficiency and allocative efficiency.

The decomposition between technical efficiency and allocative efficiency shows that the former is by far the more significant in determining overall (cost) efficiency.

These results are consistent with other studies carried out with different samples and in different countries. For example Berger and Humphrey (1997) surveying 122 studies on bank efficiency point out that: “the mean and median efficiencies for the non-parametric techniques are .72 and .74 respectively (...) the range is .31 to .97”. Our results are also consistent with Resti (1997) and Ferrier and Lovell (1990).

On average, large banks show higher efficiency than the others (except in 1995), whereas medium-sized banks always have the lowest scores (Table 2).

---

[5] For the DEA estimations we used the DEAP 2.1 software package (Coelli 1996a).

Table 2 – Efficiency scores by bank size (%) (Variable returns to scale)

	Large			Medium-sized			Small		
	Technical	Allocative	Total	Technical	Allocative	Total	Technical	Allocative	Total
1995	73.7	87.8	64.7	62.2	89.5	55.1	75.9	85.8	64.1
1996	77.0	91.2	70.1	65.4	91.4	59.7	74.2	86.0	62.5
1997	77.3	93.1	72.0	68.7	90.5	62.0	77.6	88.3	67.7
1998	78.0	92.5	72.1	69.5	91.8	63.5	76.7	90.2	68.4
1999	78.8	93.7	73.8	67.0	94.2	63.0	73.8	92.2	67.2

The breakdown by geographical area shows that banks of the North are more efficient, on average, than those of the Centre and South.

Table 3 – Efficiency scores by geographical area (%) (Variable returns to scale)

	North-West			North-East			Centre			South		
	Tech.	Alloc.	Total	Tech.	Alloc.	Total	Tech.	Alloc.	Tota l	Tech.	Alloc.	Total
1995	71.2	88.8	62.6	69.9	89.0	61.4	64.4	91.2	58.4	73.6	82.4	59.7
1996	71.9	90.1	64.6	71.6	90.7	64.6	69.4	92.6	64.0	71.2	84.1	58.4
1997	72.7	92.2	66.8	75.6	90.2	67.9	72.5	92.7	67.1	72.8	87.8	63.0
1998	75.0	93.3	69.8	75.4	91.5	68.8	73.8	92.9	68.2	71.6	89.1	62.9
1999	73.4	94.4	69.0	74.9	94.1	70.2	70.0	95.1	66.5	68.8	90.7	61.4

The DEA method allows us to calculate economies of scale by comparing the efficiency scores obtained under the assumption of constant returns to scale with those obtained under variable returns to scale. The number of banks with increasing economies of scale is very high (between 70 and 75 per cent of the total).

Table 4 – Economies of scale (number of banks)

	Increasing	Constant	Decreasing	Total
1995	314	26	109	449
1996	337	30	82	449
1997	332	15	102	449
1998	319	16	114	449
1999	366	20	63	449

It is worth noting that scale economies tend to turn from increasing to decreasing when the size of the bank increases (Table 5).

Table 5 – Economies of scale in 1999 (number of banks)

	Increasing	Constant	Decreasing	Total
Size (total assets)				
Small (up a 50 mill US$)	157	2	0	159
Medium (from 50 to 150 mill US$)	169	8	10	187
Large (over 150 mill US$)	40	10	53	103
Number of branches				
1-2	95	6	0	101
3-5	179	5	7	191
6-10	74	6	23	103
over 10	18	3	33	54
Total	366	20	63	100

3.2 Determinants of efficiency

We analyze the possible determinants of the efficiency scores estimated using DEA by running a panel regression in which the efficiency scores are set in relation to the exogenous variables specified in equation 1. A Tobit model is used in order to avoid possible distortions due to the fact that the dependent variable is constrained between the values of 0 and 1.

Table 6 – Tobit efficiency estimates

Variable	Coefficient	z	Significativity (1)
Value added per person	0.0003	5.60	*
Non interest income	0.0025	9.05	*
Competition index	-0.0346	-2.33	**
Loans/deposits	0.0006	4.33	*
Bad loans/Loans	-0.0015	-2.27	**
Small	0.0046	0.24	
Medium	-0.0683	-6.36	*
North-West	0.0354	2.12	**
North-East	0.0473	3.57	*
Center	0.0317	1.93	***
Constant	0.5401	27.86	*
sigma_u	0.0923	30.64	
sigma_e	0.0715	59.41	
rho	0.6249	0.618	

(1) *(1%), ** (5%), ***(10%).

Random effects u_i ~ Gaussian Wald chi2(10) = 294.04

Log likelihood = 2226.0447 Prob > chi2 = 0.0000

Overall, the coefficients are significant and of the expected sign. Efficiency calculated using DEA appears to be linked positively with value added per employee. Diversification of output (non-interest income) and market presence (ratio of loans to deposits) are found to have a positive influence on efficiency. It is interesting to note that the variable that proxies for the level of competition in the local market indicates that as competition increases so does efficiency. The indicator of the ratio of bad debts to total loans is negative, even if not highly significant. This ensures that efficiency is not achieved by saving on screening and monitoring.

The variables of geographical location indicate significantly higher efficiency for mutual banks of the Centre and North than those of the South, while the variables of size indicate that medium-sized mutual banks are less efficient than small ones and large ones.

4. Comparing parametric and non parametric results

Bauer et al. (1998), try to overcome the simple contraposition of parametric and non parametric approach. Considering that there is no consensus on the best method to measure efficiency and that the method employed affects the results, the authors decline six consistency conditions that should be met when using frontier estimates. Three of those are related to the mutual consistency of the different approaches: a) the efficiency scores should have comparable means and other distributional properties; b) the different approaches should rank the institutions in a similar order and c) should identify mostly the same institutions as best and worst practice. The others require that results should be consistent with reality: 1) stable over time; 2) compatible with market's competitive conditions; 3) consistent with standard non frontier performance indicators.

In order to evaluate the results obtained with the two different techniques we first refer to Bauer et al. (1998) consistency conditions. Table 7 reports descriptive statistics of the efficiency scores generated by the two different approaches[6].

Table 7 – descriptive statistics of the efficiency scores

Years	1995		1996		1997		1998		1999	
	Par	DEAV	Par	DEAV	Par	DEAV	Par	DEAV	Par	DEAV
Mean	86.4	60.6	86.7	62.7	86.9	66.3	87.2	67.2	87.4	67.0
Median	86.5	59.2	86.8	60.7	87.0	64.9	87.2	65.7	87.4	65. 6
Minimum	79.1	28.0	80.0	37.4	80.8	39.0	81.5	40.6	82.2	39 .9
Maximum	90.3	1.0	90.3	1.0	90.4	1.0	90.4	1.0	90.4	1.0
S.D. (%)	1.87	14.5	1.73	13.1	1.60	12.8	1.48	12.4	1.38	12.7
Skewness	-0.52	0.62	-050	0.77	-0.47	0.62	-0.45	0.65	-0.4 2	0.70
Kurtosis	1.11	0.17	1.06	0.49	1.01	0.27	0.97	0.40	0.93	0.32

Par: parametric; DEAV: DEA variable return to scale

[6] For the technical aspects of the parametric estimates see Annex 3

The parametric approach yields a higher average efficiency and displays less variability than the linear programming approach. Moreover, the distributional characteristics of the scores produced by the two methodologies are quite different. To further qualify this evidence we check whether the ranking of banks derived by the two scores are comparable. The results show a significant (at the 1% probability level) but declining correlation in each year (Table 8)

Table 8 – Spearman rank correlation between parametric and non parametric efficiency scores

Years	1995	1996	1997	1998	1999
1995	0.517				
1996		0.478			
1997			0.517		
1998				0.420	
1999					0.320

Tables 9 and 10 reports the proportion of banks having efficiency score in the higher 25% and in the lower 25% with both methodologies. The evidence shows that the correspondence is significant at 1%.

Table 9 – Correspondence of best practice

Years	1995	1996	1997	1998	1999
1995	50.4				
1996		46.0			
1997			52.2		
1998				46.9	
1999					39.8

Table 10 – Correspondence of worst practice

Years	1995	1996	1997	1998	1999
1995	46.0				
1996		52.2			
1997			54.9		
1998				44.2	
1999					38.9

At a first look the evidence presented above supports the view that the two methodologies produce comparable results when we analyze the X-inefficiency.

Therefore we go further and we compare efficiency/inefficiency determinants (Table 11).

Table 11 – Econometric estimates with DEA scores and translog

Variables	DEA[a]		Parametric[b]	
	Coefficient	z	Coefficient	t
Constant	0.5401	27.86	0.735	17.4
Value added per person	0.0003	5.60	-0.001	-13.80
Non interest income	0.0025	9.05	0.001	1.87
Competition index	-0.0346	-2.33	0.022	1.68
Loans/deposits	0.0006	4.33	-0.002	-19.45
Bad loans/Loans	-0.0015	-2.27	0.006	9.183
Small	0.0046	0.24	-0.171	-10.562
Medium	-0.0683	-6.36	-0.073	-6.579
North-West	0.0354	2.12	-0.002	-0.157
North-East	0.0473	3.57	-0.010	-1.024
Center	0.0317	1.93	-0.014	-1.173

a)The dependent variable is the efficiency score
b)The dependent variable is the inefficiency score

It is interesting to note that the only variable showing a different effect in the two approaches is the share of non interest income which according to the DEA estimates increases efficiency whereas in the parametric estimates increases inefficiency. The other relevant variables (value added per person, competition index, loans/deposits, bad loans/loans) are significant and affect efficiency in the same way.

Another noteworthy result[7] is that both methodologies detect the presence of economies of scale, especially for small banks.

[7] Tables and calculations are available on request

5. Conclusion

This paper has analyzed the efficiency of co-operative banks in Italy and the findings may be summarized as follow:

- There are margins to improve the efficiency of cooperative banks; according to the different methodologies the average inefficiency level ranges from 15% to 33%. Nevertheless this is also the range of inefficiency found in many other studies carried out with different samples and in different countries. Therefore we can presume that cost efficiency in credit cooperative banks is not very different from other financial institutions.
- Is confirmed the banks located in the North and in the Center of Italy are generally more efficient than the banks located in the South. We also found that there is not a linear relationship between size and efficiency.
- There is strong evidence of economies of scale especially for small and part of the medium size banks. When the bank size increases, economies of scale tend to turn from increasing to decreasing. This means that efficiency enhancing strategies based only on growing size are viable only for a segment of banks (up to 4-5 branches and 75-100 million USD in assets). Larger banks have to devise more complex strategies.
- Using statistical analysis we found that there is a significant relationship between efficiency and indicators of productivity, competition, market orientation, revenue diversification. Our reading of these findings is that part of the cooperative banks have opportunely reacted to the new market conditions reaching high level of efficiency. On the other side banks that operate on a lower efficiency level may become vulnerable to changes in their local market.

References

Allen, L., Rai, A., (1996) *"Operational efficiency in banking: an international comparison*, Journal of Banking and Finance 20, 665-672.

Banker R.D., Charnes A., Cooper W.W. (1984) Some model for estimating technical and scale inefficiencies in data envelopment analysis; in Management Science, vol. 30, 1078-1092.

Battese, G. E., Coelli, T., (1992) Frontier production functions, technical efficiency and panel data: with application to paddy farmers in India, Journal of Productivity Analysis 3, 153-169.

Battese, G. E., Coelli, T., (1995) A model for technical inefficiency effects in a stochastic frontier production function for panel data, Empirical Economics 20, 325-332.

Bauer P.W., Berger A.N., Ferrier G.D. Humphrey D.B. (1998) "Consistency conditions for regulatory analysis of financial institutions: a comparison of frontier efficiency methods", in Journal of Econmics and Business.

Berger N., Humphrey D.B. (1997) Efficiency of Financial Institutions: International Survey and Directions for Future Researches; Wharton Financial Institutions Center Working Paper.

Berger, A.N., Hunter, W.C., Timme, S. G., (1993) The efficiency of financial institutions: a review and preview of research past, present and future, Journal of Banking and Finance 17, 221-49.

Berger, A.N., Mester, L.J., (1997) Inside the black box: what explains differences in the efficiencies of financial institutions? Journal of Banking and Finance 21, 895-947.

Cardilli D., Di Battista L., (1997) "Il ruolo del patrimonio nel modello di proprietà e controllo delle banche di credito cooperativo italiane"; Cooperazione di Credito n. 156-157.

Casu B., Molyneux P. (2000) A comparative study of efficiency in European Banking; Wharton School Center for Financial Institutions, University of Pennsylvania Center for Financial Institutions Working Paper series n.17

Cavallo, L., Rossi, S.P.S., (2000) An X-efficiency analysis of different banking organisational types in Europe. In Bonilla, M., Casasus, T., Sala, R. (Eds.) Financial Modelling, Physica-Springer Verlag, Germany.

Cavallo, L., Rossi, S.P.S., (2001) Do environmental variables affect the performance and technical efficiency of the European banking system? A stochastic frontier approach, European Journal of Finance, forthcoming.

Charnes A., Cooper W., Rhodes E. (1978) "Measuring the efficiency of decision making units"; in European Journal of Operational Research.

Charnes A., Cooper W., Sun D., Huang Z. (1990) "Polyhedral cone-ratio DEA models with an illustrative application to large commercial banks"; in Journal of Econometrics 46, 73-91.

Coelli, T. (1996) A Guide to FRONTIER Version 4.1: A computer program for stochastic frontier production and cost function estimation, Centre for Efficiency and

Productivity Analysis CEPA Working Paper 96/07, University of New England Armidale, NSW, 2351 Australia.

Coelli, T. (1996a) A guide to DEAP Version 2.1: A data envelopment analysis (computer) program, Centre for Efficiency and Productivity Analysis CEPA Working Paper 96/08, University of New England Armidale, Australia

Coelli, T., Prasada Rao, D.S., Battese E. (1997) An Introduction to Efficiency and Productivity Analysis, Kluwer Academic Publishers, Boston.

Colwell R.J. and Davis P.E. (1992) "Output and productivity in banking" Scandinavian Journal of Economics, n. 94.

Cusimano G., Vassallo E. (1998) "Redditività ed efficienza delle banche italiane maggiori e grandi"; Il Risparmio n.4-5.

Debreu G (1951) The coefficient of resource utilisation, *Econometrica*, 19, 273-292.

Destefanis S., Pavone A. (1996) "Analisi dell' efficienza tecnica e banche di credito cooperativo. Un' estensione e un' applicazione dell' approccio FDH", Quaderni di Statistica e di Matematica Applicata alle Scienze Sociali, Vol XIII, n. 1-4.

Dietsch, M., Lozano Vivas, A. (2000) How the environment determines the efficiency of banks: a comparison between the French and Spanish banking industries, Journal of Banking and Finance 26 (6) 985-1004.

Di Salvo R., Galassi F., (1997) "Asimmetrie informative e funzione-obiettivo della banca cooperativa locale"; Cooperazione di Credito n. 156-157.

Farrel, M.J. (1957) The measurement of Productive efficiency, Journal of the Royal Statistical Society, Series A, General, 120 (3): 253-281.

Farrel M.J. and Fieldhouse M. (1962) Estimating efficient production function under increasing returns to scale, *J. Roy. Statistics Society* Ser.A 125, 252-267.

Favero C.A., Papi L. (1995) "Technical efficiency and scale efficiency in the italian banking sector: a non-parametric approach"; Università Bocconi, Workshop su Efficienza, Economie di Scala e Dimensione delle Banche, 21 settembre 1995.

Ferrier G.D., Lovell C.A.K. (1990) "Measuring cost efficiency in banking"; Journal of Econometrics 46.

Ferrier G.D., Kersten K., Vanden Eeckaut P. (1994) "Radial and non radial efficiency measures on DEA reference technology: a comparison using US banking data"; CORE discussion paper n. 9423.

Fried, H.O., Lovell C.A.K., Schmidt, S. (1993) The Measurement of Productivity Efficiency: Techniques and Applications, Oxford University Press, London.

Fried H.O., Lovell C.A.K. and Vanden Eeckaut P. (1993) "Evaluating the performance of US credit unions"; Journal of Banking and Finance, Vol. 17 n.2-3.

Gobbi G., (1995) "L'efficienza e la produttività nelle banche italiane nell'ultimo decennio" in Cooperazione di Credito n.148.

Gobbi G., Pellegrino G. (1995) "La misurazione del prodotto bancario"; Ricerche Quantitative per la Politica Economica, Perugia Convegno B.d'I. CIDE.

Grifell-Tatié E., Lovell C.A.K. (1996) "Profits and Productivity"; Wharton Financial Institutions Center Working Paper.

Humphrey D.B. (1985) "Costs and scale economies in bank intermediation"; in R.C. Aspinwall and R. Eisenbeis, eds., Handbook of banking strategy (Wiley, New York).

Hunter W.C. (1997) "Il ruolo delle banche locali e regionali tra concorrenza e progresso tecnico. L'esperienza degli Stati Uniti", Cooperazione di Credito 156-7.

Hunter W.C. and Timme S. (1995) "Core deposits and physical capital: a re-examination of bank scale economies and eifficiency with quasi-fixed inputs", Journal of Money Credit and Banking, N. 27, pp. 165-85.

Koopmans, T. (1951) Activity Analysis of Production and Allocation, John Wiley & Sons, Inc. New York.

Mester, L. (1993) Efficiency in the Saving & Loans industry, Journal of Banking and Finance 17 (2-3) 267-286.

Parigi G., Sestito P., Viviani U. (1992) "Economie di scala e diversificazione nell'industria bancaria: il ruolo dell'eterogeneità tra imprese"; Temi di Discussione Banca d'Italia n. 174.

Prometeia (1999) "Analisi dei bilanci bancari".

Resti A. (1994) "Il dibattito su efficienza delle banche e economie di scala: il contributo della DEA ed un'applicazione ai dati italiani"; Politica Economica n.2.

Resti A. (1995a) "L'efficienza delle banche italiane: risultati dell'applicazione comparata di tecniche econometriche e matematiche"; in Banca Impresa Società.

Resti, A., (1997) Evaluating the cost efficiency of the Italian banking system: what can be learnt from the joint application of parametric and non-parametric techniques, Journal of Banking and Finance 21 221-250.

Rigon A., 1996. L'analisi della performance, in Marco Onado (a cura di) La Banca Come Impresa, pg. 469-528.

Siems T.F., Barr R.S. (1998) Benchmarking the productive efficiency of US banking; in Financial Industry Studies, Federal Reserve Bank of Dallas.

Tulkens H. (1993) "On FDH efficiency analysis: some methodological issues and applications to retail banking, courts and urban transit"; CORE Reprint n.1046.

Tulkens H., Malnero A. (1994) "Nonparametric approaches to the assessment of the relative efficiency of bank branches"; Core Discussion Paper n. 9447

Vassallo E. (1999) "Efficienza statistica e dimensione del sistema bancario italiano"; Studi e note di economia n.1

Annex 1-A

Methodological approaches to model the production process in the banking industry

Five methodological approaches are most frequently used in the literature:

1. The *production approach* interprets the bank as a unit producing services through the utilization of capital and labour. Output is measured in "physical" quantities (number of accounts, number of transactions, etc.).

2. The *intermediation approach* interprets the role of the bank as an intermediary between units in deficit and units in surplus. In this model bank deposits are included among the inputs of production.

3. The *asset approach* is a variant of the intermediation approach in which liabilities are considered input and assets output.

4. The *value added approach* treats those financial statement items that absorb a significant share of capital and labour as output and the remainder as either input or insignificant output.

5. Finally, the *user cost approach* identifies the inputs of the production process in the banking industry as "*the net cost a bank must sustain in a given period of time in order to hold one unit of the financial instrument associated with the service*". In operational terms, user cost is calculated as the difference between all the revenues and all the costs (including the opportunity cost) generated by a financial instrument in the bank's portfolio. For example, the cost of using a bank loan can be approximated by the difference between the interest rate on a riskless security of equal amount (opportunity cost) and the expected yield of the loan. Here again, deposits are included among outputs.

Annex 1-B

The choice of input and output variables

Inputs and outputs are, by definition, flow variables. When flow data are not available, stock variables are used as proxies (implicitly assuming that stocks generate homogeneous flows).

The choice of input and output variables reflects the concept of the production process to be analyzed. In DEA literature there is an abundance of models that use combinations of proxies of capital and labour and variables proxying for bank output.

Input variables:

- ➢ Labour: the optimal flow variable would be the number of hours actually worked (possibly divided by grade of personnel). The hourly cost of labour would be used as the price. A proxy variable that refers to stocks is the number of staff (assuming that the average number of hours worked is equal) and, for the price, the average wage. Another possibility is to use total labour costs (assuming equality of the price of labour). In this case the different qualities of labour employed are "endogenized".
- ➢ Capital: the variable should reflect the consumption of physical capital associated with the production process. One flow variable is depreciation. The problem is that the value shown in the financial statements does not express the real "consumption" of capital. The same drawback is also found for the corresponding stock variable that is frequently used, i.e. fixed assets. Another variable used as a proxy of capital is the number of branches.
- ➢ Other administrative costs. These can be approximated by the cost of intermediate goods. Generally, the income statement item "other administrative costs" is used.

Output variables: these ought to be the flows of services produced in the time span considered. These are practically impossible to measure with the data available to us. Here again, stock variables (loans and deposits) are used to proxy for flows (Gobbi 1995, Resti 1995a). Whereas for so-called imputed services (services deriving from intermediation activity between units in deficit and units of surplus) the use of stocks is plausible and theoretically justified (Gobbi 1995), for actual services income is used as a proxy.

Annex 2

Survey of studies using non-parametric techniques to analyze the efficiency of Italian banks.

Non-parametric methods began to be widely used in studies of bank efficiency in Italy in the nineties. Among the first to adopt them, Resti (1994) applies DEA to the data of a limited sample of banks, developing a model that can be classified as belonging to the value added approach (VAA). More extensive both methodologically and from the standpoint of the database is the study by Resti (1995a), who compares estimations of banks' efficiency level obtained by applying parametric and non-parametric methods. The sample consists of 270 banks, with data on the annual accounts for 5 years (1988 through 1992). The results show a level of efficiency that is rather stable over time, between 66 and 69 per cent in the constant returns to scale (CRS) model and around 74-75 per cent in the variable returns to scale (VRS) model. The dispersion of efficiency within the sample is pronounced and there is also a significant, stable efficiency differential between banks of the North and those of the Centre and South. Favero and Papi (1995) use the DEA method to measure the technical efficiency of a sample of 174 banks on the basis of data for 1991. They implement two models, one consistent with the intermediation approach (IA), the other with the asset approach (AA). Average efficiency is around 88 per cent (CRS) and 90 per cent (VRS) in the intermediation approach and around 80 per cent (CRS) and 84 per cent (VRS) in the asset approach. After measuring efficiency by applying DEA the authors analyze its determinants. They find a positive relationship with bank size and the share of profits attributable to income from services. Market structure (proxied by a variable based on population and degree of industrialization) is found to have no effect and banks' regional location a weak effect. Destefanis and Pavone (1996) apply a variant of non-parametric methods called free disposal hull (FDH) characterized by the absence of assumptions on the convexity of the production frontier. In particular, they propose a version of the FDH method "adjusted" to take account of slacks. The analysis is developed using 1994 annual accounts data for a sample of 505 mutual banks and the choice of input and output variables is specified on the basis of the asset approach and the value added approach. The results show average efficiency scores of between 72 and 88 per cent in the models with value-added-approach specification and between 80 and 94 per cent in those constructed according to the asset approach. The authors deepen the investigation of geographical disparities in efficiency with an econometric analysis that utilizes a limited variable dependent (tobit) model. They find that the results depend strongly on the type of model used. Mutual banks in the South are less efficient according to the value added approach, whereas those in the Centre and North-East suffer by comparison under the asset approach. The ratio of bad debts to loans has a negative impact in both specifications, while size has a negative effect on efficiency only under the asset approach.

Cusimano and Vassallo (1998), after conducting a study of profitability of a group of large banks, use the DEA method to evaluate their efficiency under the intermediation approach. The average level of efficiency (calculated for 1995 and 1996) is rather high (between 97 and 98 per cent), although the sample of only 21 banks is very small. Vassallo (1999) applies DEA to a sample consisting of the 40 largest Italian banks for the period from 1991 to 1996. Here again, the efficiency scores are high and increase over time (from 91 to 96 per cent). The technical efficiency of major banks is always higher than that of large and medium-sized banks.

AUTHORS	OUTPUT VARIABLES	INPUT VARIABLES	Period	Approach
Resti (1994)	Customer loans Customer deposits Net lending to banks	Branches Employees Funding from banks +CDs	1988-91	VAA
Resti (1995a)	Performing customer loans Customer deposits Income from services	Employees Fixed capital	1988-92	VAA/UCA
Favero Papi (1995)	Loans to banks Securities Income from services	Employees Capital (book value) Loanable funds Financial capital	1991	AA
	Loans to banks Securities Income from services Loanable funds	Employees Capital (book value) Financial capital		IA
Destefanis Pavone (1996)	Customer loans Other assets	Customer deposits Branches Free capital Employees	1995	AA
	Customer loans Other assets Customer deposits	Branches Free capital Employees		VAA
	Customer loans Customer deposits	Branches Free capital Employees		VAA
Cusimano Vassallo (1998)	Customer loans Securities	Branches Employees Capital Reserves Customer deposits	1995-96	IA
Vassallo (1999)	Customer loans Securities	Employees Capital and reserves Customer deposits	1991-96	IA

AUTHOR	SAMPLE	AVERAGE EFFICIENCY SCORES (%)						
Resti (1994)	43 MEDIUM-SIZED BANKS 1988-91				N.A.			
Resti (1995a)	270 BANKS FOR 5 YEARS			1988	1989	1990	1991	1992
		CRS		66.5	68.8	67.9	69.2	67.7
		VRS		74.3	75.7	73.9	75.0	73.4
Favero	174 BANKS				IA		AA	
Papi		CRS			87.8		79.4	
(1995)		VRS			90.9		83.9	
Destefanis	505 MUTUAL BANKS			IA		VAA		VAA
Pavone		a		80.4		73.7		71.8
(1996)		b		89.4		81.2		79.4
		c		94.9		92.7		88.8
Cusimano	21 MAJOR AND LARGE BANKS				1995		1996	
Vassallo		CRS			97.0		97.2	
(1998)		VRS			98.0		98.1	
Vassallo	40 BANKS FOR 6 YEARS							
(1999)			1991	1992	1993	1994	1995	1996
		CRS	85.1	81.5	82.9	86.0	87.2	90.4
		VRS	89.2	87.6	90.2	92.8	93.0	94.5

Annex 3

Stochastic cost frontier

The stochastic frontier model explains the deviation of the observed cost function from the efficient frontier with an error term split in two components: the random noise, and the technical or allocative inefficiency. The cost function can be expressed in this way (Battese and Coelli, 1992):

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

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;
V_{it} are random variables which are assumed to be iid $N(0, \sigma_V^2)$;
U_{it} are non-negative random variables accounting for the inefficiency cost measuring how far the *i-th* firm operates above the efficient cost frontier. In this model U_{it} accounts for both technical and allocative inefficiencies.

The cost efficiency (EFF_{it}) for the *i-th* firm is measured using the following expression:

$$EFF_{it} = E(C_{it}| U_{it}, X_{it})/ E(C_{it}| U_{it} = 0, X_{it}) \qquad (2)$$

where X_{it} are the regression parameters. This expression can assume values between 1 and infinity and it corresponds to e^{Uit}.

Using the Battese and Coelli (1995) specification, we can model the inefficiency term, $U_{it,}$ as an explicit function of a vector of environmental variables z_{it} which may influence the *i-th* firm's efficiency:

$$U_{it} = z_{it}\delta + W_{it} \qquad (3)$$

W_{it} is the truncation of normal distribution with zero mean and variance σ^2.

In running the model, the stochastic cost frontier (1) and the inefficiency specification (3) are simultaneously estimated using the maximum likelihood method, where 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 model

In our analysis we employ 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 specified the cost function as a translog stochastic frontier.[8]

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

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

where:
TC = total cost
y_i is the i-th output
x_k is the price of the k-th input.
The logaritms of y_i and x_k are all expressed as differences from the mean sample.
In estimating the equation, we impose:

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

$\beta_{hk} = \beta_{kh} \ \forall$ i,j(h,k=1,.....m)

2) the linear homogeneity conditions by normalizing total cost (TC) and the price of labor (w) by the price of capital (k). This reduces the number of parameters to estimate and corresponds to imposing restrictions on the parameter:

$$\sum_{k=1}^{2}\alpha_k = 1; \qquad \sum_{k=1}^{3}\lambda_{ik} = 0 \textit{ for all i.}$$

We first estimated the cost frontier on the full longitudinal sample, using the Battese Coelli (1992) model. From the estimation of the model we obtained the values of inefficiency for each firm included in the sample. Using these values we compute the average cost efficiency for each class size and for each geographical area.

[8] The translog specification is the most widely used functional forms in the empirical literature on bank efficiency. It presents the well-known advantages of being a flexible form and of including, as a particular case, the Cobb-Douglas specification.

In order to check if differences in inefficiency are influenced by a number of variables we then re-estimated the cost frontier simultaneously with the inefficiency specification term as specified below.

Table reports magnitude and t-statistics of the coefficients of the inefficiency's determinants obtained by the simultaneous estimation of the following system, using the Frontier 4.1 software (Coelli, 1996):

$$\begin{cases} \ln \mathrm{C_{st}} = \ln\mathrm{C}(\mathrm{y_{st}}, \mathrm{w_{st}}, \Theta) + (V_{st} + U_{st}) \\ U_{st} = \delta_0 + \delta_1 C\mathrm{om}\, p_{is} + \sum_{b=1}^{p} \delta_{bs} BallI_{bs} + \sum_{i=1}^{n-1} \delta_{is} dArea + \sum_{k=1}^{n-1} \delta_{ks} dSize + W_{st} \end{cases}$$

where: $\sigma^2 = \sigma_\upsilon^2 + \sigma_\varpi^2$; $\gamma = \sigma_\upsilon^2/\sigma^2$.

Table A – Translog cost function and inefficiency model estimates

Variables	Parameters		
		Coefficient	t-test
	α_0	3.018	84.350
ln y1	α_1	0.450	40.542
ln y2	α_2	0.375	29.702
ln y3	α_3	0.057	6.129
ln w	α_4	0.496	36.666
ln s	α_5	0.418	31.045
$(\ln y1)^2/2$	α_6	0.104	2.737
$(\ln y2)^2/2$	α_7	0.152	3.407
$(\ln y3)^2/2$	α_8	0.086	3.315
$(\ln w)^2/2$	β_1	-0.093	-2.286
$(\ln s)^2/2$	β_2	-0.134	-3.114
ln y1ln y2	α_9	-0.052	-1.635
ln y1ln y3	α_{10}	-0.023	-0.960
ln y2ln y3	α_{11}	-0.083	-2.568
ln w ln s	β_3	0.078	2.280
ln y1.ln w	λ_1	0.045	1.279
ln y2.ln w	λ_2	-0.067	-1.552
ln y3.ln w	λ_3	-0.022	-0.808
ln y1.ln s	λ_4	-0.091	-2.614
ln y2.ln s	λ_5	0.084	2.091
ln y3.ln s	λ_6	0.017	0.612
	δ_0	0.735	17.399
Vap	δ_1	-0.001	-13.797
Loans/Deposits	δ_2	0.001	1.874
Non interest income	δ_3	0.022	1.676
Competition index	δ_4	-0.002	-19.454
Bad loans/loans	δ_5	0.006	9.183
Small	δ_6	-0.171	-10.562
Medium	δ_7	-0.073	-6.579
North-West	δ_8	-0.002	-0.157
North-East	δ_9	-0.010	-1.024
Center	δ_{10}	-0.014	-1.173
	$\sigma 2$	0.015	33.959
	γ	0.491	9.521
Log. Likewood	1566.32		
N. of observations	2244		
N. of cross-sections	449		
N of years	5		

MERGERS AND ACQUISITIONS BETWEEN MUTUAL BANKS IN ITALY: An analysis of the effects on performance and productive efficiency

Roberto Di Salvo,* Maria Carmela Mazzilis*, Andrea Guidi[9]**

* Federcasse, Research Dept.
Via Massimo D'Azeglio, 33
Rome, Italy
Tel +3906482951
Rdisalvo@federcasse.bcc.it

** Fondo di Garanzia dei Depositanti del Credito Cooperativo

Abstract

The paper is aimed at testing the hypothesis that the M&A wave over the past ten years has increased the level of efficiency of co-operative credit banks (CCBs), both in terms of overall performance and productive efficiency.

The logical development is hinged on two steps: 1) an explorative analysis which is based on the observation of balance sheet ratios by quantiles, 2) a DEA application for estimating productive efficiency scores.

The analysis refers to 94 CCBs which have been involved in M&As over the period 1995-1998 and is carried out on both merged and non-merged banks, either before concentration or in the subsequent years.

[9] The Italian version of this paper will be published in the Proceedings of the Conference "Competition and Efficiency of Cooperative Banks in Europe; Key-issues for Further Development" held in Rome on 21-22 June 2001, *Cooperazione di Credito*, n. 173-174, January-March 2002.

We are particularly indebted to Francesco Cesarini and the Advisory Board of the Review *Cooperazione di Credito* for their support and useful comments. We wish to thank David T. Llewellyn who participated at the Conference and helped us frame this work within a broader mutual-issues perspective. Finally, a special thank is addressed to Robert DeYoung for his comments and encouragement for further research.

The usual disclaim applies.

The explorative analysis mainly shows a higher level of fee-based income for merged banks, which is consistent with the hypothesis that concentration strategies enhance diversification. It also detects some degree of cost reduction just after merging. The DEA application models (CRS and VRS) tends to confirm the results of the previous analysis and estimates higher efficiency for merged banks, a lower efficiency degree for pre-merger banks, and a significant degree of scale economies.

JEL Classification is: G21 G28
Keywords: banks, mergers

1. Introduction, principal conclusions and limitations

In the past few years the Italian banking system has undergone intense restructuring, with an increasing number of bank mergers and acquisitions.

The reasons possibly prompting small banks to embark on mergers and acquisitions are manifold: first, the drive to adopt a policy of external growth aimed at economies of scale enabling the institution to enter new markets or defend its local base of operations (strategic-territorial motivations); second, the possibility of diversifying banks' activities, with the associated benefits in terms of risk control and income growth (strategic-operational motivations); third, the hope of achieving a sounder balance-sheet situation in the face of operational imbalances (rescue motivations). The mix of motivations can vary considerably, depending on the operational position (in balance or not) and the role (active or passive) of the banks involved.

Most of the mergers involving small banks are motivated by the drive to become more competitive (in the case of active banks) and to safeguard balance-sheet stability and profitability (in the case of passive banks).

Our study empirically tests whether the numerous concentrations that have taken place in the recent years between mutual banks (*banche di credito cooperativo*) have actually resulted in gains in operational and productive efficiency.

The analysis we performed on a significant number of concentrations between mutual banks in the four years 1995-98 highlights several economic and strategic factors:

- As a rule, the concentrations involved banks with high cost ratios.
- The improvement in overall operating conditions following mergers and acquisitions was very small.
- Concentrations had a marked positive effect on income from services, probably the consequence of an expansion of the range of services offered by the bank resulting from the merger.
- Cost efficiency improved slightly following mergers and acquisitions (by an average of 1.7 per cent).

- The economies of scale achieved by means of mergers and acquisitions were reasonably significant (5 per cent in the years following the operation).

Despite the relative stability of the results we obtained on a significant number of operations, some of the effects of concentrations may not have been fully captured owing to the limited post-merger observation period, especially in the case of the operations carried out in 1998. Moreover, the nature of financial statement data – for the moment the only data available in time series – precludes developing an analytical model incorporating a wider range of explanatory variables for banks' production process and hence able to yield a more accurate evaluation of the effects of mergers and acquisitions.

2. Studies of bank mergers[10]

Within an extensive study of the restructuring of the Italian banking system in the early nineties, *Malavasi (1995)* examines some mergers that were carried out in 1993 and 1994, using several financial statement indicators to identify their effects in terms of cost control, product diversification and exposure to credit risk. For the non-parent banks involved, the objectives of cost rationalization were significant and economies of scale tended to emerge gradually with the passage of time. On the other hand, in the case of the parent banks concentrations did not have significant effects, particularly on efficiency levels.

In an analysis of 34 concentrations between Italian banks in the years between 1988 and 1993, *Comana (1995)* finds that the outcomes depended essentially on the organizational and market compatibility of the banks involved. The empirical results of the analysis were neither unequivocal nor an adequate basis for generalizations concerning the effectiveness and efficiency of mergers.

The study by *Resti (1997)* considers 67 mergers involving 114 banks between 1986 and 1995 and seeks to identify a measure of "extra-efficiency" that expresses whether and to what extent each bank in the sample was more or less efficient than the benchmark in the pre- and post-merger periods. On average, the results show a gain in efficiency, although the benefits of mergers were particularly significant only where the banks involved had a similar market base and banks resulting from the merger were not overly large.

Giorgino and Porzio (1997) perform a descriptive analysis of mergers, acquisitions and asset transfers in Italy between 1985 and 1997, examine the determinants of these operations and their effects on the banks involved, and investigate the reactions of the market in terms of the value of listed banks. They find strategic-territorial motivations more important than considerations of size, especially in the more recent years. As to the operations' effects, there was a general increase in the ratio of customer loans to total bank assets,

---

[10] This survey is limited to the most recent studies carried out in Italy. For the extensive international literature on the subject, see the survey by Berger, Demsetz and Strahan (1998) and the works by Berger and Humphrey (1994), DeYoung (1993; 1997), Pilloff (1994) and Vander Vennet (1996).

a positive impact on indicators of efficiency in the case of mergers and a negative one in that of acquisitions.

Among the most recent studies, *Focarelli, Panetta and Salleo (1998)* analyze a sample of mergers, acquisitions and majority transfers between Italian banks other than mutual banks in the period 1984-1996. The effects of concentrations, examined by comparing the pre- and post-merger values of financial statement indicators, did not include any gain in cost efficiency for the banks resulting from mergers. However, there was an increase in profitability, with more efficient management of capital and growth in net income from services.

A study by *Clemente (1997)* of mergers and acquisitions between mutual banks in the period 1990-1994 finds that "strategic" concentrations did not produce significant gains in efficiency and profitability in the short term. In the case of "rescue" operations, there was no appreciable mitigation of the weaknesses of the "passive" banks, especially as regards the quality of the loan portfolio and the shortfall of capital. These findings are in line with those for larger banks involved in concentrations.

A study by *Di Salvo, La Torre and Maggiolini (1998)* analyzes the determinants of mergers and acquisitions between Italian mutual banks, using a sample of some 130 operations carried out in the period 1990-1997. They find that strategic factors prevailed, in contrast with the emphasis usually placed on rescue motivations. In particular, bank mergers in the North and Centre were primarily motivated by the growth strategies developed by a number of core banks, whereas those in the South more often were dictated by the pursuit of stability.

The present analysis of the effects of mergers and acquisitions on mutual banks' performance rounds out the previous study within the framework of a line of inquiry that the Research Department of Credito Cooperativo has been developing for a number of years.

3. Logical structure, method of analysis and data structure

Analysis of mergers between mutual banks differs from that of the general run of bank mergers in several respects. In the first place, the operations in question exclude acquisitions of control by virtue of mutual banks' cooperative nature and are not subject to market valuation inasmuch as the banks involved are unlisted. Second, mutual banks' objective function differs from the conventional one based on the two-fold assumption of profit maximization and cost minimization. In reality, it incorporates composite objectives, among which that of the bank's stability over time appears to prevail.[11] In this respect mutual banks constitute a distinct banking industry whose features are better analyzed separately from those of other banks.[12]

The analysis is therefore logically developed in two phases: a descriptive and exploratory phase, to examine the behaviour of the banks involved in mergers in the light of different parameters (distribution of financial statement ratios by quantiles); and a mathematical and statistical phase (using data envelopment analysis), to estimate banks' pre- and post-merger efficiency under the two assumptions of constant and increasing returns to scale. The two phases are complementary and entirely consistent with the assumption of a specific objective function of mutual banks. The decision to use a non-parametric method is supported by preliminary investigation showing that the non-parametric technique is well-suited to studying the behaviour of banks of a type where the use of conventional production or cost functions is inappropriate.

Considering the data available for making homogeneous intertemporal comparisons, it was decided to focus on the concentrations that took place between 1995 and 1998. The data are drawn from the Bilbank archive of banks' annual accounts.

The operations for which it proved possible to analyze a sufficient number of annual accounts numbered 45 and involved a total of 94 banks (Table 1).[13]

---

[11] Of course, this objective is compatible with that of maximizing profits in the longer run, allowing for the possibility of deviation from cost efficiency in the short run. See Di Salvo and Galassi (1997) and Cardilli and Di Battista (1997).

[12] On this subject, see W.C. Hunter (1997).

[13] Overall, there were 64 concentrations involving 134 mutual banks in the period 1995-98. Our sample thus covers 70.3 per cent of all such operations in the period.

Table 1

Concentrations by geographical area

	1995	*1996*	*1997*	*1998*	**Total**
Centre	2	1		1	**4**
North-East	9	8	5	6	**28**
North-West	3	1		1	**5**
South	2	4	1	1	**8**
Total	**16**	**14**	**6**	**9**	**45**

Concentrations by type of operation

	1995	*1996*	*1997*	*1998*	**Total**
Mergers	6	5	4	2	**17**
Acquisitions	10	9	2	7	**28**
Total	**16**	**14**	**6**	**9**	**45**

The exploratory analysis was performed using 13 financial statement ratios capable of depicting banks' operational situation from the point of view of capitalization, risk, profitability, cost efficiency and branch network productivity. The indicators were calculated for the period preceding the concentration on aggregated accounts of the banks participating in the operation; for the post-merger period the ratios were calculated on the accounts of the post-merger bank.[14] For purposes of benchmarking, the same indicators were also calculated for a significant number of mutual banks for the different reference periods.[15]

[14] The accounts for two financial years preceding the merger and two or three financial years following it were examined.

[15] The mutual banks analyzed number 469 out of a total of 619 in 1995, 436 of 591 in 1996, 440 of 583 in 1997, and 449 of 563 in 1998. Mutual banks formed in 1993 or later were excluded.

The following parameters were used:

Capital indicators
FREE CAPITAL/TOTAL ASSETS (PL/TA)

Income indicators
GROSS OPERATING RESULT/ TOTAL ASSETS (RLG/TA)
NET INCOME FROM SERVICES/ TOTAL ASSETS (CNS/TA)

Cost indicators
OPERATING COSTS/ TOTAL ASSETS (CO/TA)
STAFF COSTS/ TOTAL ASSETS (SPER/TA)
STAFF COSTS/ NUMBER OF STAFF (SPER/DIP)
OPERATING COSTS/ NUMBER OF BRANCHES (COP/SPORT)
OPERATING COSTS/ GROSS INCOME (COP/MINTM)

Productivity indicators
DEPOSITS/ NUMBER OF STAFF (DEPTOT/DIP)
LOANS/ NUMBER OF STAFF (CR/DIP)

Distribution indicators
DEPOSITS/ NUMBER OF BRANCHES (DEPTOT/SPORT)
LOANS/ NUMBER OF BRANCHES (CR/SPORT)

Risk indicators
BAD DEBTS/ LOANS (SOFF/CR)

The productive efficiency of the banks involved in mergers and acquisitions was estimated using data envelopment analysis (DEA), which has been found to be particularly well-suited to studies of banks in general.[16] The statistical analysis was performed on several years preceding and following the merger, and for benchmarking purposes was extended year by year to mutual banks not involved in M&As.[17]

In applying DEA we adopted the value added approach, with bank outputs including deposits as well as loans and inputs including some variables proxying for labour and capital.

[16] See Resti (1997).

[17] The statistical analysis uses the same set of mutual banks as the exploratory analysis.

In particular, we used the following as measures of output:

- loans
- deposits
- net income from services.

The measures of input were:

- number of branches
- staff costs
- other operating costs.

The DEA models incorporate, alternatively, the assumption of variable returns to scale (VRS) and constant returns to scale (CRS), the former hypothesizing the existence and the latter the absence of economies of scale in the production technology adopted.[18]

The CRS model allows us to calculate a technical efficiency score, measuring the ability to produce the maximum quantity of outputs using the same quantity of inputs

Removing the constraint of constant returns to scale, the VRS model allows us to divide the efficiency score into pure technical efficiency and scale efficiency.

In both models, scores range from 0 to 1. Units with a score of 1 are the most efficient.

We also empirically tested a Cost-DEA model in order to calculate allocative efficiency, i.e. the ability of the bank to select the optimal mix of inputs as a function of their respective "prices".

In general, pre-merger efficiency scores were calculated on aggregated annual accounts, whereas post-merger scores refer to the efficiency of the post-merger bank.

For both the exploratory analysis and DEA it was necessary to define the set of banks in order to calculate the benchmark of those involved in M&As.

[18] See the Methodological Appendix.

We decided to adopt a "moving sample" and examine each of the four subperiods for the concentrations that took place in 1995, 1996, 1997 and 1998 separately. This enabled us to safeguard both the representativeness of the sub-universe of reference (for each subperiod an average of more than 75 per cent of the universe of mutual banks was considered) and the intertemporal comparability of the performances of the banks involved (the results of the individual banks in the pre- and post-merger years are compared with the same set of reference).

We did not analyze the annual accounts for 1993, for which the Bilbank database is thin and the quality of the data inadequate.[19]

[19] See the Methodological Appendix.

4. The results of the exploratory analysis

The exploratory analysis enabled us first of all to verify the existence of a significant shortfall in the performance of merged or acquired mutual banks compared with the others in the period immediately preceding the concentration. This was especially true with regard to costs: more than 60 per cent of the banks examined in the pre-merger period had cost ratios higher than the median of the distribution. Some disadvantage was also found with regard to the indicators of productivity (especially those relating to deposits) (Table 2).

Table 2

Performance indicators prior to the merger/acquisition
% of cases in which the value of the indicator is below the median of the distribution

PLIB_TA	51%
RLG_TA	58%
CNS_TA	49%
COP_TA	62%
SPER_TA	67%
SPER_DIP	60%
COP_SPORT	62%
COP_MINTM	47%
DEPTOT_DIP	67%
CR_DIP	51%
DEPTOT_SPORT	42%
CR_SPORT	42%
SOFF_CR	38%

The exploratory analysis also allowed us to capture by first approximation some of effects on the performance of the banks involved in M&As (Table 3):

- a widespread improvement in profitability deriving from non-credit intermediation services, found for more than half of the banks (and presumably due to the expansion of the range of services offered);
- a discernible curbing of the ratio of operating costs to total assets, recorded for around one third of the banks. Improvement in the cost/assets ratio was

not accompanied by a similar containment of costs in relation to income (the cost/income ratio worsened in 40 per cent of the cases);

- a broadly unchanged level of performance vis-à-vis the pre-merger period as measured by the indicators of productivity and distribution capacity;
- a significant worsening in the risk indicator, partly attributable to more stringent analysis of the quality of the loan portfolio on the occasion of the merger.

Analysis of each of the three years following the merger showed that positive effects on the profitability of services began to emerge more clearly from the second year onwards. By contrast, the appreciable improvement captured by the ratio of operating costs to total assets (COP_TA) and the indicator of productivity (DEPTOT_DIP) emerged as early as the first year.

Table 3

Descriptive/Exploratory Analysis
Results related to the average of the post merger/acquisition period

legend:	**+**	***moving to a better position***
	-	***moving to a worse position***
	=	***staying in the same position***

	PLIB_TA	COP_MINTM	RLG_TA	CNS_TA	COP_TA	SPER_TA	SPER_DIP	COP_SPORT	DEPTOT_DIP	CR_DIP	DEPTOT_SPORT	CR_SPORT	SOFF_CR
+	13	14	12	23	13	8	15	12	14	12	10	9	6
-	15	22	19	11	10	12	17	12	13	12	12	15	14
=	17	9	14	11	22	25	13	21	18	21	23	21	25

	PLIB_TA	COP_MINTM	RLG_TA	CNS_TA	COP_TA	SPER_TA	SPER_DIP	COP_SPORT	DEPTOT_DIP	CR_DIP	DEPTOT_SPORT	CR_SPORT	SOFF_CR
+	29%	31%	27%	51%	29%	18%	33%	27%	31%	27%	22%	20%	13%
-	33%	49%	42%	24%	22%	27%	38%	27%	29%	27%	27%	33%	31%
=	38%	20%	31%	24%	49%	56%	29%	47%	40%	47%	51%	47%	56%

5. Data envelopment analysis

5.1 Main results

Generally, data envelopment analysis (DEA) confirms the findings of our exploratory analysis, adding further indications on the effects of mergers and acquisitions on productive efficiency. As a group the mutual banks involved in mergers and acquisitions display, in the period preceding the operation, poorer efficiency scores than the others (a gap averaging 9 per cent), which is consistent with the hypothesis that a need for reorganization or reinforcement underlies the operation itself. And in the post-merger period we find an improvement in efficiency (averaging 1.7 per cent) that comes mainly the next year, with a stabilization in the subsequent years but at a level that is higher than in the pre-merger period. The improvement is most notable in the mergers that took place in the three years from 1995 through 1997; for those in 1998, it is not significant.

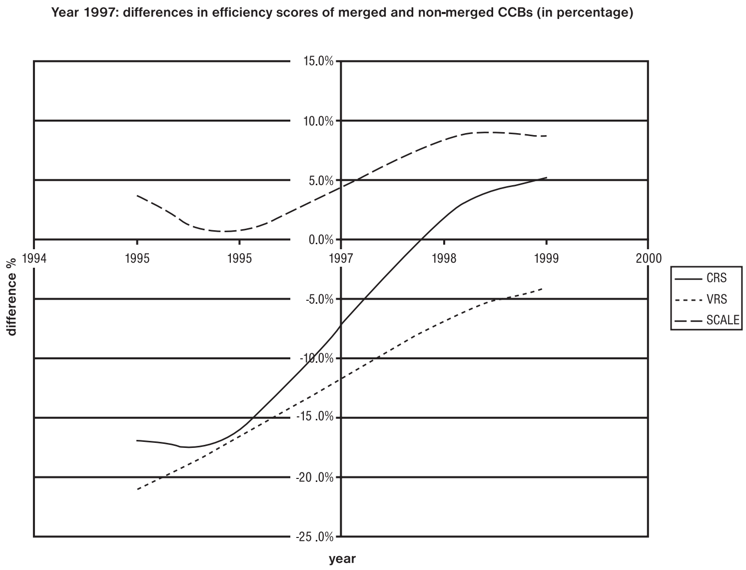
Our analysis also finds that the institutions took advantage of economies of scale in the wake of M&A operations. Their scale economy score in fact rose by an average of 5 per cent in the years following mergers (see Graph 1 – Graph 2 next page).

5.2 The constant returns model

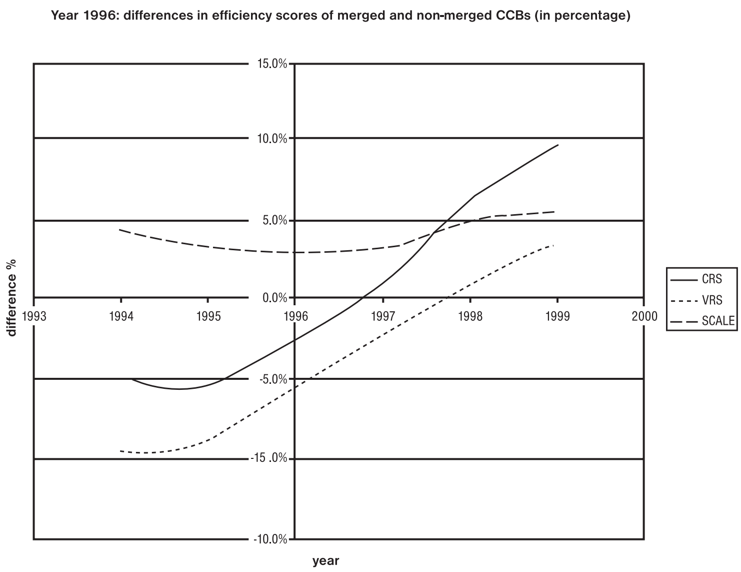
Our results for mergers effected in 1995 show that the merged mutual banks had been significantly behind the others in efficiency. In the immediate pre-merger year, 1994, the gap was 8.1 per cent in their average technical efficiency score. After the merger there was a sudden turnaround: after hitting its worst in 1996 at 10.7 per cent, the differential shrank steadily and indeed was virtually eliminated (1.6 per cent).

The results using 1996 as reference year corroborate those for 1995. The banks involved in mergers had an efficiency score 5 per cent lower than those of other banks, on average, in the two run-up years. After the merger we find that the gap is closed and the merged institutions actually have an edge just a year later. In 1997 the merged mutual banks display an average efficiency

GRAPH 1



GRAPH 2



score 1 per cent higher than the others. This advantage grows in the subsequent years (6.2 per cent in 1998, 9.5 per cent in 1999).

For 1997, the efficiency gap of the merging institutions in the two previous years was 16 per cent. Following the merger, we find a sharp improvement in the average efficiency score of the merged banks, which was reflected in the differential with the others: in 1998, the first post-merger year, they had a positive advantage of 1.8 per cent; this increased to 5.2 per cent in 1999.

5.3 Variable returns model

As we saw in Section 3, assuming variable returns to scale we can split the score into two components: "pure technical efficiency" and scale efficiency. On technical efficiency the banks merged in 1995 had an average score 12 per cent lower than the others in the run-up to the merger, while on scale economies they had an advantage of 3.2 per cent. Until a year after the merger (1996) their pure efficiency score went down, but afterwards it improved markedly. Their efficiency gap narrowed from 12 per cent in 1994 to 8.4 per cent in 1998. Their scale economy scores also rose sharply in 1996, and from 1997 on they were always 5 per cent above those of the other banks.

Analyzing 1996 mergers, we see a clear gain in efficiency for the institutions involved. In the two years previous, they had suffered an efficiency gap of about 9 per cent, but as early as the second post-merger year they were ahead of the rest. In 1998 the merged banks had an average efficiency 1 per cent higher than the others. In 1999 the edge was about 4 per cent. As for the banks merged in 1995, the advantage in scale efficiency was around 5 per cent starting in the second year after the merger, following a decline in the first year.

Taking 1997 as base year, we again find that the merged banks were, on the average, more inefficient than the others. The gap for the years 1995 and 1996 was 20 and 17 per cent respectively. Though they failed to bridge the entire gap, the merged institutions nevertheless made up a considerable distance, narrowing the disadvantage to just 4 per cent in 1999, with a clear recovery in efficiency. On scale economies, the merger-bound institutions scored lower than the others in 1996, the year before their mergers, but in the years following they had an average advantage of 8.5 per cent.

5.4 Cost DEA model

For base year 1997 we also ran another application. Using input variables indicating physical quantities of productive factors (number of staff and number of branches) and their prices (staff costs and other operating costs), we were able to perform a cost data envelopment analysis, in order to separate the overall cost efficiency score into technical and allocative efficiency components. Here again the banks involved in mergers show a clear decrease in cost inefficiency compared with the other mutual banks. However, the gap seems to be reduced more by reason of an ability to improve their own ratio of output to input (technical efficiency) than to success in choosing the optimal mix of productive factors for a given output (allocative efficiency). Net of the gain in technical efficiency (from an initial score 20 per cent below the average in 1995 to a gap of only 4.2 per cent in 1999), we find an insignificant narrowing of the gap in allocative efficiency (from a disadvantage of about 5 per cent in 1995 and 1996 to one of 1 per cent in 1998 and 1999).

The results for 1998 are not significant for our analysis, owing in part to the small range of years available in the post-merger period.

Methodological Appendix

A. Choice of the set

For both methods of analysis – descriptive and DEA – it was necessary to define the universe to which to refer in calculating the position of the banks involved in mergers and acquisitions before and after the event. There were a number of possible alternatives:

1. an "open sample", taking as the universe each year all the mutual banks in the Bilbank database;
2. a common subset of banks listed in the database for the entire period considered (1992-2000); in this case the sample would have consisted of about 200 banks (accounting for about 45 per cent of total mutual bank assets);
3. a "moving sample", separately examining each of the four sub-periods, relating to the mergers occurring in 1995, 1996, 1997 and 1998.

We opted for the third approach, which enabled us to safeguard the representativeness of the sample (for each sub-period we examined about 75 per cent of the mutual banking system in terms of assets) and intertemporal comparability of the performance of merged banks (because the performance of the individual banks in pre- and post-merger years is compared with the same control group).

We did not analyze the accounts for 1993, because for that year the Bilbank database carried relatively few mutual banks, and the data were of poor quality.

In brief, the analytical framework was the following:

“MOVING SAMPLE” FRAMEWORK

1992		1994	**1995**	1996	1997	1998	
		1994	1995	**1996**	1997	1998	1999
			1995	1996	**1997**	1998	1999
				1996	1997	**1998**	1999

199X *year of merger*

199X *period for which accounts are analyzed*

B. Exploratory analysis

We analyzed the position of the merged banks in the pre- and post-merger periods by subdividing the distribution of our chosen performance indicators into quantiles. We took eight intervals:

min. – 12.5th percentile;
12.5th – 25th percentile;
25th – 37.5th percentile;
37.5th – 50th percentile;
50th – 62.5th percentile;
62.5th – 75th percentile;
75th – 87.5th percentile;
87.5th percentile – max.

Each of the 45 banks involved in a merger or acquisition was assigned a score (from 1 to 8) for each of our financial statement indicators for the pre-merger and for the post-merger period. We checked the variability of the score between the pre- and post-merger periods, in order to assess the effect of the merger on the banks’ performance in terms of capitalization, risk, profitability, efficiency and branch productivity.

Finally, we analyzed the effect of the merger on the performance indicators for each of the three post-merger years to check the lag with which the impact was felt and the consistency of the results over time.

C. Data Envelopment Analysis

Non-parametric statistical techniques, generally grouped together as techniques of data envelopment analysis (DEA), solve a problem of linear programming to construct an efficient frontier vis-à-vis which to compare the position of each decision-making unit (here, each bank) in the output-input space. In a word, we begin with the concept of economic efficiency, which can be separated into two parts:

- technical efficiency
- allocative efficiency.

Consider, for example, a firm that produces one output and uses two inputs. Assuming constant returns to scale and knowing the production isoquant (SS') for a hypothetical efficient firm, one can measure the first type of efficiency (technical efficiency).

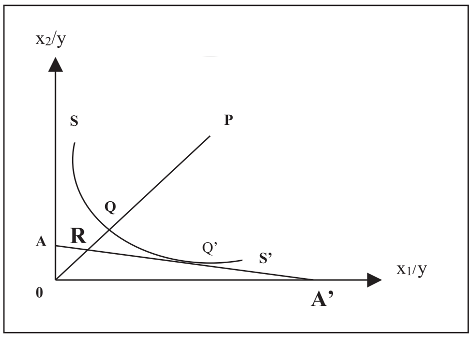


FIGURE 1

Given an inefficient firm positioned at point P in **FIGURE 1**, technical inefficiency can be represented by the distance PQ. This in turn, considered as the ratio between 0P and QP, can be seen as the percentage by which the utilization of factors can be reduced without diminishing output. Allocative efficiency can be measured when one knows the prices of the productive factors (x_1 and x_2). In the figure above, knowing the straight-line segment AA', which represents the prices of productive factors, allocative efficiency is given by the distance RQ. Allocative efficiency can be defined as the cost reduction resulting from the recomposition of the quantities of factors utilized from Q to Q'.

Assuming that there are *k* inputs and *m* outputs for each of the *n* firms examined, the production process for each firm (or decision-making unit) can be represented by the vectors $\mathbf{x}_i$ and $\mathbf{y}_i$.

The production process can also be represented by the ratio:

$$[1] \qquad \boldsymbol{u'y}_i \,/\, \boldsymbol{v'x}_i$$

in which ***u*** is the vector of the output weights and ***v*** that of the input weights.

To select the optimum weights for purposes of determining the frontier, we must specify and resolve the following linear programming problem:

$$[2] \qquad \max_{\boldsymbol{u},\boldsymbol{v}} \ (\boldsymbol{u'y}_i \,/\, \boldsymbol{v'x}_i)$$

$$\text{st} \qquad \boldsymbol{u'y}_j \,/\, \boldsymbol{v'x}_j \ 1, \ j=1, 2, \ldots\ldots, N$$

$$\boldsymbol{u}, \boldsymbol{v} \geq 0$$

The constraint implies that once we have found the values of ***u*** and ***v*** that maximize the efficiency of firm *i*, the measure of efficiency must be less than or equal to 1. A limitation of formalization [2] is that it admits of an infinite number of solutions. To overcome this problem, we impose a further constraint:

$$[3] \qquad \boldsymbol{v'x}_i = 1$$

The dual representation[20] of the problem is as follows:

$$[4] \qquad \min_{\theta,\lambda} \theta$$

$$\text{st} \qquad -\boldsymbol{y}_i + \mathbf{Y}\lambda \geq 0$$
$$\theta\boldsymbol{x}_i + \mathbf{X}\lambda \geq 0$$
$$\lambda \geq 0$$

where θ is a scalar and λ a vector of constants. This form is generally preferred because it is subject to fewer constraints. θ represents the efficiency score for the firm examined.

[20] Duality entails a representation of the production process in which production costs vary as a function of output volume and the prices of productive factors. Obviously the objective is to minimize this function.

This technique enables us to select the most efficient units and construct on these the efficient frontier. To the other units we attribute an efficiency score ranging from 1 to 0, varying as a function of the unit's distance from the efficient frontier. The greater its inefficiency, the lower the score.

This model assumes constant returns to scale. If one wishes to eliminate this constraint, one must introduce a model providing for variable returns to scale that includes the additional convexity constraint $\boldsymbol{p'}\lambda = \mathbf{1}$ where $\boldsymbol{p'}$ is a unit vector. The linear programming problem thus becomes:

$$[5] \qquad \min_{\theta,\lambda} \theta$$

$$\text{st} \qquad \begin{aligned} &-\boldsymbol{y}_i + \mathbf{Y}\lambda \geq 0 \\ &\theta \boldsymbol{x}_i + \mathbf{X}\lambda \geq 0 \\ &\boldsymbol{p'}\lambda = \mathbf{1} \\ &\lambda \geq 0 \end{aligned}$$

Comparing the inefficiency/efficiency scores of the constant and variable returns to scale models, one may decompose technical efficiency into two components: pure technical efficiency and scale efficiency.

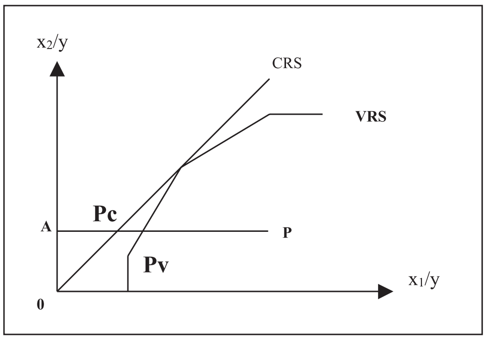


FIGURE 2

In fact, in **FIGURE 2** we can readily observe the difference between point **Pc** and point **Pv**. The former is the efficiency score in the constant-returns model, the latter that in the variable-returns model. The difference between segment **Apc** and segment **Apv** is due precisely to the difference in scale efficiency. This may be calculated as the ratio between the technical efficiency scores in the two models:

[6] $TE_{CRS} = \mathbf{APc} / \mathbf{AP}$

[7] $TE_{VRS} = \mathbf{APv} / \mathbf{AP}$

[8] $SE = \mathbf{APc} / \mathbf{Apv} = TE_{CRS} / TE_{VRS}$

Since we also know prices, we can calculate allocative efficiency, and the problem thus becomes:

[9] $\min_{\lambda, x_i^*} \boldsymbol{w}_i' \boldsymbol{x}_i'^*$

$$\text{st} \quad \begin{aligned} & -\boldsymbol{y}_i + \mathbf{Y}\lambda \geq 0 \\ & \boldsymbol{x}_i^* + \mathbf{X}\lambda \geq 0 \\ & \boldsymbol{p}'\lambda = \mathbf{1} \\ & \lambda \geq 0 \end{aligned}$$

where **w** is the vector of input prices and $\mathbf{x}_i^*$ that of input quantities that minimize the total cost of inputs. Allocative efficiency can be derived by dividing the efficiency score (cost efficiency = CE) by the technical efficiency given by the models set out above:

[10] $AE = CE / TE$

References

Berger A.N., Humphrey D.B., 1994, "Bank Scales Economics, Mergers. Concentration and the efficiency: the U.S. experience", working paper 94-25, Financial Institution Center, The Wharton School, University of Pennsylvania.

Berger A.N., Demsetz R.S., Strahan P.E., 1998, "The Concentration of the Financial Services Industry: Causes, Consequences, and Implications for the Future", Federal Reserve Bank of New York, *Staff Reports*, Number 55, December.

Cardilli, D., Di Battista, M.L., 1997, "Il ruolo del patrimonio nel modello di proprietà e controllo delle banche di credito cooperativo italiane", in *Cooperazione di Credito*, 156-7, April – September.

Clemente C., 1997, "Concentrazioni bancarie e mercati locali in Italia", *Cooperazione di credito*, n. 155, ECRA, Rome.

Coelli T.J., 1996, *A Guide to DEAP version 2.1:* "A Data Envelopment analysis (Computer) Program", in Centre for Efficiency and Productivity Analysis (CEPA) Working Papers, CEPA.

Comana M., 1995, "Crescita esterna e performance bancarie: analisi di 34 casi recenti", in Materiali Assbank, December, Milano.

Cornett, M.M., Tehranian H., 1992, "Changes in corporate performance associated with bank acquisitions", in *Journal of Financial Economics*, n.31, pp.211-234.

Cybo Ottone A., Murgia M., 1996, "Merger and acquisitions in the European banking markets, mimeo", ABI.

DeYoung R., 1993, "Determinants of cost efficiencies in bank mergers", working paper 93-1, Office of the Controller of the Currency, Washington D.C.

DeYoung R., 1997, "Bank Mergers, X-efficiency, and the Market for Corporate Control", *Managerial Finance*, 23.

Di Salvo, R., Galassi, F., 1997, "Asimmetrie informative e funzione-obiettivo della banca locale cooperativa", in *Cooperazione di Credito*, 156-7, April – September.

Di Salvo R., La Torre M., Maggiolini P., 1998, "Le operazioni di concentrazione tra Banche di Credito Cooperativo. Caratteri distintivi e fattori determinanti", in *Cooperazione di Credito n. 162*, ECRA, Rome.

Elyasiani E., Mehdian S.M., 1990, "Efficiency in the Commercial Banking Industry. A Production Frontier Approach", *Applied Economics, n.4*.

Ferrier G.A., Lovell G.A.K., 1990, "Measuring cost Efficiency in Banking: Econometric and Linear Programming Evidence", *Journal of Econometrics*, 46, pp. 229-245.

Focarelli D., Panetta F. and Salleo C, "Why do banks merge? Some empirical evidence from Italy", paper presentato al convegno CEPR "The Changing European Financial Landscape", Bruxelles, 24-26 September 1998.

Forsund F.R., Lovell G.A.K., Schmidt P., 1980, "A Survey of Frontier and their Relationship to Efficiency Measurement", *Journal of Monetary Economics*, May.

Giorgino M., Porzio C., 1997, “Le concentrazioni bancarie in Italia: alcuni fattori interpretativi”, in *Bancaria,* n.12.

Hunter, W.C., 1997, “Il ruolo delle banche locali e regionali tra concorrenza e progresso tecnico. L’esperienza degli Stati Uniti”, in *Cooperazione di Credito*, 156-7, April – September.

Malavasi R., 1995, “Ristrutturazioni bancarie e performance aziendali”, atti del Convegno “Ristrutturazione del sistema bancario: aggregazioni e fusioni tra intermediari”, Cagliari, December 1995.

Pilloff S.J., 1994, “Performance changes and shareholder wealth creation associated with mergers of publicly traded banking institutions”, working paper 94-10, Financial Institution Center, The Wharton School, University of Pennsylvania.

Resti A., 1994, “l dibattito su efficienza delle banche e economie di scala: il contributo della Data Envelopment Analysis ed un’applicazione ai dati italiani, in *Politica Economica*, n.2, pp. 269 311.

Resti A., 1997, “Le fusioni tra banche accrescono l’efficienza? Un’analisi dell’esperienza italiana”*, 1986-1995*, in Materiali Assbank, September, Milano.

Vander Vennett R., 1996, “The effect of the mergers and acquisitions on the efficiency and profitability of EC credit institutions”, in *Journal of Banking and Finance*, n.20 (9), pp. 1531-1558.

SUERF –
Société Universitaire Européenne de Recherches Financières

SUERF is incorporated in France as a non-profit-making Association. It was founded in 1963 as a European-wide forum with the aim of bringing together professionals from both the practitioner and academic sides of finance who have an interest in the working of financial markets, institutions and systems, and the conduct of monetary and regulatory policy.

SUERF is a network association of central bankers, bankers and other practitioners in the financial sector, and academics with the purpose of analysing and understanding European financial markets, institutions and systems, and the conduct of regulation and monetary policy. It organises regular Colloquia, lectures and seminars and each year publishes several analytical studies in the form of *SUERF Studies*.

SUERF has its full-time permanent Executive Office and Secretariat located at the Austrian National Bank in Vienna. It is financed by annual corporate and personal membership fees. Corporate membership currently includes major European financial institutions and Central Banks. SUERF is strongly supported by Central Banks in Europe and its membership comprises most of Europe's Central Banks (29 in total, including the Bank for International Settlements and the European Central Bank), banks, other financial institutions and academics.

SUERF STUDIES

1. G.M.M. Gelauff and C. den Broeder, **Governance of Stakeholder relationships; The German and Dutch experience**, Amsterdam, 1997, ISBN 90-5143-024-8.
2. Rolf Skog, **Does Sweden need a Mandatory Bid Rule, a critical analysis**, Amsterdam 1997, ISBN 90-5143-025-6.
3. **Corporate Governance in Central and Eastern Europe; Transition Management is a Tough Job**. Two papers. Amsterdam, 1998, ISBN 90-5143-027-2.
   1) Debora Revoltella, **Financing Firms in East European Countries: An Asymmetric Information and Agency Costs Approach**
   2) Peter H. Haiss and Gerhard Fink, **Seven Years of Financial Market Reform in Central Europe**
4. Joseph Bisignano, **Towards an Understanding of the Changing Structure of Financial Intermediation; An Evolutionary Theory of Institutional Survival**, Amsterdam, 1998, ISBN 90-5143-026-4. *(out of print)*
5. David T. Llewellyn, **The New Economics of Banking**, Amsterdam, 1999, ISBN 90-5143-028-0.
6. John Calverley, Sarah Hewin, Kevin Grice, **Emerging Stock Markets after the Crisis**, Amsterdam, 2000, ISBN 90-5143-029-9.
7. **Strengthening Financial Infrastructure: Deposit Insurance and Lending of Last Resort** (two contributions), Amsterdam, 2000, ISBN 90-5143-030-2.
   1) Richard Dale, **Deposit Insurance in Theory and Practice**
   2) Christian de Boissieu and Franco Bruni, **Lending of Last Resort and Systemic Stability in the Eurozone**.
8. Cem Karacadag and Michael W. Taylor, **The New Capital Adequacy Framework: Institutional Constraints and Incentive Structures**, Vienna, 2000, ISBN 3-902109-00-9.
9. Miguel Sebastián and Carmen Hernansanz, **The Spanish Banks' Strategy in Latin America**, Vienna, 2000, ISBN 3-902109-01-7.

10. M.M.G. Fase and W.F.V. Vanthoor, **The Federal Reserve System Discussed: A Comparative Analysis**, Vienna, 2000, ISBN 3-902109-02-5.

11. Willem H. Buiter and Clemens Grafe, **Central Banking and the Choice of Currency Regime in Accession Countries**, Vienna, 2001,
ISBN 3-902-109-03-3.

12. Sanjiva Prasad, Christopher J. Green, and Victor Murinde , **Company Financing, Capital Structure, and Ownership: A Survey, and Implications for Developing Economies**, Vienna, 2001,
ISBN 3-902109-04-1.

13. Martin M.G. Fase, **Investments in Painting: The interaction of monetary return and psychic income,** Vienna, 2001,
ISBN 3-902109-05-X.

14. Alexandre Lamfalussy, **Reflections on the Regulation of European Securities Markets**, Vienna, 2001, ISBN 3-902109-06-8.

Order Form: www.suerf.org