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Risk Preference and Investments Quality as Determinants of Efficiency in the Italian Banking System

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Abstract

The Italian banking system is characterized by deep efficiency inequality between banks operating in different regions, with northern banks that largely outperform the southern ones. Moreover the ratio of non-performing loans to total loans is significantly higher in the South than elsewhere. In view of these evidences we asked: is the efficiency gap of the southern banks (and therefore their lower screening and monitoring ability) the primary source of their higher level of bad loans? Or is the poorer quality of the southern bank loans (due to the adverse macroeconomic environment) that causes lower efficiency?
The results offer rather concrete evidence in favour of the hypothesis that is a lower managerial efficiency which causes an increase in non-performing loans, whereas the effects of exogenous environmental shocks are negligible.
As a second point to investigate, we recognize that banks have different risk aversion which differently affects the choice of input vector and we expressly take into account the capitalization degree (as a buffer against the risk) in estimating the bank cost stochastic frontier.

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1 Introduction

The measurement of bank efficiency is heavily influenced by hypothesis on management behaviour and the real nature of bank output, the quality of which is increasingly important in order to correctly evaluate management performance.
The inclusion of output quality avoids the problem of measuring efficiency, which stems from the limited comparability of banks characterized by different investment structures. For example, banks which reduce the level of screening or monitoring of investments may be evaluated as being efficient (in costs) if compared with banks which invest a lot of resources to ensure high loans quality. This conclusion, however, would be conditioned by the fact that the type of output produced by both banks is not homogenous.
As an important point to consider we asked if this quality is a result of internal management processes or a mainly exogenous one, therefore able to condition efficiency.

In the literature the problem of endogenous *non-performing loans* is overcome by assuming that the eventual external component, or impact of the macroeconomic cycle on this, affects all banks in an almost symmetrical way, while the cross sectional variability reveals the differences in efficiency. This theory is not very strong when applied to the Italian economy whose structural conditions are such that, even if the economic cycle were synchronized between Northern and Southern Italy, it would affect the local economies in completely different ways. In the context of a dualistic economic system the hypothesis that output quality is exclusively a product of efficiency differentials instead of a product of macroeconomic environmental conditions, is too strong. We postulated the following question: is the lower level of efficiency that causes poor quality of bank loans or is the adverse macroeconomic conditions that cause a lower loans quality and therefore a suboptimal bank performance?
This will be one of the two topics dealt with, in an attempt to clarify (in relation to the particular reality of Italian banks), whether it is right or not to consider the quality of bank loans as a mere environmental variable and the effects that this assumption produces on a derivation of efficiency which takes this into account.

The other topic we will consider is management behaviour, in particular, to remove the assumption of bank managers risk neutrality, demonstrating how this changes their perception of reaching their own objectives.
The literature has highlighted how risk aversion degree conditions the choice of input by banks, and especially how it conditions their choice of capital level. Since an increase in the capital level reduces the risk of insolvency to which banks are subjected, the managers, if adverse to risk, could be encour-

aged to choose a capital level greater than that necessary to minimize costs and therefore, if their aversion to risk is not taken into consideration, this choice would be deemed inefficient.
Therefore, risk and its many implications on banks performance measurement is the second point we will discuss.

The article is structured in the following way: the second part deals with theoretical studies and is divided into two sections, one on the loan quality, the other on risk. Part three provides some empirical studies on quality and risk, also in two sections (3.1 on quality, 3.2 on risk). Part four shows the data used and choices made in constructing the variables. Part five is the methodology used in the evaluation. Part six presents the results and part seven the conclusions.

2 Theoretical studies on quality and risk

2.1 Loans quality

The aim of this section is to clarify, from a theoretical point of view, the conditions which may favour inefficient performance, how inefficiency deteriorates the loans quality and, finally, to what extent the structure of the Italian credit system is left open to these types of situation.
The theoretical analysis concentrated mainly on the possible causes of inefficient management behaviour and identified the most important aspects of the problem in individual behavioural functions. The need to investigate (and expand) the concept of underlying behavioural functions in the banks management depends on the fact that the neoclassical theory reduces the description of companies to the simple production function, or rather of a technological relationship between input and output. One of the most recent contributions to the theory of industrial organization, the *expense-preference* approach of Williamson is an attempt to overcome this limited concept.
This theory, based on the premise that different people (shareholders, managers, customers) with different and often conflicting preferences operate in a company, assumes that managers can pursue objectives other than that of maximizing profit. In this context it is possible that managers, interested in maximizing their specific function, may decide on a less than perfect allocation of resources, for example increasing the size of the company more than necessary or increasing certain expenses such as in personnel or company image[1]. In order for *expense-preference*, or any other similar inefficient behaviour, to have these distorting effects particular conditions are necessary, such as: transaction costs and non competitive conditions in output, capital

[1]In the case of banks this could be an increase in loans with consequent deterioration in quality.

and labour markets.
The existence of transaction costs, and in particular monitoring costs, permits a trade-off between marginal benefits of monitoring and related marginal costs. In fact, when there are monitoring costs, owners could be inclined to tolerate *expense-preference* behaviour each time the advantages of monitoring for each shareholder is less than the cost which they would incur in activating controls. It may be presumed that the incentive of the owners to supervise the operations of the managers is much lower when company ownership is further divided.
Transaction costs alone are not sufficient to create a sub-optimal equilibrium such as *expense-preference*, in order that this happen there must also be non competitive conditions in the market in which the company operates. The importance of competition in the output market was highlighted by Williamson (1963) who showed how, where there is perfect competition, the companies in which sub-optimal management behaviour prevailed would be eliminated. As a result of the importance placed by Williamson on competitive conditions of the output market, the first empirical analysis concentrated mainly on the relationship between the degree of monopoly of the output market and the number of employees or personnel expenses. Edwards (1977) demonstrated how banks which operate in monopolistic conditions have higher personnel expenses and more employees than those which operate in competitive markets.
Banking markets are characterized by a certain degree of monopoly (Diamond 1984) whether due to their specificity in exploiting scale economies in monitoring loan customers or gathering private information. Therefore, in the light of observations on the importance of competitive conditions in the output market as a regulatory measure for *expense-preference* behaviour, banks are shown to be particularly vulnerable to sub-optimal management choices.
The other conditions which create sub-optimal behaviour are the absence of competition in the labour and in the capital markets. As regards the former, it is clear how an efficient labour market would not be an incentive to sub-optimal behaviour as the managers would be interested in defending their reputation in order to avoid future discrimination; as regards the capital market, it is obvious that if it functions well, it then guarantees excellent conditions for efficient management thanks to the external regulation created by the threat of hostile take-over bids to which managers who do not maximize the profitability are subject.
On the basis of these considerations we can conclude that, a not excessively sub-divided ownership, together with an efficient capital market, can be an important regulatory measure in the management behaviour. On the other hand, a company which is mainly public, associated to a less than dynamic

capital market, favours sub-optimal behaviour [2]. Therefore, if we consider the Italian situation, characterized by a capital market still at the consolidating stage and a labour market conditioned by previous public ownership of the main banks, it is clear how the problem of inefficient management exists and therefore, theoretically, the poor quality of loans could be the result of inefficient management other than adverse environmental conditions.

Once the conditions which lead to distorted managerial behaviour were clarified, the theory tried to explain how such behaviour leads to a deterioration in the loans quality.
Firstly, the pursuit of a dimension greater than that coherent with the maximization of profits implies an accommodating credit policy and therefore acceptance of higher than optimal risk levels (Morelli and Pittaluga 1998).
Secondly, prevailing sub-optimal managerial behaviour (probable in the Italian market, as previously shown) on the whole leads to less efficiency in the banks and therefore, for this reason, less ability to discriminate between good and bad loans quality (Berger and DeYoung 1997, Williams 2003).
The aim of our study is to test the theory that deterioration in the output quality is a consequence of inefficient management processes and, as such, is assimilated to an output of the production function, against the alternative theory that this is exogenous as it is determined by the environmental conditions in which the bank operates.
We do not intend to verify *tout-court* the exogeneity nature of non-performing loans with respect to bank efficiency, but rather their greater or lesser marked dependency on non-managerial phenomena and, in particular, if the significant differentials in the level of non-performing loans observed in the Southern regions are the result of precarious macroeconomic conditions - and therefore decisive in compromising the performance of banks - or are the result of poor management of southern local banks.
From an operative point of view, if the loan quality is considered mainly a result of the management process, then it will be included as an output in the estimation of the cost (or profit) functions; if, however, it is considered an environmental outcome it will be introduced as an external variable in the vector of inefficiency explanatory variables.

In conclusion, in order to have an idea of the relevance of the phenomenon it is suffice to observe the incidence of non-performing loans on total loans, greater in the South compared to the rest of the country and, as such, shows an obvious deterioration as from 1993 (Table 1). The process of deterioration in loans quality peaked in 1996, a year in which non-performing loans,

[2] Competition in the output market is not dealt with because the banking markets are characterized by a sort of *intrinsic* monopoly, as previously mentioned, and because if all banks on a certain market have *expense-preference* behaviour, competition is no longer a prevention factor.

on a national scale, reached approximately 11 per cent of total loans. Although recent years have shown a progressive improvement in the conditions of loans, the difference between geographical areas, and in general between Northern and Southern Italy, remains significant. The substantial and persistent difference in the amount of non-performing loans supports the theory in which the environment is the main reason for generating bad loans: due to the relevance of the implications, caution is required before concluding in favour of one theory as opposed to another. The *Granger* test proposed in this study intends to provide empirical evidence in favour of, or against, the non-performing loans exogeneity hypothesis.

Year	Italy	North-West	North-East	Center	South and Isles
1990	5,49	3,55	4,38	6,01	10,11
1991	5,68	3,48	4,27	6,65	10,51
1992	5,77	3,64	4,38	6,27	10,98
1993	6,94	4,58	5,52	7,42	12,70
1994	8,90	5,73	6,92	9,51	16,74
1995	10,20	6,07	6,91	10,78	21,97
1996	11,39	6,20	6,80	12,00	27,24
1997	9,11	5,43	5,92	9,25	21,89
1998	9,01	5,19	5,23	9,51	22,70
1999	7,97	4,42	4,30	8,37	21,71
2000	6,45	3,53	3,53	6,95	18,26
2001	4,92	2,70	2,71	5,16	15,05
2002	4,54	2,68	2,52	4,92	12,91
2003	4,54	2,74	2,71	5,00	12,16
2004	4,73	2,80	3,37	5,30	11,51
2005	4,57	2,74	3,21	5,18	11,01

Source: Bank of Italy

Table 1: Ratio of non-performing loans to total loans (1990-2005)

2.2 Risk aversion

Hughes and Mester (1994) have shown how banks are not neutral to risk and do not choose the level of their net capital exclusively in order to minimize costs. Conversely, they observe how banks which are more averse to risk could choose to finance their investments using a higher amount of equity compared to deposits (choosing to be less in debt). Since equity is a typically more onerous source of financing than deposits, this could lead to the conclusion that banks which are more averse to risk produce their output inefficiently (choosing the wrong mix of productive factors). The evaluation of inefficiency would actually be distorted by the fact that the choice of mixed

productive factors is affected by the different propensity to risk of the people involved, and that should be taken into consideration (Kwan and Eisenbeis 1995, Shrieves and Dahl 1992).
From a merely operative point of view, the analysis of Hughes and Mester (1994) provides a test which verifies two alternative theories on the objective function which bank managers are assumed to maximize (a mere profit function *vs* a broader utility function). The test shows that the underlying function of the manager's behaviour is utility or rather, a function which, as well as profits, also includes the level of risk to which bank management is exposed [3]. There is, therefore, a trade-off between profit and risk: managers, in retaining an amount of equity higher than that of cost minimizing, give up part of the profits in exchange for fewer risks.

The role of risk assumed by bank management is important not only in determining the best level of capitalization, but it also affects the general level of costs through risk premium which the depositors expect in exchange for resources entrusted to the bank [4]. In other words, if on the one hand equity capital is considered in the same way as an alternative source of funding, on the other it performs the additional function of constituting a sort of guarantee against the insolvency risk.

Another role of equity is to inhibit the moral hazard behaviour to which bank managers might be tempted. As widely discussed in the literature on risks, financial institutions with low equity levels are more willing to take greater risks by virtue of the fact that they would benefit from any positive result and suffer losses, at most, equal to the capital invested. Another reason to explain the greater risk propensity of institutions with low capital is that the managers are subject to less shareholder scrutiny.

Therefore, in the light of these observations, it would seem that the demand function of a bank's equity capital, in cases of non neutral risks, must consider not only the minimization of costs but also the various repercussions on risk profile this entails.
All of these considerations, which concern the different aversion of bank management to risk, seem to be even more decisive in explaining the level of equity adopted -and the consequences in terms of cost and profit- when considering the Italian market, characterized by banks with different legal organizational structures and, presumably, different risk preferences.

[3] Actually, the risk is indirectly accounted in the utility function as it contains: output amount, quality of assets, profit, financial capital. It is therefore the level of financial capital which represents a measure of the manager propensity to protect himself against risk.

[4] It is obvious that the different levels of equity capital that a bank can use to produce a fixed output vector determine different risks of insolvency.

	Mean	Std.Dev.	Min	Max
CCB	0.114	0.033	0	0.274
CB	0.054	0.027	0.012	0.254
LC	0.069	0.045	0.002	0.578

Source: Elaboration on Bilbank data

Table 2: Equity capital asset ratio

Table 2 shows the level of equity against total assets in the different types of banks operating in Italy. As shown, the level of equity used by the Co-operative Credit Banks (Banche di Credito Cooperativo, CCB hereafter) is considerably higher in relation to those of Co-operative Banks (Banche Popolari, CB hereafter) or those registered as Limited Companies (Società per Azioni, LC hereafter). This difference reflects a greater aversion to risk by the Co-operative Credit Banks as, given their mutualistic nature, the objective functions of the owners merges with that of the customers (Mayers and Smith 1988).
Where this difference is not taken into account the evaluation of efficiency would be distorted for the banks more averse to risk. This is the reason why this study will specifically consider the particular function of equity capital for bank management, introducing the level of capitalization of banks in the econometric specification of the cost and profit frontier function[5].

3 Econometric literature

3.1 Investment quality

This section will summarize the most recent studies on the nature of loan quality and, in particular, the dynamics of non-performing loans which are the best proxy available for an appropriate evaluation of quality.
The most significant aspect as regards this study is the relationship of causality between bank efficiency and non-performing loans. As previously mentioned, one of the questions we will try to answer is: does the high level of non-performing loans (due to the adverse economic-environmental conditions) compromise results in terms of bank efficiency or are inefficient banks - incapable of screening and monitoring borrowers - who generate bad quality output. In other words, the meaningful point is not so much in which direction the relationship between non-performing loans and efficiency moves,

[5]Table 10 shows the same ratio - equity on total assets - divided on the basis of the bank size. As expected, the smaller banks have a considerably higher level of capitalization compared to large ones and this is due both to their greater aversion to risk and because they are mainly the Co-operative Credit Banks.

as the direction of the temporal connection which links these variables. The following contributions use this particular research focus.

Berger and DeYoung (1997) were the first to perform an empirical study on the nature of the causality connection that links non-performing loans to bank efficiency. The study suggests four basic interpretative theories on the nature of non-performing loans and management behaviour. The first is *bad management*; this assumes that bank management inefficiency determines a deterioration in assets quality over time. From this point of view managerial inefficiency is reflected in the poor screening and monitoring of borrowers with obvious repercussions on the general level of non-performing loans[6].
The second theory, *bad luck*, assumes that non-performing loans are exogenous to management choices and depend on macroeconomic shocks or are to be found in adverse macroeconomic-environmental conditions. Compared to the previous theory the connection is obviously inverted: first there is the shock, which increases the non-performing loans, followed by the increased problematic nature of loans which affect bank efficiency. In other words, a more problematic environment depreciates the loan quality and the resulting increase in non performing loans increases the costs of credit management for the bank, the higher cost per product unit results in a deterioration of efficiency performance.
The third possible theory, *skimping behaviour*, is different from the others in that it assumes that the direction of the causality link between variables is positive and not negative, or rather, that increased efficiency is followed by an increase in non-performing loans. The theory is that managers choose a plan to minimize costs in the short term to the detriment of loan quality in the long term. At the time this reduces the amount of resources invested per output unit (reducing screening and monitoring costs) thus resulting in improved cost efficiency but, in time, this improved performance is followed by an increase in non-performing loans as the credit previously given begins to show the first signs of problems.
The fourth and final theory, *moral hazard*, starts from the assumption that managers of undercapitalized banks are less averse to risk, suggesting a causality link between equity capital and non-performing loans level: low levels of capital imply greater risk taking, reflected over time in a greater variability in output quality.
The results of Berger and DeYoung (1997) regarding the United States banking system conclude that the theory of *skimping behaviour* can be excluded in favour of *moral hazard*. However, the results do not completely resolve the exogeneity problem of non performing loans.

[6]This is the endogeneity hypothesis of non-performing loans as these are held to be the result of specific (and wrong) managerial choices.

Williams (2003) carried out a study using the same methodology and interpretative theories but, unlike the previous one, this was performed on a sample of European banks. The results suggest that the main reason for non-performing loans is, without doubt, managerial inefficiency with no confirmation of the *moral hazard* theory.

Morelli and Pittaluga (1998) adopted a different approach to explain the determinants of banks output quality.
Starting with the empirical evidence on the trend of non-performing loans in the Italian banking system from the early 1990s, the authors proposed an interesting analysis of the causal connection between structural aspects of the banking system and the increase in non-performing loans. The initial results attributed the increase observed in the three years from 1993-96 essentially to the real economic trend and that significant changes in the quality loan screening could be excluded [7].

Morelli and Pittaluga (1998) also investigated the possible causality connection between the behaviour of Italian banks and their characteristic excessive risk compared to the European average. In other words, they tried to identify any eventual specificity in the behaviour of Italian banks. The main econometric results obtained show that the risk in loans is higher in banks with lower productivity and profitability, that are less exposed to competition in the output market and public ownership. Therefore, there are characteristics in the Italian banking system, or at least part of it, which are associated to a higher than average level of non-performing loans. From this point of view a squeeze on the net interest spread from growing competitive pressure should represent a significant incentive to the control of credit risk.
In conclusion, with reference to the internal market, the aforementioned study seems to support the exogeneity theory in generating high levels of non-performing loans.

3.2 Risk preference

The study of risk in the empirical literature on banks has taken different approaches depending on the type of econometric model used. This section will summarize the most recent contributions beginning with the one used in our study.

Mester (1996) estimated the effect of risk propensity on efficiency in the United States banks in 1991-1992. Equity capital was the proxy used to measure risk aversion, this variable is directly inserted in the parametric

[7] This result does not change when considering only banks in the South: there seems to be a close relation between worsening loans quality and real economic trend even when considering single geographic areas.

specification of cost function and treated as a further bank production output. Inserting the equity level as part of the cost function avoids the evaluation errors which are highlighted in the literature on risk. The author also performed a correlation analysis of efficiency levels with a set of explanatory variables including equity capital.
The results show a significant negative relation between capital-asset ratio and inefficiency thus providing empirical evidence on the important role of risk (previously identified in theoretical studies) on the banks behaviour.

Kwan and Eisenbeis (1995) attempted to measure cost efficiency in a sample of large American banks from 1986 to 1991. It clearly emerged that omission of risk among cost function variables determines an under-evaluation of the efficiency of the more capitalized banks.

A similar approach was taken by Altunbas et al. (2000) who measured cost efficiency in a sample of Japanese banks by correcting for risk aversion and highlighting the effects that this correction entails in order to determine the optimal size of the company. Also in this case the correction includes equity capital among the elements which make up the cost function.

The following studies have a different approach to that used in the present one, however all include risk in the analysis of the managerial results.

In a sample of commercial banks in the United States, Gorton and Rosen (1995), showed that a useful indication on the managers propensity to assume high risks is the amount of equity capital which these managers possess. They observed that banks assume higher risks when the managers' capital share is sufficient to guarantee an expensive external market discipline (making hostile take-overs difficult) but is not enough to align the managers' objectives with the owners interest (it does not completely resolve agency conflict). Equally, where the capital share owned by the managers is consistent a greater aversion to risk is observed.

Another study on bank risks was carried out by Merton (1977) and showed that when there is an insurance on deposits at fixed premium not correlated to the bank risk, shareholders have more incentive to take additional risks in order to maximize the value of the insurance premium payed.

Girardone et al. (2004) used a two-stage approach to measure the determinants of cost efficiency in a sample of Italian banks in 1993-1996. The evaluation of a logistic regression of inefficiency scores on a set of explanatory variables showed how the equity capital is inversely correlated to inefficiency. This conclusion is not really sufficient to state that an increase in the equity capital-asset ratio determines a reduction in inefficiency, the link could also

be in the opposite direction: or rather, a more efficient bank would make more profits and consequently could assign a higher amount to capital.
A positive relation emerged between non-performing loans and inefficiency; the authors interpreted this result as confirmation of the fact that higher levels of efficiency are usually associated with a better ability to evaluate loans portfolio. This conclusion, unlike the causality analysis performed in this paper, does not consider another possibility: that the high levels of non-performing loans determine high levels of inefficiency.

4 Data and variables

A sample of 550 banks was evaluated on the basis of balance sheet information comprised in the Bilbank dataset for the period 1993-2003. The panel included all banks for which balance sheet data was available for at least nine out of the eleven years studied. In this way the estimates were performed using 5,621 observations, corresponding to approximately 70 per cent of the total observations on the entire banking system. The sample was divided, taking into consideration the size and legal structure of the company, i.e. Co-operative Credit Banks (CCB), Co-operative Banks (CB) and Limited Companies (LC). Table 3 shows the number of observations in relation to different classification criteria[8].

	Sml	Med	Lar	Tot
CCB	1396	2421	68	3885
CB	2	62	236	300
LC	7	328	1101	1436
Tot	1405	2811	1405	5621

Elaboration on Bilbank data

Table 3: Sample observations

In constructing the variables a hybrid approach was adopted compared to the classic approach which considers the stock and flow variables separately. In particular, bank products were identified in the total loans, deposits and revenue from services. The use of stock variables (loans and deposits), as proxy for the production value, in addition to flow variables (revenue from services) is justified by the fact that the elements in the asset and liability statement involve the continuous production of services which constitute a good approximation of bank production (Lucchetti et al. 1999).
In the *intermediation approach* (Berger et al. 1986) the bank was considered

[8]The division based on size considered the distribution of the total assets variable in the whole sample. Small banks are those whose total assets are under the first quartile; medium-sized banks have a total assets value between the first and third quartile; large banks are in the last distribution quartile.

as using three inputs, labour (x_1), capital (x_2) and "raised funds" (x_3) and producing three outputs, deposits (y_1), commercial loans (y_2) and interbank loans plus investment securities (y_3) (Giannola et al. 1997).
The problem of the dual nature of deposits in the definition of bank input and output, was resolved by following Berger and Humphrey (1991), and including the cost of funding in the input and the volume of deposits in the output.
Following the proposal of Hunter and Timme (1995) repeated by Rogers (1998), a fourth output, the non-traditional activities of the bank (y_4) was considered, using total non-interest income as proxy, or rather income from active commission and other operating income. The non-traditional activities which provide income other than from interest and commission are those which produce profits, premiums, rent (also figuratively), fees and expense reimbursement accounted for in the other operating income.
The activities which are more or less non-traditional and produce commission are basically from credit guarantees, cash and payment services, management, intermediation and financial counselling, share and currency negotiation, asset management, tax collecting services, insurance products and factoring services.
With regard to interbank loans and the total investment security (y_3) we preferred to consider them as a distinct output.

The following is a summary of the methods used in calculating the price of input factors used by the bank (w_1, w_2, w_3).
The labour factor was calculated by measuring the annual average number of employees for each bank in the sample. The cost of labour factor was calculated by subtracting from the personnel costs (equal to the sum of salaries and wages, welfare contributions, contributions for retirement and pension funds) the yield (hypothetical) of these funds, approximately calculated on the basis of the interbank interest rate at three months for the year studied. This correction seems necessary, as observed by Ricci (1997), since funds deferred for personnel expenses are recorded at nominal value and not at discounted value, a non-adjustment for the yield (hypothetical) of the funds would produce an over-evaluation of the labour cost. The labour factor price (w_1) is then calculated by dividing the cost of labour (previously calculated) by the average number of employees [9].

The capital factor was measured by the budget values of the bank's own capital (tangible and intangible fixed assets) and other borrowed capital in the form of rents or leasing. The cost of the bank's own capital is obtained

[9] As Mester (1987) observed, the labour cost should also consider the different types of jobs (full-time, par-time, hourly wage etc.) and include employee benefits in the calculation.

by summing the cost of using the calculated capital to the depreciation cost, the former is calculated by applying the interbank rate at three months to the fixed assets.
The cost of borrowed capital is given by rent expenses, leasing and other administration costs (electricity, telephone, stationery and advertising).
The price of the capital factor (w_2) is measured by dividing the total cost of capital (owned and borrowed) by "raised funds", following a procedure based on the theory of a constant ratio between capital and "raised funds", introduced by Mester (1987).
The system of using "raised funds" as a denominator of total capital cost depends on the problem of measuring physical capital pertained in the bank accounting (Mester 1987).

As regards "raised funds" (x_3), together with bonds issued and customer deposits[10] the "other sources of loanable funds"[11], generally disregarded in literature (Giannola et al. 1996), should be considered. These are:

1. Funds included in the assets and liabilities statement, such as risk and deferred expenses funds (the fund for general banking risks which is part of the net capital is excluded), personnel funds, or rather the retirement and pension funds and similar expenses, external administration funds;

2. Subordinate liabilities, i.e. subordinate loans, or "financial instruments whose negotiating scheme establishes for the holder of representative loan documents to be reimbursed after other creditors in the event of bankruptcy" and hybrid equity instruments, such as irredeemable bank liabilities (Costi 1994);

3. "Free Capital", measured by the difference between net capital and the sum of fixed material/immaterial assets and shareholding, or rather, the difference between non fixed assets and liabilities (not all directly interest bearing or burdensome). "Free capital" is therefore the part of net capital which can be used in operations and therefore directly generate income for the bank.

The cost of funding from customer deposits, banks deposits or represented by securities is calculated by considering the aggregate interest expense and assimilated expenses. Commission expenses are added to this aggregate to

[10] According to the theory adopted, deposits are simultaneously production input and output.

[11] In this study the "other sources of loanable funds" were included in the calculation of price capital (x_3) as denominator as they are not only sources of "loanable funds" but also funds used for buying capital: it therefore seems right to divide the cost of capital by the sum of deposits, bond issued and "other source of loanable funds" without excluding the latter.

account for costs related to atypical, nontraditional funding. In the same way, when considering the income from bank operations, income commission must be added to the interest income and assimilated revenues.
The possibility to consider commission expenses in the costs of funding derives both from the difficulty in keeping banks service operations separate from that of intermediaries and from the recognition that competition between banks for funding is also in the services offered, from which the bank derives as much income commission as expense commission.
Other funding costs are linked to funds and the liabilities defined in points 1), 2) and 3). These are other sources of funding used by the banks in their operations without paying a specific cost or, however, are debts incurred by the bank at lower rates than that of the market and the difference compared to the market rate should be calculated in the interest expenses. The procedure for doing this is to calculate a nominal cost for their use considering interbank interest rate at three months as a reference.

The so-called "free capital" merits a separate discussion (sub.3). As Giannola et al. (1996), observed, bank net capital can be divided between a) fixed non-current assets, used to finance non-operative assets such as non-instrumental assets, goodwill and equity holding; b) invested assets, used to finance physical capital used in operations; c) "free capital" which is another form of funding. The availability of other sources of funding does not imply a direct expense for the bank but however, imposes the need to consider the nominal cost linked to its use for bank operations. The cost of this type of funding is also calculated on the basis of the interbank interest rate at three months.
Once all the elements useful in determining the cost of "raised funds" have been calculated in this way, in order to obtain the price of this productive factor (w_3) it is divided by the sum of the deposits, securities and "other sources of loanable funds".

The variable which measures the "credit intensity" of bank's activity(CL/EA) is obtained from the ratio between commercial loans and earning assets; that relative to degree of risk aversion (E/TA) is equal to the ratio between equity capital plus reserves and total assets.
Finally, the variable which measures loans quality (NPL/L) is obtained from the ratio between loan loss provisions - net of recovery value - and the total loans [12].

As Hughes and Mester (1993) observed the ratio between non-performing

[12] The ratio between non-performing loans and total loans was created by examining the flow variables instead of the stock in order to better understand the effect of the dynamics on the non-performing loans trend: the use of variation instead of the amount of risk reserves on credits is less exposed to the effects of mere budget policy.

loans and total loans forms the best available proxy to estimate how much of the bank resources are actually used in monitoring activities, but constitutes only an ex-post measure of loan quality: not all poor quality credit is transformed into non-performing loans just as not all good quality credit will continue to be so. As there is no variable to measure the ex-ante quality of allocated credit the previously described approach will be used in this study.

The last two variable are the total costs (TC) and profits (U). The former are calculated by considering all expenses incurred by the bank, including those for interests. Profits are obtained from the difference between total revenues and total costs. Revenues from bank operations are measured by interest income and assimilated profits and, since the non-traditional bank operations are to be considered, also from commission (including that on deposits).
Finally, all series were deflated using the added value (at factor costs) of monetary and financial intermediary services (base year 1995) as a price index.
Table 4 shows the most significant information on these variables.

Variable	Obs	Mean	Std.Dev	Min.	Max
y_1	5621	277475.1	466726	5026.706	3867995
y_2	5621	173668.1	299965.3	2120.9	2500980
y_3	5621	132484.3	232529.7	2868.4	2086288
y_4	5621	6095.8	12374.34	29.52913	119292
w_1	5621	52.29342	5.730682	24.2897	83.18565
w_2	5621	.0189601	.0047275	.0068699	.0416697
w_3	5621	.0450434	.0198578	.0103899	.1198979
e	5621	24138.95	34811.13	584.5852	251937.3
np/ll	5621	.0059479	.0045204	3.59e-06	.0405675
ta	5621	335135.7	561350.6	5963.324	4615104
cl/ea	5621	.5176013	.1346166	.0934997	.9716791
tc	562	25781.07	46209.62	605.877	443910.4
u	5621	3466.962	6813.561	-16356.03	79521.18
e/ta	5621	.1017688	.0383725	.0083132	.4032875

Thousand of euro

Table 4: Sample Descriptive Statistics

5 Methodology

This section will explain the empirical evaluation model and the econometric methods used. There are three stages in the model: 1) an estimate of efficiency scores (of cost and profit) for the sample banks using a stochastic frontier inefficiency effect model (Battese and Coelli, 1995) and inserting risk aversion in the selected parametric specification; 2) using the efficiency scores obtained in the point one, the *Granger* causality test is performed to verify the exogeneity theory of non-performing loans compared to managerial inefficiency hypothesis (endogeneity); 3) a conclusive estimate of efficiency scores is obtained taking into account the results of the causality connection performed in the point two.

The usual stochastic frontier derivation models, initially proposed by Aigner et al. (1977) and Meeusen and van den Broeck (1977), do not permit the inclusion of any efficiency explanatory variable in the frontier estimation. The type of approach prevalent in the literature is that proposed by Pitt and Lee (1981) and Kalirajan (1981), where a two stage technique is adopted in order to investigate the explanatory factors of efficiency: the first stage estimates the stochastic frontier, deriving the inefficiency scores; in the second stage the inefficiency values regression is performed on a series of variables thought to potentially explain the trend.
As Kumbhakar et al. (1991), Reifschneider and Stevenson (1991) and Huang and Liu (1994), noted, the two stage approach is formally incorrect as, in the specification of the regression model in the second stage the inefficiency distribution hypothesis on which the stochastic frontier models are based are contradicted[13].

An alternative approach to the two-stage technique, which does not have these limitations, is that originally proposed by Kumbhakar et al. (1991) and adapted for panel models by Battese and Coelli (1995). Considering a general production function for panel models, we have

$$Y_{it} = \exp(x_{it}\beta + V_{it} - U_{it}) \tag{1}$$

where Y_{it} is the output produced by the unit i in year t;
x_{it} is a vector $(1 \times K)$ referring to production function input;
β is a vector of production function parameters which must be estimated;
V_{it} is the mere stochastic error assumed to be distributed as a Normal variable $iid \sim N(0; \sigma_v^2)$, with a zero mean and independently distributed by the inefficiency component U_{it};
U_{it} is the residual non-negative random variable which measures the inefficiency of production process after disentangling the stochastic error. On assume that it is independently, but non identically, distributed. Therefore, U_{it} is obtained through zero truncation of a normal distribution with mean $z_{it}\delta$, and σ_u^2 variance;
z_{it} is a vector $(1 \times m)$ of explanatory variables associated to the mean inefficiency levels of the different economic units observed over time;

[13]These models assume that inefficiency is an identically and independently distributed random variable.

δ is a vector $(m \times 1)$ of coefficients to estimate.
Equation 1 shows the classic representation of production function in stochastic frontier models, the difference in the approach suggested by Battese and Coelli (1995) consists in the assumption that inefficiency, U_{it} in the model, is not identically distributed for all units observed and all the time, but instead follows a truncated normal distribution, the mean of which varies from unit to unit and year to year, depending on a series of explanatory variables (z_{it}).
If all the elements of the δ coefficients vector are null, then this means that none of the explanatory z variables suggested determine the translation of the mean on which the distribution of inefficiency was based, and therefore the model becomes a half normal distribution type proposed by Aigner et al. (1977). If, however, all the δ coefficients are null, except for the δ_0 constant, then the model becomes a truncated normal one like those suggested by Stevenson (1980) e Battese and Coelli (1988, 1992).

The inefficiency component, U_{it}, included in equation 1 can be specified as

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

where the random variable W_{it} can be derived from truncation of a Normal distribution with a zero mean, σ^2 variance and truncation point equal to $-z_{it}\delta$, so that $W_{it} \geq -z_{it}\delta$. This assumption is coherent with the theory that U_{it} is a non negative random variable extracted from a $N^+(z_{it}\delta, \sigma^2)$ distribution.

The estimate method adopted consists in a simultaneous ML equations of stochastic frontier parameters and of inefficiency explanatory ones. The maximum likelihood function and the partial derivates in the model parameters were calculated by Battese and Coelli (1993), the same function is then re-parameterized following Battese and Corra (1977) and so we have $\sigma_S^2 \equiv \sigma_V^2 + \sigma^2$ and $\gamma \equiv \sigma^2/\sigma_S^2$.
Once the total residues of the estimated function are obtained ($U_{it} + V_{it}$) the mere inefficiency component (U_{it}) is broken down according to the method suggested by Jondrow et al. (1982) and the exact level of efficiency is then calculated using the estimator proposed and calculated by Battese and Coelli (1993).
The efficiency level of the unit i in year t will finally be equal to[14]

$$TE_{it} = \exp(-U_{it}) = \exp(-z_{it}\delta - W_{it}). \tag{3}$$

As regards our scheme, the first step is the estimate of cost and profit efficiency scores using a model which takes into account the risk aversion of banks management and, moreover, allows the derivation of scores which vary

[14] See Coelli et al. (1999) and Kumbhakar and Knox Lovell (2000) for methodology and the concepts of efficiency and measuring techniques.

from unit to unit and from year to year. The time variation of scores in time is a qualifying point of the econometric method chosen as the most common models used do not permit the evaluation of this variation or (Battese and Coelli 1992) permit an estimate of only a trend or convergence parameter of the system, thus hindering any analysis of the time dynamic of the single units observed. Both aspects of the problem (risk and time dynamics) are adapted to our analysis using an *inefficiency effect model* (Battese and Coelli 1995) which considers a series of explanatory variables of inefficiency and inserts a proxy of risk aversion directly in the cost and profit function estimatation.
The cost (and profit[15]) function used is the Translog (Caves and Christeensen 1980) and as well as output vectors (y_1, y_2, y_3, y_4) and the factor prices (w_1, w_2, w_3) there is also a risk aversion variable (E) and a trend variable (T) to include all the structural technological changes which determine *Hicks's* neutral frontier translation[16].

$$\begin{aligned} lnTC = \alpha_0 + \sum_{i=1}^{4} \alpha_i lnY_i + \sum_{i=1}^{3} \beta_i lnW_i + \tau_1 lnE + t_1 T \\ +\frac{1}{2}[\sum_{i=1}^{4}\sum_{j=1}^{4} \delta_{ij} lnY_i lnY_j + \sum_{i=1}^{3}\sum_{j=1}^{3} \gamma_{ij} lnW_i lnW_j \\ +\phi_1 lnE lnE + t_{11}T^2] + \sum_{i=1}^{3}\sum_{j=1}^{4} \rho_{ij} lnW_i lnY_j \\ + \sum_{i=1}^{3} \psi_{i\tau} lnW_i lnE + \sum_{i=1}^{4} \theta_{i\tau} lnY_i lnE + v + u. \end{aligned} \quad (4)$$

Since the duality theorem requires the objective function to be homogenously linear in the input price, the following restrictions were applied to

[15]Only the cost function is reported in the text, the profit one is obtained in the same way, by simply substituting the total costs -on the left of equal in equation 4- with profits. This is the *alternative* profit function firstly suggested by Berger and Mester (1997). The variables are Y_1 = deposits, Y_2 = commercial loans, Y_3 = interbank loans and investment securities, Y_4 = non-traditional activities, W_1 = labour factor price, W_2 = capital factor price, W_3 = price of "raised funds", E = financial capital, T = time.

[16]Some authors (Mitchell and Onvural 1996) maintain the superiority of the *Fourier flexible* form versus *Translog* since the former is more flexible, especially when data show an increased variability around the mean value. Berger and Mester (1997) however, calculate that the difference in the mean efficiency levels estimated with the two functions is rarely more than 1 per cent.

the parameters reported in equation 4:

$$\sum_{i=1}^{3}\beta_i = 1;\ \sum_{i=1}^{3}\gamma_{ij} = 0\ \ \forall\, j;$$
$$\sum_{i=1}^{3}\rho_{ij} = 0;\ \sum_{i=1}^{3}\psi_{ij} = 0\ \ \forall\, j. \qquad (5)$$

Young's theorem on the invariance of cross derivates in regard to derivation order, requires the following symmetry constraints:

$$\delta_{ij} = \delta_{ji}\ \ \forall\, i,j,$$
$$\gamma_{ij} = \gamma_{ji}\ \ \forall\, i,j. \qquad (6)$$

The explanatory model of inefficiency is:

$$E[U_{it}] = \delta_0+\delta_1 D_{1it}+\delta_2 D_{2it}+(\delta_3+\delta_4 D_{1it}+\delta_5 D_{2it})\frac{CL}{EA}+\delta_6 T+\delta_7 lnTA. \quad (7)$$

In the specification of the inefficiency effects model (eq.7) the following variables which are thought to explain the distribution of inefficiency term U_{it} are used: the variables D_1 and D_2 are dummies which have the value of one when the banks are CBB and CB, respectively; CL/EA expresses a proxy of credit intensity equal to the ratio between commercial loans and earning assets; T is the time variable which includes the banks ability to converge towards the efficient frontier due to learning phenomena; TA is total assets, necessary to include the size effect on the different banks performances.

Once scores are obtained in this way we can move on to the second stage. The possible exogenous nature of non-performing loans compared to managerial inefficiency is investigated. The *Granger* test was used and the basic interpretative theories follow those of Williams (2003) and Berger and DeYoung (1997).
The model is as follows:

$$\left(\frac{NPL}{L}\right)_{it} = f\left[\left(\frac{NPL}{L}\right)_{ilag}, EFF_{ilag}, \left(\frac{E}{TA}\right)_{ilag}, \left(\frac{CL}{EA}\right)_{ilag}, Y_t, T_i, (T_i\cdot Y_t)\right] \quad (8)$$

$$EFF_{it} = f\left[\left(\frac{NPL}{L}\right)_{ilag}, EFF_{ilag}, \left(\frac{E}{TA}\right)_{ilag}, \left(\frac{CL}{EA}\right)_{ilag}, Y_t, T_i, (T_i\cdot Y_t)\right] \quad (9)$$

The dependant variables in equations 8 and 9 are derived, respectively, from the ratio between loan loss provisions on the total loans (NPL/L) and cost/profit efficiency scores (EFF) previously calculated (at the stage 1 of our scheme). As well as the lagged dependent variables further control

variables were included as explanatory variables, such as the degree of capitalization as a measure of risk aversion (E/TA) and the propensity of the bank to give loans (CL/EA). The test involves verifying the significance of the parameters in the two equations; that is, if the causality connection is from efficiency to non-performing loans (eq. 8) or if the other theory is true, or rather that is the past history of non-performing loans that explains and causes (in *Granger* meaning) the levels of efficiency (eq. 9). We could, therefore, accept the *bad management* hypothesis if the link, in the first equation, between past efficiency and non-performing loans is significantly different from zero and negative; conversely, the *bad luck* theory is valid in the case of a significant and negative link between past non-performing loans and efficiency in the second equation.
The other variables in the equation were included in an attempt to account for any eventual correlation between the banks in one year (Y_t), between banks of the same type (T_i) and between banks of the same type in the same year ($Y_t \cdot T_i$)[17]. The model was estimated with OLS including up to 5 lags in the explanatory variables; the inclusion of a large number of lags should guarantee the elimination of any eventual correlation between errors (Keane and Runkle 1992).

The last stage is a new and final estimate of efficiency scores (cost and profit): in this estimate assets quality (npl/l) is included in equation 7, if the results of the causality test support the theory of exogenous non-performing loans, it is otherwise directly inserted in the cost/profit function (eq. 4), if non-performing loans are thought to be a product of intrinsic managerial inefficiency (endogeneity hypothesis).

6 Results

In order to be brief, the results of the estimates in point 1 of our plan are reported in the Appendix. They are calculated in order to use the *Granger* test and will only be considered as preliminary results.
Tables 14 and 15 report parameters values of the cost/profit Translog functions specified in equation 4[18]. Tables 16 e 18 -referred to profit function- and tables 17 e 19 -referred to the cost one- contain otherwise the δ values of equation 7, the estimated error variance and the LR correct specification

[17] T represents two dummies which take the value of 1 for the CBB and CB, respectively. Y represents 10 temporal dummies, one for each of the following 10 years.

[18] The number of parameters evaluated for the cost function is less than that for profits as, in the former, the last four cross-products were excluded in order to increase the degree of freedom and improve the result of the maximum likelihood function. This was also done by Bonaccorsi di Patti and Hardy (2005).

model test[19].
As regards profit efficiency, the parameters of the inefficiency explanatory variables are all significant except for δ_2 and δ_5. The composite error variance (σ^2) is mostly attributable to inefficiency since more than 98 per cent of total variability is due to U_{it}; the LR correct specification test allows us to reject the hypothesis that the model is not an *inefficiency effects* one, or rather that are null all the δ and also the γ parameter.
With regard to cost efficiency, the parameters of equation 7 are all significantly different from zero except for δ_7. Also in this case the almost total deviation of the observed values from the frontier can be attributed to inefficiency since the γ parameter is very close to 1. Finally, the hypothesis of incorrect model specification can also be rejected for the cost frontier. (tab. 19).

Causality analysis was performed using the scores of cost and profit efficiency calculated at point 1 of our plan; the estimate equations are numbers 8 and 9. This was done by varying the number of lags of the lagged variables to obtain more robust results compared to those obtainable by the simple F test on the parameters of a single model[20]. Therefore, the following results relate to the causality analysis performed both by constructing a model with different numbers of lags (estimating models at 2, 3 and 4 lags), both by using profit and cost efficiency scores in place of the EFF variable in the model equation (eq. 8 e 9).

Hypothesis	Number of Lags			
	2 lags	3 lags	4 lags	5 lags
Bad Management (profit)	-0.0458***	-0.0339***	-0.0171*	-0.0099*
Bad Luck (profit)	0.0052	0.0009	-0.0023	-0.0052
Bad Management (cost)	0.0128	-0.0195	0.0377	0.0488
Bad Luck (cost)	0.0029	0.0061	0.0041	0.0038

Table 5: Granger Causality Results

Tables 5 sum up the main results referred in tables 20, 21, 22 and 23 in Appendix. In the light of these results only the endogeneity theory of non-performing loans is never refuted and is, at the same time, robust whit respect to the number of temporal lags used. The low efficiency levels - and therefore poor ability of inefficient banks to screen and monitor customers -

[19]The γ parameter is equal to the ratio of inefficiency error variance to total error variance $\left(\frac{\sigma_u^2}{\sigma^2}\right)$. If γ tends to one than it implies that deviation from the efficiency frontier is largely due to inefficiency, whereas a γ value close to zero implies that deviation is mostly due to stochastic error (Coelli et al. 1999).

[20]Williams (2003) compares the results obtained with 2, 3 and 4 lags and then chooses the invariant results regarding the number of lags.

generate high levels of non-performing loans over time. As table 5 show the sum of the parameters relating to efficiency is always negative when using equation 8 (the *bad management* hypothesis) and profit efficiency [21]. In all other the cases the results are not significant and the sum varies according to the number of lags in the model.
The absolute value of the sum of the parameters, showed in the first line of table 5, measures the intensity of the past efficiency effect on the quality of current assets. The results show a decreasing trend, suggesting that the most consistent part of the temporal causal link between efficiency and asset quality runs out over a period of two or three years[22].
In conclusion, the loans quality must be considered like an additional bank output since it is mainly generated by, more or less, efficient managerial choices. Therefore, with reference to the Italian banking system it seems that we can agree that the differentials in the non-performing loans levels between banks with their head office in the North or South of the country are the result of management inefficiency rather than environmental factors[23].
These results are strengthened by what emerges from a recent study of the effects of latest merger and acquisitions process upon profitability and riskiness of Italian banks (Focarelli et al. 2002). In this analysis seems that the loans quality of acquired banks improves strongly after acquisition, perhaps due to the transfer of superior managerial capacity from the acquiring to the acquired[24].

Apart from the exogeneity theory on non-performing loans, another possible interpretation of the nature and quality of assets remains. According to this theory the deterioration in quality of screening and monitoring by banks is not a result of inefficient management - as maintained by the *bad management* theory - but is rather the consequence of a behavioural model to which bank management wants to adhere. More specifically, the deregulation process of the 1980s and early 1990s led banks to assume additional risks on the belief of both explicit and implicit deposit insurance. This would have translated into an aggressive policy on the loans market and ultimately in a deterioration of screening and monitoring activities thus determining increased risk in bank loans. The data in table 6 show clear empirical ev-

[21] A negative link between efficiency and non-performing loans is coherent, in the model theory, with the hypothesis that: at time t bank efficiency decreases, at time $t+n$ a deterioration in assets quality is noted (increased non-performing loans) as a consequence of poor monitoring and investment choices by the inefficient bank.

[22] The significance of the estimates also decreases (from 1 to 10 per cent) as the number of lags increases.

[23] In our study we refer to the managerial inefficiency instead of *scope* or *scale* inefficiency. Berger and Humphrey (1997) find that the bulk of inefficiency is the managerial one, whereas the *scale* or *scope* component turn out to be insignificant.

[24] This result can be interpreted as an indirect evidence in favour of the endogeneity loans quality hypothesis.

idence opposing the hypothesis that an increase in non-performing loans is attributable to a new behavioural model of managers, or lower selection criteria of loans, in order to increase the volume of commercial loans compared to other earning assets. Although the propensity to provide credit increased constantly and quite uniformly in the years studied for the three types of banks considered, the level of non-performing loans remained constant for some years and on the whole decreased significantly[25].

Year	CI	NPL	CI	NPL	CI	NPL
	CBB		*CB*		*LC*	
1993	0.414	0.0071	0.495	0.0099	0.522	0.0121
1994	0.430	0.0067	0.499	0.0081	0.543	0.0098
1995	0.449	0.0063	0.525	0.0096	0.550	0.0125
1996	0.435	0.0058	0.513	0.0086	0.533	0.0102
1997	0.459	0.0054	0.533	0.0068	0.553	0.0096
1998	0.489	0.0053	0.568	0.0076	0.590	0.0091
1999	0.543	0.0046	0.606	0.0057	0.629	0.0081
2000	0.586	0.0049	0.633	0.0058	0.657	0.0057
2001	0.568	0.0043	0.613	0.0059	0.665	0.0056
2002	0.594	0.0038	0.623	0.0058	0.676	0.0048
2003	0.629	0.0042	0.689	0.0058	0.703	0.0063

Elaboration on Bilbank data

Table 6: Credit intensity and loans quality (1993-2003)

Having completed the analysis on the assets quality we now consider the third point in our plan relative to the ultimate estimate of efficiency scores. Concluding in favour of the endogenous nature of non-performing loans we must consequently include the level of these - as an additional output - in equation 4 rather than - as an environmental variable - in equation 7. The model we evaluated is a Translog one where both non-performing loans

[25]The banks propensity to provide credit is measured by credit intensity (CI) approximated by the ratio between commercial loans and earning assets (CL/EA) (Morelli and Pittaluga 1998).

(NPL/L) and risk aversion (E) are included in the output[26].

$$lnCT = \alpha_0 + \sum_{i=1}^{4} \alpha_i lnY_i + \sum_{i=1}^{3} \beta_i lnW_i + \pi_1 lnNPL/L + \tau_1 lnE + t_1 T$$
$$+\frac{1}{2}[\sum_{i=1}^{4}\sum_{j=1}^{4} \delta_{ij} lnY_i lnY_j + \sum_{i=1}^{3}\sum_{j=1}^{3} \gamma_{ij} lnW_i lnW_j$$
$$+\phi_1 lnElnE + t_{11}T^2] + \sum_{i=1}^{3}\sum_{j=1}^{4} \rho_{ij} lnW_i lnY_j$$
$$+\sum_{i=1}^{3} \psi_{i\tau} lnW_i lnE + \sum_{i=1}^{4} \theta_{i\tau} lnY_i lnE + v + u. \quad (10)$$

However, the explanatory efficiency equation remains unchanged (eq. 7) as do the conditions of regularity and symmetry previously reported.
Tables 24 and 25 in Appendix show the parameters values of the translogarithmic function of costs and profits as defined in equation 10[27]. Tables 28 and 29 show the results of the LR test of correct specification; all hypothesis on joint nullity of the parameters of the *inefficiency effect* model are completely rejected, the same can be said for the hypothesis on the absence of inefficiency formulated by imposing $\gamma = 0$[28]. Tables 26 and 27, in Appendix, show the estimates of the explanatory variables of mean distribution of inefficiency (eq. 7); sign and significance of explanatory variables are summarized in table 7.

Parameter	δ_0	δ_1	δ_2	δ_3	δ_4	δ_5	δ_6	δ_7
Cost Inefficiency	-	-	-	+	+	+	+	-
Profit Inefficiency	-	+	(-)	+	-	(+)	(-)	+

()=Parameter not significant

Table 7: Sign of inefficiency effects variables

As regards the parameter for CCB (δ_1), we can see that this is negative for cost inefficiency and positive for profit inefficiency. This means that for one bank, being a CCB has a negative effect on the mean distribution of cost inefficiency and a positive one on that of profit. In other words it reduces

[26]While risk aversion (E) fully interacts with the other output and the prices in the cost/profit function, the assets quality (NPL/L) does not multiply any other variables; this is in order to avoid excessively reducing the degrees of freedom of the estimates given the number of observations available (see also Altunbas et al. (2000)).

[27]The homogeneity linear condition of prices was imposed by dividing both the total costs (or profits) and the price vector for the price of the labour factor w_3.

[28]The LR test is calculated as $LR = -2\{ln[L(H_0)/L(H_1)]\} = -2\{ln[L(H_0)] - ln[L(H1)]\}$, the degrees of freedom are given by the number of restrictions imposed and the critical values are those tabulated by Kodde and Palm (1986).

cost inefficiency (increase efficiency) and increases profit inefficiency (reduce efficiency)[29].
Being a Co-operative Banks (CB) determines a reduction both in cost and profit inefficiency compared to banks with the legal organizational structure of Limited Companies (δ_2 is negative for both efficiency specifications, even if it is not significant in the distribution of profit efficiency). On the whole, from the joint interpretation of the sign of parameters $\delta 1$ and δ_2 we can observe that the institutional set-up of a non LC bank has a positive effect on the reduction of inefficiency (cost and profit) with only one exception of profit inefficiency for CCB Banks.
The consolidating process of the Italian banking system, characterized by the widespread adoption of the LC institutional structure and motivated by the desire to achieve higher levels of efficiency, does not seem to be greatly supported by the empirical evidence which has so far emerged.
The advantage of this approach is that, while previous analysis on the importance (and often the superiority) of institutional structures different to that of LC were restricted to providing efficiency differentials between different types of banks (Altunbas et al. 2001, Bonin et al. 2005, Crespi et al. 2004, Delfino 2003), the *inefficiency effects* model permits to single out the effect of the institutional variable from the mix of variables which influence efficiency.

As to the intensity of credit measured by the (CL/EA) variable, an increase determines a worsening performance by banks on both frontiers (costs and profits) unless such an expansion - of commercial loans compared to earning assets - concerns the Co-operative Credit Banks; in this case the sign of the δ_4 parameter is negative for profit efficiency. These results show reduced profitability in traditional bank activities, especially in commercial loans; the only exception is the CCB banks which still have a margin of expansion, even if restricted to only profit efficiency. The greater ability of the CCB banks to gain a better return on loans may depend on the particular nature of governance in these banks, on the privileged information channels they can create with their customers, or even on the possibility to offer less standardized, and therefore more remunerative, products (even if more expensive)[30].
These results, unlike the previous ones, confirm the current trend in the operative strategies of Italian banks. The widespread and growing importance of "non-traditional" activities as a source of income for bank management is also a choice which can improve both cost and profit efficiency in the banks involved.

[29]The following is a correct interpretation of the signs: the negative sign means that the variable has positive effects on efficiency and the positive sign has negative ones.
[30]Moreover, the CCB banks potentially have more room to expand commercial loans since they register a lower index of credit intensity (see table 6).

The δ_6 parameter of the time variable - which measures the related phenomenon of learning - shows concordant signs with previous analysis (Giordano and Lopes 2005). Time has a negative effect on cost efficiency and a positive one on profit efficiency; therefore, it seems that banks show signs of positive dynamism as regards their ability to converge towards the profit frontier while the same cannot be said for the cost minimization[31]. The persistent problem on the costs side may depend on structural rigidity which impedes the rapid decrease in cost per product unit or the use of more efficient productive processes.

Finally, the bank size has positive effects on cost efficiency and negative ones on profit efficiency. As far as cost efficiency is concerned, there is evidence in favour of the existence of economies of scale in the banks production process. Bank size, however, negatively affect profit efficiency as the increase in the distance between lender and borrower (usually associated with large sized banks), the organization of the large bank network, the products standardization and the deterioration of superior information channels of the small local banks are all factors which can explain the difficulties of the large banks in achieving their full profit potential. These results confirm the ability of local banks to effectively and successfully compete in the markets characterized by global operators. The reason for the continuing vitality of local banks is due to the fact that they offer a different product from large global banks and attract customers which external global banks would find difficult to serve (De Young et al. 2004, Carter et al. 2004, Berger et al. 2004).

The presentation of results is concluded by an analysis of efficiency levels. The mean cost and profit banks efficiency, distributed by legal structure and size is reported in tables 8. Tables 30 and 31 in Appendix show the efficiency scores for each of the classifications used (size and institutional structure) and for the years of the sample (1993-2003). Since this index is the result of an econometric specification expressly created for recording the efficiency time variations of the economic units studied, it is possible to obtain useful information on the dynamics of single banks - not only on the whole system - and make inter-temporal comparisons.
From a first analysis there is an unequivocal ranking, placing the LC banks in last place in terms of both cost and profit efficiency. The same order

[31] It should be made clear that the sign of the parameter (δ_6) indicates only the effect of time on the ability of the economic units to minimize the distance from the efficiency frontier. The real deviation depends on the interaction of the variable in question with all other variables which influence the distribution of mean inefficiency; in the terms of our model, the trend of the efficiency scores depends on the interaction of all variables included in equation 7.

	SML	MED	LAR	CCB	CB	LC
Cost Efficiency	.9676	.9622	.9278	.9680	.9434	.9221
Profit Efficiency	.9306	.9356	.9018	.9347	.9077	.9060

Table 8: Cost and profit mean efficiency

applies to the size of bank, the large ones have the worst mean results[32]. The fact that the large banks have the worst efficiency scores does not contradict the results of the parameter sign analysis obtained from *inefficiency effects* equation (eq. 7). The fact that the δ_7 parameter concerning the bank size is negative for cost efficiency is surely an indication in favour of the existence of scale economies in the bank production function, but the analysis of mean efficiency indicates that these beneficial effects are overwhelmed by relationship-organizational diseconomies as bank size increases. Above the threshold represented by the best minimum size, increasing diseconomies of scale seem to emerge, presumably because of the difficulty in managing complex structures[33].

As regards legal structure, the Co-operative Credit Banks are characterized by the best mean performances both for costs and profits while, for size, the smaller banks have the highest cost efficiency and the middle-sized ones the highest profit efficiency.
An interesting aspect which emerges from the comparison of mean efficiency scores is that, as far as size is concerned, there are substantial differences only between the large banks and the rest. As regards the classification based on institutional characteristics a clear order for cost efficiency, can be observed, with the Co-operative Credit Banks in first place, while for profit efficiency there is a substantial equivalent between the Co-operative Banks and Limited Companies Banks.
In the analysis of the temporal dynamics of scores, apart from the changes in each single year, it is possible to observe the basic tendencies of the Italian banking system. In the overall picture of deterioration in efficiency scores for all banks and on both frontiers, the LC have the worst performance deterioration, especially for profit efficiency which shows a greater than 7.5 per cent reduction compared to a mean reduction in the other banks of 3.6 (CB) and 1.8 (CCB). The results are the same if cost efficiency is used as a reference; the LC banks register a drop in the mean efficiency level of approximately

[32]An overlying effect of the two results is obvious since the LC banks are those which, on average, are at the high tail of the distribution of total assets (see also table 3).

[33]Studies on European banks show that, above a best minimum threshold, the average costs remain substantially unchanged first, then increase as a consequence of scale diseconomies (Amel et al. 2004).

7, the CB 5.5 and the CCB 1.5[34].
With reference to profit efficiency and considering the legal structure of the banks, over the years the Italian banking system has seen a substantial assimilation of performance between the Co-operative Banks and the Limited Companies ones, and consequently a greater split between the Co-operative Credit Banks and the rest of the system. This rose from 0.271 to 0.433 in terms of profit efficiency between Co-operative Credit Banks and Co-operative Banks and fell from 0.152 to 0.137 between the latter and Limited Company ones[35].
As for cost efficiency, the Co-operative Banks, which began at the same position as the Co-operative Credit Banks (0.0004 difference) clearly worsen, accumulating a differential of approximately 0.383 efficiency points. Compared to the Limited Company Banks the difference grew slightly from 0.247 to 0.380, resulting in an equidistant position in 2003 compared to the rest of the system.

These results seem to confirm the impression that, having undergone important consolidation processes in recent years that notably changed its form, the real peculiarity of the Italian banking system is the widespread presence of Co-operative Credit Banks which positively distinguish themselves from the group of Co-operative Banks and Limited Company ones, which instead, are affected by the same basic tendencies and show increasing degrees of homogeneity (at least in performance).

7 Conclusion

As far as the nature of the bank loan quality is concerned, the results offer rather concrete evidence in favour of the endogeneity theory of non-performing loans. According to this theory, the differentials in the levels of non-performing loans are the result of the different abilities of banks in selecting the best investment plans and monitoring their progress and therefore, indirectly, they would be the natural consequence of the differences in terms of efficiency recorded in the credit system. Therefore, the theory in which the main cause of the differentials in loan quality is the economic context in which banks operate, does not seem to hold (exogeneity theory).

[34]The same is true for the large banks which show profit efficiency deterioration of around 6.8 compared to a reduction in the middle-sized banks of 1.6 and in the smaller banks of 2.7. As regards cost efficiency, the decrease is approximately 5.7 for large banks, 1.8 for middle-sized ones and 1.1 for the smaller banks.

[35]It is worth noting that, while the initial divide (0.152) was in favour of LC, the final one was in favour of Co-operative Banks. This means that the absolute variation was wider than that registered between the Co-operative Credit Banks and the Co-operative ones but the relative distance was less. Basically, this result is due to the particularly rapid deterioration in Ltd. Company efficiency.

In the light of these results it seems a positive valuation could be expressed on the phenomena of merger and acquisition which involve efficient banks in the role of active participants in the operation. The transmission of better management ability to the passive bank - usually less efficient - should produce an increase in loan quality with beneficial effects on the stability of the whole system.

However, obvious doubts arise when considering the mean efficiency of the various types of bank and the effect that some explicative variables have on these mean levels. The clearest data to emerge is the net superiority of the Co-operative Credit Banks, in terms of both cost and profit efficiency, compared to the rest of the system. This type of bank follows the general organizational structure and behavioural model of the mutual bank, strongly rooted in the territory and focused on *relationship banking*. Although these banks have a small share in the market, the analysis of the *inefficiency effects* model provides information contrary to the belief that they are destined to be progressively marginalized. In fact, compared to the other legal structures, the Co-operative Credit Banks are the only ones with profitability expansion prospects in loans. This could be a more than plausible sign of an underlying and unsatisfied credit demand which, due to its peculiar nature, is not met by the offer of the bigger banks. The results, in line with much international empirical evidence, signal a deterioration in performances of the large network banks organized as Limited Companies, and also a consistent negative efficiency gap for the large-sized banks (despite their having the advantages of scale economies) and, in the Italian market, a paculiar convergence process of the Co-operative Banks towards the lowest efficiency levels of the Limited Company Banks.

If, on the one hand, the Co-operative Credit Banks have invested more in *soft information*, developed closer relationships with customers and adopted a less vertical organizational structure, on the other, the consolidation process of the Italian credit market has fostered the increase in the average size of banks and the adoption of hierarchical organizational models characterized by excessive rigidity. As a result there is a constant increase in the distance between the decision making headquarter, the loan provider and borrower company, with the consequent implementation of *hard information* treatment processes.

All of this occurs in an economy characterized by widespread small and medium enterprises, which naturally are able to produce a more heterogeneous and intangible information flow compared to the medium-large size customers. More than one perplexity arises as regards the current tendencies of the Italian banking system and it must be asked whether the deep change which is taking place in the organizational structures can effectively provide the improved efficiency which it inspired, or whether in future there will be a problem of credit availability for the Italian productive sector or, in general, the absence of a virtuous bank-industry relationship model able to act as the developing force in the Italian economy.

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APPENDIX

Market share	CCB	CB	LC
Deposits	4.81	13.02	82.16
Loans	5.07	12.92	81.99
Non Traditional Activities	6.31	14.33	79.35
Intermediated Funds	4.94	12.97	82.07

Fonte: Elaboration on Bilbank data

Table 9: Market share of different banks structure

Equity/Total Assets	Mean	Std.Dev.	Min.	Max
Small	0.121	0.040	0	0.578
Medium	0.108	0.036	0	0.493
Large	0.063	0.032	0.002	0.306

Fonte: Elaboration on Bilbank data

Table 10: Equity capital asset ratio

Variable	Obs	Mean	Std.Dev.	Min	Max
y_1	3885	75562.24	48125.78	5026.706	304194.3
y_2	3885	45107.04	34838.88	2120.9	197828.3
y_3	3885	38975.56	24286.53	2868.4	143208.7
y_4	3885	1580.369	2058.612	29.52913	12707
w_1	3885	52.76564	5.853258	24.2897	83.18565
w_2	3885	.018747	.0047747	.0081994	.0416697
w_3	3885	.0446525	.0197252	.0123457	.0923662
e	3885	10078.65	6805.486	584.5852	45519.09
npl/l	3885	.0051271	.003586	3.59e-06	.0277675
ta	3885	91108.83	57351.88	5963.324	355687.8
cl/ea	3885	.5009671	.1330128	.0934997	.9018287
ct	3885	6408.59	4271.647	605.877	26901.72
u	3885	1060.659	847.1413	-1441.063	5298.669
e/ta	3885	.1125711	.0321055	.0346529	.2749573

Thousands of euro

Table 11: CCB Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
y_1	300	1095390	897294.7	31845.22	3867995
y_2	300	650643.1	537846.6	22057.07	2500980
y_3	300	548303.9	474048.2	18638.87	2086288
y_4	300	18574.09	16732.43	357.6285	83805.84
w_1	300	50.85975	5.653691	34.93545	71.80117
w_2	300	.0175519	.0037899	.0099548	.0289026
w_3	300	.0508042	.0197153	.0126567	.1198979
e	300	67497.53	54486.9	3330.352	251080
npl/l	300	.008494	.0051251	.0001848	.0328208
ta	300	1311590	1063075	48972.52	4615104
cl/ea	300	.5397944	.1071355	.3668445	.8987448
ct	300	106664.4	93563.75	3290.691	443910.4
u	300	16498.62	15341.48	-1115.97	79521.18
e/ta	300	.0603732	.033484	.0150535	.254693

Thousands of euro

Table 12: CB Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
y_1	1436	837385.6	533238	18763.56	2576806
y_2	1436	538610.3	362866.3	11832.83	1874759
y_3	1436	384653.2	289095.6	8771.505	1536844
y_4	1436	119737.02	19230.79	267.0293	119292
w_1	1436	50.89162	4.988209	35.42903	65.82163
w_2	1436	.0199888	.0045535	.0068699	.0400999
w_3	1436	.0453225	.0201995	.0103899	.0970499
e	1436	65747.94	47157.32	7101.874	251937.3
npl/l	1436	.0083738	.0060636	.0001127	.0405675
ta	1436	1014152	641338.8	32894.61	3004968
cl/ea	1436	.5724337	.1299084	.1550281	.9716791
ct	1436	79037.55	54449.82	3235.906	278735.4
u	1436	9507.065	9110.668	-16356.03	58782.13
e/ta	1436	.0713586	.0379822	.0083132	.4032875

Thousands of euro

Table 13: LC Descriptive Statistics

	Coefficient	Standard-Error	t-Ratio
α_0	19.87	0.345	57.57
α_1	-1.542	0.261	-5.903
α_2	0.978	0.168	5.800
α_3	0.568	0.116	4.876
α_4	-0.092	0.046	-2.013
β_1	-0.875	0.049	-17.82
β_2	0.371	0.070	5.274
τ_1	-0.144	0.073	-1.977
t_1	-0.004	0.003	-1.136
δ_{11}	-0.103	0.033	-3.094
δ_{12}	0.040	0.035	1.113
δ_{13}	0.100	0.031	3.201
δ_{14}	-0.069	0.013	-5.218
δ_{22}	0.081	0.030	2.649
δ_{23}	-0.082	0.027	-3.024
δ_{24}	-0.0007	0.009	-0.080
δ_{33}	-0.009	0.019	-0.483
δ_{34}	0.017	0.005	2.937
δ_{44}	0.012	0.002	5.398
γ_{11}	0.181	0.003	51.56
γ_{12}	-0.052	0.009	-0.055
γ_{22}	0.125	0.012	10.10
ϕ_1	-0.012	0.002	-4.603
t_{11}	0.006	0.0005	11.72
ρ_{11}	0.164	0.023	6.968
ρ_{12}	-0.133	0.015	-8.547
ρ_{13}	-0.058	0.010	-5.492
ρ_{14}	0.028	0.005	5.038
ρ_{21}	-0.043	0.028	-1.500
ρ_{22}	0.130	0.020	6.278
ρ_{23}	0.031	0.012	2.518
ρ_{24}	-0.074	0.004	-18.05
$\psi_{1\tau}$	0.014	0.007	1.841
$\psi_{2\tau}$	-0.043	0.009	-4.608
$\theta_{1\tau}$	0.035	0.032	1.111
$\theta_{2\tau}$	-0.022	0.018	-1.189
$\theta_{3\tau}$	-0.028	0.015	-1.830
$\theta_{4\tau}$	0.030	0.004	6.259

Translog specification

Table 14: Profit Function Parameters

	Coefficient	Standard-Error	t-Ratio
α_0	3.634	0.244	14.87
α_1	0.339	0.235	1.441
α_2	-0.180	0.132	-1.362
α_3	-0.063	0.140	-0.451
α_4	0.633	-0.026	0.002
β_1	-0.446	0.026	-16.84
β_2	-0.213	0.056	-3.743
τ_1	0.225	0.024	9.118
t_1	-0.003	0.002	-1.357
δ_{11}	0.112	0.0229	4.881
δ_{12}	-0.006	0.023	-0.285
δ_{13}	-0.022	0.016	-1.411
δ_{14}	-0.063	0.010	-5.857
δ_{22}	-0.005	0.022	-0.249
δ_{23}	-0.054	0.013	-4.021
δ_{24}	0.056	0.006	9.322
δ_{33}	0.052	0.012	4.154
δ_{34}	0.016	0.006	2.365
δ_{44}	-0.015	0.001	-10.60
γ_{11}	0.049	0.002	23.69
γ_{12}	0.113	0.007	15.59
γ_{22}	-0.025	0.006	-3.993
ϕ_1	0.004	0.001	4.189
t_{11}	-0.001	0.0004	-2.663
ρ_{11}	-0.043	0.021	-2.017
$\rho 12$	0.100	0.012	8.262
ρ_{13}	0.053	0.013	3.988
ρ_{14}	-0.068	0.003	-2.211
ρ_{21}	-0.142	0.020	-7.132
ρ_{22}	0.041	0.013	3.191
ρ_{23}	0.011	0.009	1.149
ρ_{24}	0.051	0.002	19.16
$\psi_{1\tau}$	-0.035	0.003	-11.49
$\psi_{2\tau}$	0.040	0.005	7.488

Translog specification

Table 15: Cost Function Parameters

	Coefficient	Standard-Error	t-Ratio
δ_0	-6.817	0.248	-27.39**
δ_1	0.483	0.116	4.140***
δ_2	-0.520	0.421	-1.232
δ_3	2.723	0.128	21.22***
δ_4	-2.951	0.146	-20.12***
δ_5	0.330	0.681	0.484
δ_6	-0.010	0.002	-2.356**
δ_7	0.121	0.026	4.533***
σ^2	0.426	0.012	34.92***
γ	0.989	0.0006	1630.5***

$\gamma = \sigma_u^2/\sigma^2$

Table 16: Profit Inefficiency Effects and Error Variance

	Coefficient	Standard-Error	t-Ratio
δ_0	-6.266	0.181	-34.53***
δ_1	0.2781	0.1673	1.661*
δ_2	-0.861	0.484	-1.779*
δ_3	0.355	0.1529	23.25***
δ_4	-3.854	0.2672	-14.42***
δ_5	2.227	0.761	2.925***
δ_6	0.028	0.002	11.71***
δ_7	0.005	0.011	0.510
σ^2	0.534	0.000	1130***
γ	0.996	0.0001	6063***

$\gamma = \sigma_u^2/\sigma^2$

Table 17: Cost Inefficiency Effects and Error Variance

Test performed	Test statistic	Degrees of freedom	Critical value	Decision
$\delta_0 = \delta 1 = \ldots = \delta_7 = \gamma = 0$	8764.69	9	27.133	Rejected

$\alpha = 0.01$

Table 18: LR corrects specification test (profit)

Test performed	Test statistic	Degrees of freedom	Critical value	Decision
$\delta_0 = \delta 1 = \ldots = \delta_7 = \gamma = 0$	2992.74	9	27.133	Rejected

$\alpha = 0.01$

Table 19: LR correct specification test (cost)

Profit	(8)*NPL*	(9)*EFF*	Cost	(8)*NPL*	(9)*EFF*
Intercept	.0703	.3586	Intercept	.0127	.2727
	(1.17)	(22.67)		(.22)	(19.30)
NPL(-1)	.2508	.0015	*NPL(-1)*	.2502	.0033
	(16.62)	(0.40)		(16.53)	(0.90)
NPL(-2)	.1553	.0039	*NPL(-2)*	.1562	-0.0004
	(10.40)	(0.94)		(10.43)	(-0.11)
NPL(total)	.4062	.0052	*NPL(total)*	.4082	.0029
$F\ test_{(2,4402)}$	293.92***	0.76	$F\ test_{(2,4402)}$	291.74***	0.44
EFF(-1)	0.1399	.4484	*EFF(-1)*	-.0324	.4967
	(2.37)	(28.84)		(-0.51)	(31.57)
EFF(-2)	-.1857	.1301	*EFF(-2)*	.0452	.2131
	(-3.18)	(8.47)		(0.69)	(13.16)
EFF(total)	-.0458	.5785	*EFF(total)*	.0128	.7098
$F\ test_{(2,4402)}$	5.55***	721.61***	$F\ test_{(2,4402)}$	0.25	1297.46***

Table 20: Granger Causality Test (2 lags)

Profit	(8)*NPL*	(9)*EFF*	Cost	(8)*NPL*	(9)*EFF*
Intercept	.7021	.3159	Intercept	.0516	0.2370
	(0.97)	(16.84)		(0.79)	(14.42)
NPL(-1)	.2209	.0021	*NPL(-1)*	.2195	.0053
	(13.52)	(0.50)		(13.40)	(1.29)
NPL(-2)	.0992	.0032	*NPL(-2)*	.0993	-.0004
	(5.85)	(0.73)		(5.84)	(-0.11)
NPL(-3)	.0806	-.0044	*NPL(-3)*	.0811	.0012
	(4.81)	(-1.01)		(4.83)	(0.31)
NPL(total)	.4007	.0009	*NPL(total)*	.3999	.0061
$F\ test_{(3,3824)}$	136.74***	0.49	$F\ test_{(3,3824)}$	134.95***	0.72
EFF(-1)	.1441	.3865	*EFF(-1)*	-.0248	.4406
	(2.27)	(23.38)		(-0.36)	(25.44)
EFF(-2)	-.2272	.1444	*EFF(-2)*	.0666	.1498
	(-3.28)	(8.02)		(0.85)	(7.66)
EFF(-3)	.0492	.0928	*EFF(-3)*	-.0613	.1622
	(0.76)	(5.52)		(-0.83)	(8.76)
EFF(total)	-.0339	.6237	*EFF(total)*	-.0195	.7526
$F\ test_{(3,3824)}$	3.94***	413.99***	$F\ test_{(3,3824)}$	0.35	714.70***

Table 21: Granger Causality Test (3 lags)

Profit	(8)*NPL*	(9)*EFF*	Cost	(8)*NPL*	(9)*EFF*
Intercept	.0868	.3492	Intercept	.0388	.1798
	(1.01)	(15.48)		(0.51)	(9.46)
NPL(-1)	.2356	.0029	*NPL(-1)*	.2348	.0062
	(13.02)	(0.62)		(19.97)	(1.38)
NPL(-2)	.0541	.0049	*NPL(-2)*	.0539	-.0019
	(2.89)	(1.00)		(2.87)	(-0.42)
NPL(-3)	.0620	-.0022	*NPL(-3)*	.0635	.0014
	(3.18)	(-0.44)		(3.25)	(0.29)
NPL(-4)	.0702	-.0079	*NPL(-4)*	.0698	-.0016
	(3.65)	(-1.57)		(3.62)	(-0.34)
NPL(total)	.4219	-.0023	*NPL(total)*	.422	.0041
$F\ test_{(4,3261)}$	81,67***	1.01	$F\ test_{(4,3261)}$	80.99***	0.52
EFF(-1)	.1443	.3423	*EFF(-1)*	-.0576	.4144
	(2.02)	(18.29)		(-0.77)	(22.13)
EFF(-2)	-.2048	.1224	*EFF(-2)*	.0435	.1428
	(-2.74)	(6.24)		(0.51)	(6.73)
EFF(-3)	.0366	.0836	*EFF(-3)*	-.0833	.1226
	(0.46)	(4.04)		(-0.94)	(5.52)
EFF(-4)	.0068	.1039	*EFF(-4)*	.1351	.1092
	(0.09)	(5.22)		(1.59)	(5.15)
EFF(total)	-.0171	.6522	*EFF(total)*	.0377	.789
$F\ test_{(4,3261)}$	2.20*	222.93***	$F\ test_{(4,3261)}$	0.80	447.17***

Table 22: Granger Causality Test (4 lags)

Profit	(8)*NPL*	(9)*EFF*	Cost	(8)*NPL*	(9)*EFF*
Intercept	.0855	.2892	Intercept	.0374	.2033
	(0.87)	(11.46)		(0.43)	(9.00)
NPL(-1)	.2527	.0034	*NPL(-1)*	.2520	.0067
	(13.24)	(0.71)		(13.29)	(1.37)
NPL(-2)	.0443	.0060	*NPL(-2)*	.0449	.0008
	(2.20)	(1.17)		(2.22)	(0.17)
NPL(-3)	.0151	-.0019	*NPL(-3)*	.0166	.0003
	(0.72)	(-0.35)		(.79)	(0.07)
NPL(-4)	.0166	-.0066	*NPL(-4)*	.0168	-.0032
	(0.76)	(-1.18)		(0.77)	(-0.58)
NPL(-5)	.0739	-.0061	*NPL(-5)*	.0721	-.0008
	(3.21)	(-1.04)		(3.12)	(-0.14)
NPL(total)	.4026	-.0052	*NPL(total)*	.4024	.0038
$F\ test_{(5,2708)}$	55.48***	1.13	$F\ test_{(5,2708)}$	54.97***	0.47
EFF(-1)	.1515	.3089	*EFF(-1)*	-.1172	.3944
	(2.05)	(16.27)		(-1.49)	(19.16)
EFF(-2)	-.2302	.1494	*EFF(-2)*	.0415	.1454
	(-2.91)	(7.34)		(0.47)	(6.32)
EFF(-3)	.0416	.0691	*EFF(-3)*	-.0532	.1094
	(0.51)	(3.29)		(-0.57)	(4.46)
EFF(-4)	.0323	.09	*EFF(-4)*	.1326	.1009
	(0.35)	(3.82)		(1.30)	(3.79)
EFF(-5)	-.0051	.0826	*EFF(-5)*	.0451	.0184
	(-0.06)	(3.82)		(0.42)	(0.66)
EFF(total)	-.0099	.7	*EFF(total)*	.0488	.7685
$F\ test_{(5,2708)}$	2.02*	162.60***	$F\ test_{(5,2708)}$	0.92	265.5***

Table 23: Granger Causality Test (5 lags)

	Coefficient	Standard-Error	t-Ratio
α_0	19.94	0.354	56.30
α_1	-1.566	0.267	-5.855
α_2	0.995	0.174	5.710
α_3	0.539	0.110	4.895
α_4	-0.090	0.049	-1.817
β_1	-0.881	0.048	-18.14
β_2	0.366	0.071	5.148
π_1	-0.0002	0.001	-0.220
τ_1	-0.112	0.074	-1.518
t_1	-0.005	0.003	-1.593
δ_{11}	-0.114	0.033	-3.419
δ_{12}	0.049	0.036	1.338
δ_{13}	0.110	0.031	3.462
δ_{14}	-0.067	0.013	-5.161
δ_{22}	0.076	0.032	2.362
δ_{23}	-0.090	0.027	-3.291
δ_{24}	-0.002	0.008	-0.302
δ_{33}	-0.012	0.019	-0.664
δ_{34}	0.016	0.005	2.862
δ_{44}	0.012	0.002	5.501
γ_{11}	0.181	0.003	51.10
γ_{12}	-0.052	0.009	-5.617
γ_{22}	0.126	0.012	10.06
ϕ_1	-0.012	0.002	-4.658
t_{11}	0.006	0.0005	12.51
ρ_{11}	0.169	0.023	7.285
ρ_{12}	-0.137	0.016	-8.580
ρ_{13}	-0.056	0.009	-5.729
ρ_{14}	0.027	0.005	4.636
ρ_{21}	-0.053	0.029	-1.806
ρ_{22}	0.136	0.021	6.319
ρ_{23}	0.034	0.012	2.810
ρ_{24}	-0.074	0.004	-17.72
$\psi_{1\tau}$	0.011	0.007	1.473
$\psi_{2\tau}$	-0.040	0.009	-4.315
$\theta_{1\tau}$	0.023	0.032	0.734
$\theta_{2\tau}$	-0.015	0.019	-0.795
$\theta_{3\tau}$	-0.023	0.014	-1.594
$\theta_{4\tau}$	0.030	0.004	6.281

Translog Specification

Table 24: Profit Function Parameters

	Coefficient	Standard-Error	t-Ratio
α_0	3.007	0.165	18.16
α_1	1.367	0.160	8.507
α_2	-0.458	0.097	-4.705
α_3	-0.357	0.070	-5.034
α_4	0.474	0.023	20.57
β_1	-0.395	0.019	-20.650
β_2	0.212	0.041	5.083
π_1	0.005	0.0006	8.004
τ_1	-0.083	0.026	-3.186
t_1	-0.009	0.001	-5.131
δ_{11}	0.214	0.013	16.33
δ_{12}	-0.095	0.013	-6.990
δ_{13}	-0.100	0.012	-7.987
δ_{14}	-0.036	0.008	-4.439
δ_{22}	0.053	0.013	3.838
δ_{23}	0.009	0.009	0.993
δ_{24}	0.043	0.005	8.566
δ_{33}	0.088	0.009	8.881
δ_{34}	0.008	0.003	2.269
δ_{44}	-0.021	0.001	-16.18
γ_{11}	0.047	0.001	29.69
γ_{12}	0.054	0.004	11.34
γ_{22}	0.081	0.007	10.89
ϕ_1	0.002	0.0008	2.676
t_{11}	-0.00002	0.0003	-0.075
ρ_{11}	-0.107	0.012	-8.530
$\rho 12$	0.096	0.008	11.25
ρ_{13}	0.069	0.005	11.91
ρ_{14}	-0.054	0.002	-22.03
ρ_{21}	-0.032	0.016	-2.010
ρ_{22}	-0.007	0.011	-0.689
ρ_{23}	-0.002	0.006	-0.358
ρ_{24}	0.034	0.002	13.12
$\psi_{1\tau}$	0.008	0.003	2.366
$\psi_{2\tau}$	0.003	0.004	0.831

Translog Specification

Table 25: Cost Function Parameters

	Coefficient	Standard-Error	t-Ratio
δ_0	-6.674	0.236	-28.22***
δ_1	0.430	0.133	3.233***
δ_2	-0.287	0.453	-0.634
δ_3	2.727	0.337	8.071***
δ_4	-2.851	0.312	-9.111***
δ_5	0.025	0.756	0.033
δ_6	-0.007	0.005	-1.239
δ_7	0.096	0.042	2.257**
σ^2	0.438	0.020	21.37***
γ	0.988	0.0006	1462.7***

$\gamma = \sigma_u^2/\sigma^2$

Table 26: Profit Inefficiency Effects and Error Variance

	Coefficient	Standard-Error	t-Ratio
δ_0	-0.413	0.132	-3.120***
δ_1	-1.037	0.062	-16.48***
δ_2	-0.654	0.137	-4.750***
δ_3	0.238	0.094	2.527**
δ_4	0.380	0.101	3.754***
δ_5	0.753	0.204	3.678***
δ_6	0.046	0.003	12.42***
δ_7	-0.022	0.007	2.935***
σ^2	0.038	0.00003	1135.80***
γ	0.927	0.001	480.64***

$\gamma = \sigma_u^2/\sigma^2$

Table 27: Cost Inefficiency Effects and Error Variance

Test performed	Test statistic	Degrees of freedom	Critical value	Decision
$\delta_0 = \delta_1 = \ldots = \delta_7 = \gamma = 0$	8765.19	9	27.133	Rejected
$\delta_0 = \delta_1 = \ldots = \delta_7 = 0$	5429.16	8	25.370	Rejected
$\delta_1 = \ldots = \delta_7 = 0$	122.51	7	23.551	Rejected

$\alpha = 0.01$

Table 28: LR correct specification test (profit)

Test performed	Test statistic	Degrees of freedom	Critical value	Decision
$\delta_0 = \delta_1 = \ldots = \delta_7 = \gamma = 0$	3976.66	9	27.133	Rejected
$\delta_0 = \delta_1 = \ldots = \delta_7 = 0$	2776.68	8	25.370	Rejected
$\delta_1 = \ldots = \delta_7 = 0$	611.33	7	23.551	Rejected

$\alpha = 0.01$

Table 29: LR correct specification test (cost)

Cost Efficiency	SML	MED	LAR	Profit Efficiency	SML	MED	LAR
1993	.9718	.9670	.9467	1993	.9440	.9445	.9283
1994	.9746	.9706	.9488	1994	.9459	.9517	.9251
1995	.9743	.9693	.9489	1995	.9221	.9282	.9008
1996	.9708	.9699	.9469	1996	.9137	.9177	.8820
1997	.9702	.9633	.9400	1997	.9249	.9278	.8821
1998	.9635	.9607	.9245	1998	.9443	.9510	.9321
1999	.9608	.9588	.8988	1999	.9556	.9523	.9226
2000	.9654	.9603	.9236	2000	.9301	.9356	.9055
2001	.9568	.9590	.9224	2001	.9100	.9146	.8687
2002	.9675	.9632	.9227	2002	.9289	.9472	.9137
2003	.9610	.9495	.8919	2003	.9184	.9293	.8651

Table 30: Bank Size Efficiency Dynamics

Cost Efficiency	CCB	CB	LC	Profit Efficiency	CCB	CB	LC
1993	.9707	.9711	.9464	1993	.9455	.9184	.9336
1994	.9753	.9650	.9448	1994	.9486	.9300	.9327
1995	.9764	.9630	.9394	1995	.9249	.9239	.9062
1996	.9736	.9640	.9407	1996	.9163	.8859	.8908
1997	.9702	.9631	.9299	1997	.9266	.8993	.8909
1998	.9667	.9405	.9152	1998	.9479	.9486	.9347
1999	.9650	.8814	.8992	1999	.9576	.8612	.9296
2000	.9655	.9402	.9174	2000	.9357	.9198	.9028
2001	.9628	.9371	.9136	2001	.9154	.8860	.8674
2002	.9686	.9332	.9125	2002	.9436	.9275	.9133
2003	.9554	.9171	.8791	2003	.9282	.8849	.8612

Table 31: Bank Structure Efficiency Dynamics