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RELATIONSHIP LENDING, DISTANCE AND EFFICIENCY IN A HETEROGENEOUS BANKING SYSTEM

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Relationship Lending, Distance and Efficiency in a Heterogeneous Banking System¹

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Abstract

During the last decades banks have progressively moved towards centralized and hierarchical organizational structures. Therefore, the investigation of the determinants of bank efficiency and relationships with the functional distance between the bank head-quarter and operational units have become increasingly important. This paper extends the literature on bank efficiency examining the impact of different bank business models on the efficiency of the Italian banks, distinguished by size and type over the period 2006-2009. Using a stochastic frontier approach, the intertemporal relationships between bank efficiency and some key variables, as distance and income diversification (used as proxies of different organizational banking models) are investigated. Results suggest that organizational structure significantly affects cost efficiency, being different between bank groups.

Keywords: relationship lending; bank groups; credit risk; stochastic frontiers; panel data.

JEL classification: G21; L11; L25.

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1. Introduction and motivation

During the last decades, banks have progressively moved towards largest, centralized and hierarchical organizational structures. In the attempt to improve their performance some banks passed from the traditional "originate to hold model" to the "originate to distribute model" where banks do not hold the loans they originate but repackage and securitize them. The prevalence of the "originate to distribute" model over the past twenty years has led to a significant growth of the structured finance market all over the world. Many of these new products have been re-intermediated in banks' balance sheets in the attempt to increase bank performance. The investment in non-interest generating activities have implied bank performance vulnerability, with particularly destabilizing effects during turbulence time. As suggested by recent literature, this effect has been stronger for large banks (cf. De Jonghe, 2010; Demirgüç-Kunt and Huizinga, 2010 and 2011). Taking into account the destabilizing effects produced by the recent financial crisis, many banks have become increasingly concerned about controlling and analyzing their costs and revenues, as well as measuring the risks taken to produce acceptable returns.

In line with these developments, recent literature has evolved examining alternative banking organizational models, risk and efficiency issues (cf. Kano et al., 2011; Berger and Udell, 2011; Demirgüç-Kunt and Huizinga, 2010 and Fiordelisi et al., 2011). With reference to efficiency issues, the level of attention has increased due to the growing complexity and competitiveness of the relevant market situation and different methodological approaches have been employed to investigate financial firm efficiency (for some recent studies see JBF special issue, 34, 2010; Bos et al., 2009 and Fiordelisi et al. 2011).

Among efficiency determinants, size, capital, risk and environmental factors, reveal to be the most investigated, conversely at our knowledge no empirical studies have analyzed whether relationship lending factors influence bank efficiency levels.

According to the Church Tower Principle (CRP), proposed by Carling and Lundberg (2005, p. 40), "the bank is the church tower and from its outlook it can screen and monitor firms in its proximity". Authors refer to this as asymmetric information, which increases in distance. This principle appears to be particularly relevant for the Italian banking system whose lending service is mainly addressed to SMEs being highly opaque. The distance between the bank HQ and its branches could exacerbate the loan evaluating process, negatively affecting the overall bank efficiency. The rationale is that as the distance between the borrowing firm and the bank loan decision unit increases the relationship lending weakens and the firm credit evaluation process becomes problematic (cf. Alessandrini et al., 2009).

The different banking business attitudes can also be analysed by considering the degree of income and asset diversification. Since the early 1990s, in Italy as well as in the US and other European countries, the banking industry has moved from interest towards non-interest income models. Although financial assets diversification policies aim to increase the return they may generate a higher risk and destabilizing effects, affecting the overall bank performance. Whether this strategy positively affects risk-adjusted bank profitability, or, in contrast, the strong increase in non-interest income causes a troublesome growth of profit instability is an empirical question. Some Authors evidence that the higher volatility of net-interest income outweighs diversification benefits (Mercieca et al., 2007 and Lozano-Vivas and Paiouras, 2010). As regards Italy, Chiorazzo et al. (2008) show that the opposite result holds: the shift toward activities generating non-interest income has been proved to be beneficial. Furthermore, it has been shown that diversification gains associated with non-interest income diminish with bank size, *that is* small banks with very little non-interest income share make financial performance gains from increasing non-interest income. This result, however, is not necessarily confirmed during financial turbulence period.

The novelty of the paper relies on the investigation of the relationships between bank lending attitude and efficiency. In particular, the paper extends previous literature by examining whether the impact of the diverse

business models differently impact on efficiency in respect to bank size and type, over the period 2006-2009. Using a stochastic frontier approach, the intertemporal relationships between bank efficiency and some key variables, as distance and income diversification – used as proxies of different organizational banking models – are investigated. In particular, we suggest using the distance – between bank local branches and its head-quarter (HQ) – as a proxy of different banking business models. The effects of the distance on the efficiency are investigated for different bank size and type groups. Quality and riskiness of bank loans are also considered to control for other sources of bank efficiency variability.

The Italian banking market is of particular interest to examine these issues because, although after the 1993 Banking Law the Italian authorities forced a widespread deregulation aimed at improving competition, privatization and greater consolidation of the system, the coexistence of very small and very large banks with a quite different business organizational model are still present. Banks operating under the relationship lending model are able to gather additional (private) information about borrowers which is not readily available to the public, facilitating informal agreements between borrower and lender. As a consequence, borrowers receive an implicit credit insurance through more favorable loan terms when facing economic distress, while lenders are compensated by information rents during normal times (Petersen and Rajan, 1995; Allen and Gale, 1999). Then the recent financial downturn – according to the bank relationship attitude adopted – may imply heterogeneous effects on efficiency between bank groups. The evident credit quality depreciation over the period suggests including asset risk and quality when evaluating efficiency to avoid possible misleading results.

The rest of the paper is organized as follows. Section 2 provides a brief literature review on recent developments in financial firm efficiency placing particular emphasis on various studies comparing groups of banks differing by size and juridical category. Section 3 outlines the methodology and section 4 reports the results. Section 5 is the conclusion.

2. Literature review

2.1 Efficiency and bank groups

Over the last decades, empirical analysis of the relationship between efficiency, ownership and size in the banking sector have regarded country-specific and cross-country studies.

Altunbas et al. (2001) investigate how bank ownership forms – private, public and mutual – affect cost and profit X-inefficiency in the German banking market. Considering that “heterogeneity within the banking industry precludes meaningful comparison because of differences in underlying cost frontier and technologies” (*op. cit.* p. 50), the Authors suggest estimating cost and profit frontiers for the three ownership types, separately. Model estimates evidence that all types of banks benefit from widespread economies of scale, and within each ownership type the larger banks tend to realize greater economies. Moreover, the mutual banks seem to perform better than private ones, having a lower cost of funds than other banks due, for example, to their possible local monopolies.

Assuming that different size groups of banks– small, medium and large - use the same production technology, Akhigbe and McNulty (2003) show that small banks are more profit efficient than large banks. Using a two-step profit efficiency approach the Authors explore whether several factors related to banking structure competition and location, as well as the bank’s financial ratios, affect small bank efficiency scores. Some key results are reached: i) the efficiency increases with bank size. This result is not coherent with the so called information asymmetry hypothesis, that is the smallest are the banks the better are their loan customers screening with positive effects in terms of greater profit efficiency; ii) the efficiency is greater for banks operating in more concentrated markets; iii) small bank profit efficiency is negatively affected by the market non-performing loan ratio but they are not influenced by the bank internal non-performing loan ratio. Such a results are not unequivocally confirmed in the case of other

groups of banks, suggesting some degree of heterogeneity among different size banking groups (cf. Akhigbe and McNulty, 2005).

As regards the Italian banking market, Girardone et al. (2004) propose a comparative X-efficiency and economies of scale analysis for different bank groups classified with respect to size, type and geographical location. The analysis evidences that the highest cost efficiency, either in terms of X-efficiency or economies of scale, is reached by large and medium banks generally located in the northern regions. Among bank categories, the most efficient reveals to be the mutual banks. Economies of scale and local monopoly power could explain this result. A negative relationship between size and inefficiency is found only for very small banks, evidencing the relevant role played by economies of scale within this group. Furthermore, very small banks are characterized by a positive and statistical significant relation between inefficiency and risk (measured by the non-performing loans).

More recently, Girardone et al. (2009) have conducted a comparative study at the European level, investigating efficiency for different ownership bank groups across bank- and market-based countries. The rationale is that the different bank typologies – commercial, mutual and saving – are homogenous from an operational point of view but they are heterogeneous in respect to legal structure. Commercial banks can be either privately owned or joint stock companies, while saving banks can be established both by municipal authorities or by private individuals with any government involvement². Using a stochastic frontier approach, the Authors show that the most efficient Italian group is formed by saving banks, followed by mutual and commercial banks. These results hold in the case of efficiency scores based either on a common European frontier or on two separate frontiers for bank- and market based countries.

Following the same efficiency methodology in the paper we suggest investigating the relationship between banking business model and

² For more details see *op. cit.* p. 231.

efficiency estimating either a full-sample cost frontier or single cost frontiers within different bank type and size groups. In particular, we classify banks in respect to size, distinguishing between large, small and minor banks, and categories, that is mutual, cooperative & saving and other joint stock banks.

2.2 Relationship lending and bank efficiency

2.2.1 What is the role of diversification on efficiency?

Since the early 1990s, in Italy as well as in the US and other European countries the banking industry has moved from interest towards non-interest income models. An asset and income bank diversification strategy may imply positive and negative effects on the overall risk-adjusted bank profitability. Some authors show that the higher volatility of net-interest income outweighs diversification benefits. Several studies have investigated the effects of banks' divergent strategies toward specialization and diversification of banking financial activities on bank performance, bank risk, bank stability etc. for US and European countries³.

Bank income and asset diversification is also a topic of interest in the banking efficiency literature. In this respect, Lozano-Vivas and Paiouras (2010) investigate the relevance of non-traditional activities on efficiency in the case of publicly quoted commercial banks in 87 worldwide countries. The Authors analyze the relevance of non-traditional activities in the cost/profit function. As a proxy of the non-traditional activities, the off-balance sheet activities (OBS) and non-interest income are interchangeably used. The analysis suggests that, on average, cost efficiency increases if the OBS or non-interest income are considered as additional output in the cost function. With respect to profit efficiency, the results are more ambiguous. Considering OBS as additional output does not substantially change profit efficiency. Alternatively, the non-interest income based model determines higher profit efficiency scores. Akhigbe and Stevenson (2010) discuss the

³ See, among others, Stiroh (2004a, 2004b), Stiroh and Rumble (2006), DeYoung and Rice (2004), Acharya et al. (2006), Mercieca et al. (2007), Lepetit et al. (2008), Chiorazzo et al. (2008), Berger et al. (2010).

relevance of the non-traditional activities on profit efficiency for US banking holding companies over the 2003-2006 period. The analysis shows that increases in non-interest income, especially underwriting/brokerage income, negatively affects profit efficiency. The effect is less evident for medium and large banks that can offset the decrease in cost efficiency with an increase in revenue efficiency.

With reference to European small banks over 1997-2003 period, Mercieca et al. (2007) find that that the higher volatility of net-interest income outweighs diversification benefits. As regards Italy, Chiorazzo et al. (2008) show that the shift toward activities that generate non-interest income had proved to be beneficial. Diversification gains associated with non-interest income also diminish with bank size, that is small banks with low non-interest income share make financial performance gains from increasing non-interest income.

Following the above literature in the paper we consider the effects of asset diversification either in the cost function or in the inefficiency models. The aim is to investigate whether bank propensity toward non-interest income affects, and to what extent cost efficiency and whether the impact differs among different bank groups.

2.2.2 ... and what about the distance?

A large stream of the literature has investigated the relation between organizational structure, distance and lending conditions (for a survey see Cerquero et al., 2009).

If a borrower is not located close to a bank, the distance between them can act as a "physical gap" affecting both credit price and quantity conditions. From a theoretical point of view the distance influences lending conditions because of transportation costs and asymmetry of information (Degryse and Ongena, 2005). Since greater distance implies larger transportation costs, the bank can exploit at the local level a stronger monopoly power charging higher loan rates to borrowers located closest to its bank branch. Then, a

negative relation between the loan rate and the borrower-lender distance holds.

A similar result holds under the asymmetric information hypothesis. The bank borrower's evaluating process becomes more imprecise as the distance between the lender and the borrower increases. In this respect the bank operating at the local level can have an informational advantage charging higher loan rates to closer firms (hold-up). Further investigations suggest that the distance can also imply spatial credit rationing problems. As Hauswald and Marquez (2006) suggest, the distance aggravates the information asymmetry problem implying credit rationing problems for distant firms.

Another stream of research have investigated the relationships between distance, bank internal organization and lending policies. Berger et al. (2005) show that large banks lend at greater distances than small banks, being better equipped to collect and act on hard information. Mian (2006) finds that local banks are much more concentrated on borrowers displaying soft information. As for Italy, Felici and Pagnini (2008) evidence that large banks are more able to cope with distance-related entry costs than small banks, by using hard information. Moreover, the analysis suggests that banks have become increasingly able to open branches in distant markets, due to the advent of information and communication technologies. Nevertheless as suggested by the Authors distance continues to play a role: "Yet the fall in trade costs due to distance brought about by the new technologies does not imply that they are about to disappear. In other words, we do agree with a recent remark by Degryse and Ongena (2004) that 'distance dies another day'" (p. 527).

The complexity of the above mentioned relations implies that the empirical evidence may produce results that are not uniformly shared over time and across space. Petersen and Rajan (2002) show that the technological changes improve the monitoring process and thus the distance becomes less important in explaining spatial rationing. Other evidences suggest that credit scoring models could improve SMEs evaluation for large and distant

banks relaxing the necessity of relationship based models⁴ (Berger and Frame, 2007; De Young et al., 2008). More recently, Berger et al. (2010) confirm that community banks make large use of credit scores but not simply “for automatic approval/rejection of loan applicants, suggesting that these institutions continue to stress relationship lending or other lending technologies”. Because relationship lending largely relies on “soft information” that are typically collected and processed at the local level and not easily transferable (Petersen, 2004 and Stein, 2002), relationship lending becomes less feasible across large distances. Berger and Udell (2002) evidence that this type of banking attitude is associated to small and decentralized banks. Stein (2002) suggests that the bank based on its own organizational structure use different types of information. For a large hierarchically complex organization could be too costly to collect “soft information” at the local level because of high delegation costs. According to the principal-agent theory, delegation may aggravate agency problems. In other terms a large and distant bank that specializes in relationship loans should invest more in monitoring their loan officers than in the performance of their loans. Conversely, small decentralized banks characterized by a short distance between the HQ and the branch could have a comparative advantage in small business lending.

To better investigate the effects of the distance on the bank-borrower relationship a more accurate definition of distance is suggested by Alessandrini et al. (2009). According to the Authors, functional distance is “a character shared by all banks that, given the localism of their decisional centres and strategic function are necessarily close to some area and far from others”. To this respect, a department with a banking system formed by only local credit banks has the lowest value of the functional distance indicator; otherwise two departments with equally functionally distance may be characterized by different banking systems and concentration/diffusion of local banks across the territory.

⁴ On this point see also Berger and Frame (2007).

3. The study method

3.1 The model

Evaluating the efficiency of a bank involves a comparison between actual and optimal values. In particular, it is concerned with the comparison between observed outputs and maximum potential outputs obtained from given inputs; or observed inputs and minimum potential inputs to produce a given amount of outputs. It is also possible to define efficiency in terms of behavioural goals, where efficiency is measured by comparing observed and optimal costs and profits, leading to cost and profit efficiencies respectively.

In this paper, for measuring the cost efficiency of Italian banks, we use the SFA approach (Battese and Coelli, 1995). This model incorporates the estimation of cost function and the determinants of efficiency at the same time, by parameterizing the mean of the efficiency term as a function of exogenous variables.

As for the cost function we consider:

$$(1) \quad \ln(TC_{it}) = X_{it}\beta + (V_{it} + U_{it}),$$

where $\ln(TC_{it})$ is the logarithm of total production cost for bank i at time t , X indicates the natural logarithm of input prices and output quantities, β is a vector of unknown parameters to be estimated; the V_{it} s are random variables that are assumed to be independent and identically distributed, $N(0; \sigma_v^2)$. The non-negative random variables, (U_{it}) , which account for cost inefficiency, are assumed to be independently distributed, such that U_{it} is the truncation (at zero) of the $N(\mu_{it}; \sigma^2)$ -distribution, where μ_{it} is a function of observable explanatory variables and unknown parameters, as defined below. We choose the truncated normal form because of the hypothesis that the market is competitive, that is, the greater proportion of the enterprises

operate 'close' to efficiency. It is assumed that the V_{it} s and U_{it} s are independent random variables.

The parameters of the frontier production function are simultaneously estimated with those of the inefficiency model ($\beta, \delta, \sigma^2, \sigma^2_v$), in which the cost inefficiency effects are specified as a function of other variables:

$$(2) \quad \mu_{it} = \delta_0 + \sum_{m=1}^M \delta_m \ln z_{mit}.$$

In the eq. 2 the δ s are parameters to be estimated. A positive parameter value of δ_m implies that the mean inefficiency increases as the value of the m-input variable increases.

Maximum-likelihood estimates of the model parameters are obtained using the program, FRONTIER 4.1, written by Coelli (1996). The variance parameters are defined by $\sigma_s^2 = \sigma_v^2 + \sigma^2$ and $\gamma = \sigma^2 / \sigma_s^2$ originally recommended by Battese and Corra (1977). The log-likelihood function of this model is presented in the appendix of Battese and Coelli (1993). When the variance associated with the technical inefficiency effects converges toward zero (i.e. $\sigma^2 \rightarrow 0$) then the ratio parameter, γ , approaches zero. When the variance of the random error (σ_v^2) decreases in size, relative to the variance associated with the technical inefficiency effects, the value of γ approaches one.

The cost efficiency of a unit at a given period of time is defined as the ratio of the minimum cost to the observed cost needed to produce a given set of outputs. The technical efficiency of the i-th unit in the year t-th is given by:

$$(3) \quad CE_{it} = \exp(-U_{it}).$$

The cost efficiency of one unit lies between zero and one and is inversely related to the inefficiency effect.

With regard to the nature of the cost efficiency, the general stochastic frontier model encompasses the following three sub cases: 1) when $\gamma = \delta_0 = \delta_1 = \dots = \delta_m = 0$, there is no technical inefficiency (deterministic or stochastic) and the model collapses to the traditional average production function; 2) when $\gamma = 0$, technical inefficiency is not stochastic and the explanatory variables in eq. (2) must be included in eq. (1) along with inputs; 3) when all δ s (except the intercept term) are zero, the z s do not affect the efficiency levels. Hypotheses about the nature of the inefficiency can be tested using the generalised likelihood ratio statistic (LR test), λ , given by:

$$(4) \quad \lambda = -2[\ln(L(H_0)) - \ln(L(H_1))],$$

where $L(H_0)$ and $L(H_1)$ denote the value of the likelihood function under the null and alternative hypotheses, respectively. If the given null hypothesis is true, then λ has approximately a Chi-square (or a mixed Chi-square) distribution. If the null hypothesis involves $\gamma = 0$, then the asymptotic distribution involves a mixed Chi-square distribution (Coelli, 1995).

3.2 The data

We analyse an unbalanced panel data of 2,597 banks over the period 2006-2009. Data have been provided by the Italian Banking Association. The coverage of our sample relative to the population of the whole Italian banking system is nearly 90%, and it is quite stable over the analysed period.

In order to control for heterogeneity, we suggest considering different bank groups classified with respect to size and juridical category. The sample excludes: i) foreign banks; ii) the central institutions for each category of banks; iii) special credit institutions for special purposes. Table 1 reports sample data coverage by size and category over time.

Banks are grouped with respect to size, distinguishing between minor, small and large banks. Thresholds are given by Bank of Italy and are based on the average amount of total intermediation assets⁵. Then, minor banks are defined as those with average total intermediation assets lower than 1,3 billions euro; small banks are defined as those with average total intermediation assets included between 1,3 and 9 billions euro; large banks comprise all banks with average total intermediation assets higher than 9 billions euro⁶.

Minor banks represent 75% of the total number of banks in our sample, small banks correspond to 18% and large banks is only 7% of the total. In respect to bank total asset, the composition of the sample is simply reversed: the minor group represents only 6% of the entire Italian banking system, small and large bank groups are 14% and 80%, respectively.

Banks are also grouped by juridical category, distinguishing between mutual, cooperative & saving and other joint stock banks. The mutual banks are considered separately because of their characteristics: i) they are strictly linked to the local market, being present only at the HQ municipality and in the neighborhoods; ii) their mutuality characteristic along with fiscal benefits imply a greater degree of capitalization. A second group comprises cooperative & saving banks. The cooperative group is based on the Italian Banking Association classification. The saving group is identified by using the ACRI (Italian Association of Saving Banks) classification. The business model of the last two bank groups is similar, thus they are jointly considered. The third group of the other joint stock banks is obtained as a residual.

The mutual banks represent 64% of the total banking system, the cooperative & saving banks correspond to 13%, the other joint stock banks

⁵ See Bank of Italy Annual Report, 2009 – Methodological notes: tables a17.6 and a17.7.

⁶ The Bank of Italy classifies banks according to five groups: very big (with total average financial intermediation assets higher than 60 billions Euros); big (between 26 and 60 billions Euros); medium (between 9 and 26 billions Euros); small (between 1,3 and 9 billions Euros) and very small (lower than 1,3 billions Euros). Because of the small number of observations in the medium, big and very big samples separately considered, we have grouped them in one group denominated "large banks".

to 23%. With respect to the total asset, mutual banks represent 7% of the entire banking system while cooperative & saving group and the other joint stock banks are, respectively, 19% and 74%.

(insert Tab. 1 here)

3.3 The cost function specification

In the literature, the definition of bank inputs and outputs varies across studies. This study follows the so called value-added approach, originally proposed by Berger and Humphrey (1992). This approach asserts that all liabilities and assets of banks have some output characteristics, rather than categorizing them as either inputs or outputs only⁷. The econometric models are specified for panel data, with both stochastic frontier cost function and inefficiency model. A flexible functional form as the translog production function is used:

$$(5) \quad \ln(c_{it}) = \alpha + \sum_{k=1}^3 \beta_k \ln q_{kit} + \sum_{p=1}^3 \beta_p \ln(p_{pit}) + \frac{1}{2} \sum_{j=1}^3 \sum_{k=1}^3 \beta_{jk} \ln q_{jit} \ln q_{kit} + \\ \frac{1}{2} \sum_{m=1}^3 \sum_{p=1}^3 \beta_{mp} \ln(p_{mit}) \ln(p_{pit}) + \sum_{k=1}^3 \sum_p \beta_{kp} \ln q_{kit} \ln p_{pit} + \beta_E \ln E_{it} + \\ \beta_t t + \beta_{t^2} t^2 + (V_{it} + U_{it}).$$

where $\ln c_{it}$ is the natural logarithm of the operative cost of bank i in year t . Accordingly to the value-added approach and following (see among others Akhigbe and McNulty (2003), we consider three outputs, $\ln q_{kit}$ ($k=1, 2, 3$), that are: total net loans, retail deposits and fee-based financial services

⁷ The other two approaches used to define inputs and outputs in banking are: i) the intermediation approach that assumes that banks collect deposits to transform them, using labour and capital, into loans and other assets; ii) the production approach that consider banks as producers of deposit and loans in terms of the number accounts, using labour and capital.

(i.e. non-interest income assets), respectively. $\ln p_{pit}$ ($p=1,2,3$) is the logarithm of three price, that are the price for wage rate for labour, the price of borrowed price of funds and the price of physical capital, respectively. We also consider a fixed input E , that is the equity capital defined at the bank level, controlling for differences in equity capital risk across banks. Banks with lower equity ratios are assumed to be more risky, in line with Mester (1996). The cost frontier may also shift over time according to the values of the parameters β_t and β_{t2} . The conditions for ensuring that the cost function is linearly homogeneous in input price are:

$$(6) \quad \sum_{p=1}^3 \beta_p = 1; \quad \sum_{m=1}^3 \beta_{mp} = 0; \quad \sum_{k=1}^3 \beta_{kp} = 0;$$

To meet these homogeneity conditions, eq. (5) is transformed into a normalized function. Specifically, costs and input prices are normalized by the price of wage rate for labour (p_1). Then, the normalized cost function to be estimated is:

$$(7) \quad \ln(c_{it} / p_{1it}) = \alpha + \sum_{k=1}^3 \beta_k \ln q_{kit} + \sum_{p=1}^2 \beta_p \ln(p_{pit} / p_{1it}) + \frac{1}{2} \sum_{j=1}^3 \sum_{k=1}^3 \beta_{jk} \ln q_{jit} \ln q_{kit} +$$

$$\frac{1}{2} \sum_{m=1}^2 \sum_{p=1}^2 \beta_{mp} \ln(p_{mit} / p_{1it}) \ln(p_{pit} / p_{1it}) + \sum_{k=1}^3 \sum_p \beta_{kp} \ln q_{kit} \ln(p_{pit} / p_{1it}) +$$

$$\beta_E \ln E_{it} + \beta_t t + \beta_{t2} t^2 + (V_{it} + U_{it}).$$

Table A1 in the Appendix presents a detailed description of the input and output variables used in estimating the cost functions; Table 2 reports some statistics for the whole banks sample and the bank groups.

(insert Table 2 here)

3.4 What causes cost inefficiency?

We further investigate factors affecting bank efficiency in order to assess the importance of any (in)efficiency determinants. In particular, the main aim of the analysis is to examine whether bank organizational structure – proxied by functional distance, income diversification and size – differently affect bank groups efficiency. In the inefficiency model we also consider risk variables and macro environmental factors, in order to control for bank heterogeneity.

Supposing that internal and environmental economies factors impact on bank efficiency, we propose a novel specification of the inefficiency model in which the means μ_{it} , associated with the cost inefficiency of bank i at time t , are assumed to be specified as a function of three different sets of variables. The variables of interest are obviously related to business model strategy, depending on the bank branching diffusion degree (HQ-DISTANCE), its income diversification policy (DIV_{REV}) and its size (SIZE). Furthermore, to account for asset quality and the bank micro credit risk conditions, a second group of variables has been included: i) the loan-loss provisions over total net loans (LLP); ii) the traditional non-performing loans over total net loans ratio (NPL). Macro environmental effects are finally controlled by: i) the standard provincial GDP annual growth rate; ii) the provincial firm default rate; and iii) a macro non-performing loans rate.

Then the inefficiency model is specified as follows:

(8)

$$\mu_{it} = \delta_0 + \delta_{div} \ln DIV_{REV} + \delta_{fd} \ln HQ - DISTANCE + \delta_{size} \ln SIZE + \delta_{llp} \ln LLP + \delta_{npl} \ln NPL + \delta_{gdp} \ln GDP_RT + \delta_{dr} \ln DEF_RT + \delta_{npli} \ln NPL_INDEX.$$

The income diversification index (DIV_{REV}) measures for each bank the degree of diversification policy between traditional and non-interest income

activities. Using the standard definition of NET (net interest income) and NII (net non-interest income) and according to Mercieca et al. (2007), we compute the Herfindahl Hirschmann Index (HHI) revenue as follows:

$$HHI_{REV} = \left(\frac{NET}{NET + NII} \right)^2 + \left(\frac{NII}{NET + NII} \right)^2$$

and then, following Stiroh and Rumble (2006), we define the income diversification measure as:

$$(9) \quad DIV_{REV} = 1 - HHI_{REV} .$$

As suggested by Chiorazzo et al. (2008), under the constraint that NET and NII have to assume positive values, this index varies from 0.0 to 0.5. It will be zero when the bank does not diversify its activity - because either it is strongly concentrated on traditional net interest income or highly non-interest income - and equals 0.5 when it is completely diversified.

A novel measure of the functional distance (HQ-DISTANCE) between bank branches and its headquarter (HQ) is proposed. Our indicator is similar to the F-DISTANCE measure suggested by Alessandrini et al. (2009). Differently from the Authors, we construct the indicator for the i-bank at the municipal level, as follows:

$$(10) \quad HQ - DISTANCE_i = \frac{\sum_{z_b=1}^{B_i} [Branches_{i z_b} \times \ln(1 + D_{i z_b})]}{\sum_{z_b=1}^{B_i} Branches_{z_b}} ,$$

where $z_b = 1, \dots, B_i$ are the municipalities where the i -bank has branches, with $i: 1, \dots, I$. $D_{i z_b} = \sqrt{(X_{z_b} - X_{HQ_i})^2 + (Y_{z_b} - Y_{HQ_i})^2}$ is the Euclidean distance between the municipality z_b where the branch is located and the municipality where the HQ of the i -bank is located (HQ_i). The HQ-DISTANCE is calculated in respect to municipalities where at least one branch is present, that is for almost 5,900 Italian municipalities^{8, 9}.

Statistics reported in Table 3 show that the average functional distance of the Italian banking system is 40 kilometers, being strongly different between the bank groups. Large banks and joint stock banks have the highest value, respectively 166 and 116 kilometers; conversely, mutual and minor banks appear to be the most concentrated in the territory: the mean distance between the HQ and branches is respectively 10 and 17. The results suggest that the distance is correlated with the size of the bank. The scatter plots of the size and distance for the different bank groups (Fig. 1) confirm this relationship, being positive for large and joint stock banks and null for mutual and minor banks.

(insert Fig. 1 here)

In Figs. 2 the map of the HQ-DISTANCE over time are reported. The figures suggest that the operational units located in the South are the farthest from the HQs, mainly located in the Centre and in the North of Italy. This is coherent with the strong acquisition process of the south banking system carried out by the northern banks during the nineties (see among others Panetta, 2003). As expected mutual and minor banks are characterized by a

⁸ The total number of municipalities in Italy is 8,094, but in 2009 only 5,929 municipalities host at least one branch (5,926 in 2008, 5924 in 2007 and 5,926 in 2006).

⁹ Another measure of distance has been recently proposed by Cotugno et al. 2011. They compute the distance as the difference between the kilometres between the zip code (ZIP) of the bank headquarters and the zip code (ZIP) of the municipalities in which the different branches are located (excluding the bank's liaison offices) weighted by the branch's months opening time.

high proximity between the HQ and local branches, and this is particularly true for the regions where the mutual banking system is more developed (i.e. Trentino-Alto Adige, Emilia-Romagna, Marche, Veneto and Toscana). The distance increases over the investigated period by 4%.

(insert Fig. 2 here)

The bank organizational structure is also controlled considered by using a measure of bank size (SIZE) - that is the natural logarithm of total asset.

According to the literature a different bank organizational model implies a different credit risk policy. Because of the relationship lending, banks could be suffer of the so called soft-budget constraint for which when firms face an economic downturn the borrower is forced to renew the relative credit line. During a recession period, firm can be nearly certain that it will receive an additional loan from the bank. This intertemporal risk smoothing provides a sort of liquidity insurance that is especially valuable for opaque firms (small, young and innovative firms), having difficulties to signal their own creditworthiness and a higher probability of survive to an economic crisis only if close ties with a bank is achieved (Boot and Thakor, 2000).

The above considerations and the evident economic distress that caused credit quality depreciation over the period suggest including asset risk and quality in the inefficiency models to control for the effect of risk on bank cost efficiency. The standard financial ratios used in the literature on bank efficiency to estimate credit risk are the loan loss provision over total net loans (LLP) and the non-performing loans over total net loans (NPL).

The LLP index is computed for each bank as the ratio between the flow of loan-loss provisions over the stock of net loans. The loan loss provisions are determined according to IAS 39 (pp. 17) incurred loss approach. When there is evidence of impairment "the amount of the loss measured as the

difference between the asset's carrying amount and the present value of estimated future cash flows (excluding future credit losses that have not been incurred) discounted at the financial asset's original effective interest rate (i.e. the effective interest rate computed at initial recognition)" should be charged to profit or loss directly or through the use of an allowance account. A bank has to assess whether impairment exists for loans that are individually significant. Loans that are not individually impaired have to be included in a group of loans with similar credit risk characteristics and collectively assessed for impairment. Impairment of such groups of loans is estimated on the basis of historical loss experience, adjusted for changes in current conditions. However, it is forbidden to recognize expected losses as a result of future events. Recently many critics have been moved to this approach arguing that it does not reflect the true credit risk in loan portfolios and that a more accurate expected loss approach is advisable. Nevertheless some authors suggest that some degree of income smoothing persist even after IFRS adoption implying that LLP can be used as a proxy for ex-ante credit risk¹⁰. Alternatively, the NPL variable measured as the ratio between the stock of the non-performing loans over total net loans ratio is backward-looking and may be used as a proxy for ex-post credit risk¹¹ (cf. Fiordelisi et al., 2011). In the paper we use the last approach.

In the previous literature on bank efficiency the credit risk has been studied by simply considering its effect on the inefficiency equation (cf. among others Akhigbe A., McNulty J.E., 2003 and 2005; Girardone et al., 2004). However recent studies focusing on credit risk and its effects over the efficiency examine the causality of the relationship between efficiency and credit risk via capital, by using simultaneous equation models (Altunbas et

¹⁰ For an institutional comparison between the incurred and expected loss approach see IASB (2009a), IASB (2009b), IASB (2009c). For an economic perspective see among others Burrone et al., 2009 and Gebhardt and Novotny-Farkas, 2010.

¹¹ According to the Bank of Italy (see Methodological Notes to the Provincial Credit Statistics) an alternative measure of credit risk could be defined as the ratio between the flow of new non-performing loans to the stock of performing loans at the end of the previous period. Such a ratio has been used as a control variable without any substantial change in our results. Computations are available upon request to the authors.

al., 2007) and the Granger causality approach (Fiordelisi et al., 2010). In our study we deviate from these approaches because our aim is simply to evaluate the direct effect of credit risk over bank inefficiency without considering possible causality with capital. For this reason we omit from our models the capital and the loan growth rate being highly intercorrelated with the risk.

Finally, as macro indicators, we suggest using the annual growth rate of GDP (GDP_RT) and the ratio between default firms and registered firms (DEF_RT). The two macro indicators are calculated in respect to i-bank, weighting the indicator at the province level with the ratio of branches in the province in respect to the total amount of branches of the i-bank. The procedure allows to take into account of the different impact that each macro-indicator has on the bank, in respect to the presence of that bank in that province.

Among the group of environmental variable, we also include the ratio between non-performing loans and total net loans (NPL) that, using a threshold value of macro risk of the 6%, is defined as follows¹²:

$$(11) \quad \text{NPL_INDEX}_i = \frac{\sum_j \frac{\text{branches}_{ij}}{\text{branches}_i} * \left(\frac{\text{npl}}{\text{loans}} \right)_j}{\sum_j p_{ij}}$$

where $p_{ij} = \begin{cases} 1 & \text{if bank}_i \text{ is present in province } j \\ 0 & \text{otherwise} \end{cases}$ and

$$\left(\frac{\text{npl}}{\text{loans}} \right)_j = \begin{cases} \left(\frac{\text{npl}}{\text{loans}} \right)_j & \text{if } \left(\frac{\text{npl}}{\text{loans}} \right)_j > 6\% \\ 0 & \text{otherwise} \end{cases} .$$

¹² We use a threshold value of 6%, following the definition proposed by the Interbank Deposit Protection Fund. The choice is also supported by some empirical evidences. Over the period 2006-2009, the median value of NPL over total net loans has been of 4.91%, evidencing a substantial stability over time.

Data for the macro environmental variables are mainly based on ISTAT, Istituto Tagliacarne and Bank of Italy sources. Table A2 in the Appendix presents a detailed description of these variables; Table 3 reports the main statistics of the variables used in the inefficiency model.

(insert Table 3 here)

4. Results

4.1 Dynamics and spatial distribution of cost efficiency scores

Model estimates are used to investigate: i) the CE level of the Italian banking system and whether exists some degree of difference among bank groups; ii) cost efficiency dynamics ; iii) the geographical distribution of CE across the national territory; iv) whether the HQ-branch distance and income diversification affect cost efficiency, being different between bank groups.

To answer to the first three issues, we suggest using the CE values obtained by the model estimated on the full sample. To perform more straightforward comparisons, we compute the efficiency scores from a translog stochastic frontier model without the (in)efficiency model, enabling the comparison of cost efficiency over time, among groups and in the territory. Therefore, cost efficiency scores, representing the relative distance from the frontier cost realized by the best practice bank, are computed by equation (7).

The average CE value over the sample period and across the bank sample is 0.72, indicating that if banks are able to eliminate these inefficiencies, total

costs could be reduced by 28%. The most efficient banks all over the period appear to be the minor and the mutual ones. Conversely, large and the other joint stock banks show the lowest CE values. Small and saving & cooperative banks fall within the range. On average the cost efficiency differences between the most and the least efficient groups are 0.13 and 0.16 for the size and type groups, respectively.

The average efficiency per year, calculated for the full sample of bank, increases until 2008, passing from 0.76 in 2006 to 0.80 in 2008, and then it decreases in 2009 to 0.79 (Fig. 3). As expected, the recent financial crisis determines a generalized cost efficiency reduction for all the Italian bank groups in 2008 and 2009. However some differences emerge in respect to the different groups considered. The large and other joint stock banks decrease their cost efficiency of 3.16% and 3.06%, respectively. The small and saving & cooperative groups lose on average 3.11% and 2.9% respectively. Finally minor and mutual banks lose only 1.20% and 0.83% respectively.

(insert Figure 3 here)

Cost Efficiency values are also used to evaluate the geographical distribution of the banking system efficiency. In particular, cost efficiency at the municipality level is calculated as the average efficiency of banks located in the municipality, weighted by the number of their branches. The analysis allows to investigate the geographical concentration of bank efficiency across the Italian municipalities and the dynamics of the territorial efficiency distribution over the observed period of time. The maps, reported in Figures 4, suggest at least three interesting considerations: i) as expected the most efficient municipalities are those located in the centre and in the north of the country; ii) a correspondence between distance and cost efficiency is observed: banks located in the south and farthest to the HQ appear to be less efficient than banks located to the north and close to the operational units. Among banks located in the North the most efficient

are minor banks located in Trentino Alto Adige, Veneto, Emilia Romagna, Marche and Toscana; iii) the efficiency changes over time. The analysis shows some large banks located in the North – see for example the Milan neighbourhood area – have strongly lost efficiency in 2008 and 2009 compared to 2006 and 2007. This is not the case for banks located in peripheral regions, as for example Trentino Alto Adige, that – because of a different business model – maintain a quite stable value of efficiency over time.

This suggests that, besides distance, other features as size and income diversification strategies could have played a role in defining a different banking structure organization and thus the different territorial cost efficiency distribution. As we see before, these differences may vary with respect to the bank size and category, reflecting the strong heterogeneity of the Italian banking system.

(insert Figure 4 here)

4.2 Inefficiency cost model estimates

In order to control for heterogeneity of the banking system, stochastic frontier functions and inefficiency models are estimated for different groups of banks, allowing to verify the hypothesis of a single frontier for the Italian banking system. As main drivers of inefficiency, we consider the impact of business structure variables, using micro financials ratio and macro environmental factors as controlling variables in the inefficiency models.

Model estimates confirm a relevant heterogeneity between bank groups with respect to either cost frontier or inefficiency determinants (Tables 4 and 5). The null hypothesis that the cost inefficiency effects are not present in a group, given the specifications of the stochastic frontier model, is

rejected for all groups. Then we examine if all the groups share the same technology. A likelihood-ratio (LR) test of the null hypothesis, that the group stochastic frontier models are the same for all banks, is calculated after estimating the stochastic frontier by pooling the data from all groups. The values of the LR statistic are 1,138 and 1,768, respectively for groups size or type, which are highly significant. This result strongly suggests that the groups' stochastic frontiers for banks are not the same.

(insert Tables 3&4 here)

With respect to the banking business model, we first find a negative and significant relationship between HQ-DISTANCE and efficiency. Diverse results emerge in respect to the different groups. Distance appears to be an important determinant of inefficiency, in particular in minor and mutual banks. Because of their organizational structure model minor and mutual banks would be characterized by strict relationship with the territorial operational units and with the customers. Given this characteristic as the distance between bank branches and its HQ increases the cost efficiency decreases more than in the case of larger banks; *i.e.* the effect of distance on efficiency is less important in the case of other banks being minimum for large banks.

In literature the effect of financial diversification on bank performance has been largely investigated, without a general consensus. Our results appear partially coherent with Chiorazzo et al. (2008). Authors show "limits to diversification gains as banks get larger" while "small banks with very small non-interest income shares experience financial performance gains from increasing non-interest income". As DIV_{REV} rises, the bank becomes more diversified and less concentrated. The benefit of diversification outweighs the cost of NII volatility increasing efficiency, only in the case of small and minor banks. In all other cases the opposite results – even if with different

nuances in the bank groups – hold, coherently with Mercieca et al. (2007) and Lozano-Vivas and Paiouras (2010). The effect of income diversification is in fact strongly negative increasing inefficiency only for large and other joint stock banks. For mutual banks even if an increase in the diversification implies more inefficiency, the effect is quite marginal.

Finally to better investigate the effects of banking business organization structure on the inefficiency we control for the SIZE effect. Our results are coherent with some previous studies (see among others Akhigbe and McNulty, 2003 and Girardone et al., 2004) suggesting that economies of scale and efficiency gains hold only for small banks. Our results suggest that increasing bank size may improve efficiency only in the case of minor and mutual banks. Otherwise, size does not play any role in small and large banks (having already reached their best economies of scale) and decrease efficiency in the case of saving & cooperative and other joint stock banks.

As regards to micro risk conditions, model estimates reveal that, as expected, as LLP increases, bank inefficiency increases. Some exceptions emerge in the case of small and other joint stock bank, being the estimates statistically insignificant and in the case of large banks with a negative sign. As regards the NPL variable, a negative relationship with efficiency is detected, but the effect does not appear statistical significant in the case of large and other joint stock banks. A short term view could incentive a moral hazard behaviour implying less credit screening and monitoring with increasing cost efficiency. As a result, in the short run an increase of LLP may even increase efficiency while an increase in the NPL produce a null effect. As suggested by Berger and DeYoung (1997) a “cost skimping” hypothesis implies that the quality of banks loan portfolio is a consequence of the costs related to the monitoring of lending activities, generating a positive correlation between cost efficiency and bad loans. Similarly Fiordelisi et al., 2011, p. 1317 underline that a “cost skimping” hypothesis implies “a trade-off between short-term cost efficiency and future risk-taking due to moral hazard considerations. In such cases, banks appear to

be more cost efficient as they devote fewer resources to credit screening and monitoring”.

Finally, the main effects of environmental macro conditions on efficiency are controlled for. The per-capita value added growth rate (GDP) produces, as expected, a positive effect on banking efficiency even if its intensity is not homogenous among the different bank groups. The macro risk variables produce a negative effect on bank efficiency. Firm default rate (DEF_RT) is the most important determinant of efficiency in the minor and mutual banks groups; conversely, the macro credit risk (NPL_INDEX) negatively affects cost efficiency with minor intensity. The NPL_INDEX shows a stronger impact on large and joint stock banks, being characterized by a more distant branching structure distribution over the territory that may penalize the correct perception of the local macro credit risk¹³.

5. Conclusions

In this paper we investigate the cost efficiency of the Italian banking system with the aim to analyze the extent to which income diversification and relationship lending affect bank efficiency and whether the effect changes among different groups of banks, classified by size and institutional type. Using a stochastic frontier approach a strong heterogeneity within the Italian banking system is detected with respect to either the level of efficiency reached by the different groups or the determinants of cost efficiency.

The analysis of the cost efficiency for the full sample evidences that bank groups characterized by an organizational local structure (minor, mutual, small and cooperative & saving banks) are more efficient than largest and farthest banks. The average efficiency per year, calculated for the full sample of bank, increases until 2008, passing from 0.76 in 2006 to 0.80 in 2008, and then it decreases in 2009 to 0.79. As expected, the recent

¹³ The information advantage hypothesis (see among others Mester et al., 1998) suggests that small banks have access to better credit information than large banks. Moreover the closeness of the branch to the HQ implies less agency problems between the bank and the loan officer implying a better screening policy.

financial crisis determines a generalized cost efficiency reduction for all the Italian bank groups. However some differences emerge in respect to the different groups considered. The large and other joint stock banks decrease their cost efficiency of 3.16% and 3.06%, respectively. The small and saving and cooperatives groups loss on average 3.11% and 2.9% respectively. Finally minor and mutual banks loss only 1.20% and 0.83% respectively.

The geographical distribution of the efficiency scores reveals other interesting features of the banking system. In particular, the analysis allows to investigate the geographical concentration of bank efficiency across the Italian municipalities and the dynamics of the territorial efficiency distribution over the observed period of time. As expected, the most efficient municipalities are those located in the centre and in the north of the country and the existence of a correspondence between distance and cost efficiency: banks located in the south and farthest to the HQ appear to be less efficient than banks located to the north and close to the operational units.

Another interesting result comes from the comparison of efficiency loss in 2008 and 2009. Regions characterized by the presence of large banks even close to their branch network suffer more than areas where a local bank model prevails. This suggests that, besides distance, other features as size and income diversification strategies could have had a role in defining a different banking structure organization, affecting the different territorial cost efficiency distribution.

To better investigate these aspects we consider as inefficiency determinants both bank branch distance distribution and income diversification. The results confirm the importance of the distance in determining bank efficiency. As the distance increases the efficiency decreases. According to the information asymmetry theory, an organizational structure with close interaction between the HQ unit and the peripheral operational units better disentangle asymmetric information problems between lender and borrower

increasing bank efficiency. Coherently with previous evidence an increase in bank size implies a positive effect on cost efficiency only in the case of very small banks. Finally the income diversification positively affects efficiency.

The credit risk factors are also investigated. We distinguished between micro and macro risk conditions with different results. An increased credit risk implies a generalized decrease in efficiency for all the groups examined even if some exceptions emerge with reference the large group where an increase in LLP and in NPL imply according to the "cost skimping" hypothesis respectively an increase in the efficiency and any statistical significant effect. The micro risk effects on efficiency appear coherent with the results produced in the case of the macro risk consideration. Even if the macro-risk implies a definitive negative effect on the efficiency its intensity is more important in the case of large banks than in the case of minor and mutual banks. One again an asymmetric information hypothesis holds. Local banks benefit from a close approach between the HQ and the operational unit or the customer helping to better disentangle local credit risk.

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Fig. 1. The relation between SIZE and F-DISTANCE

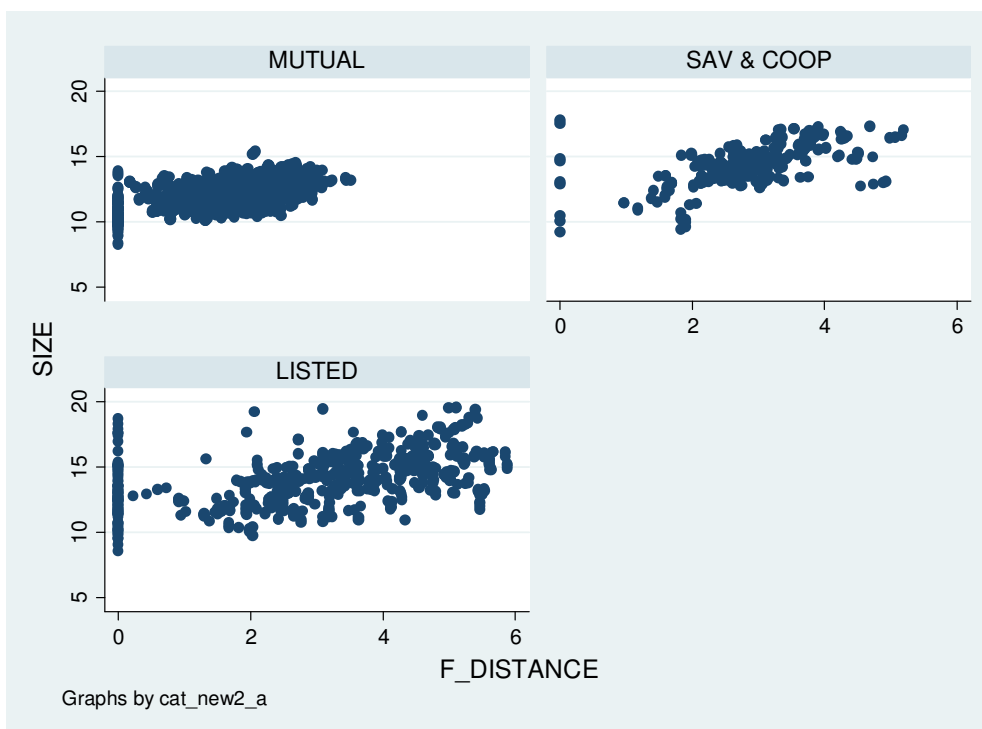
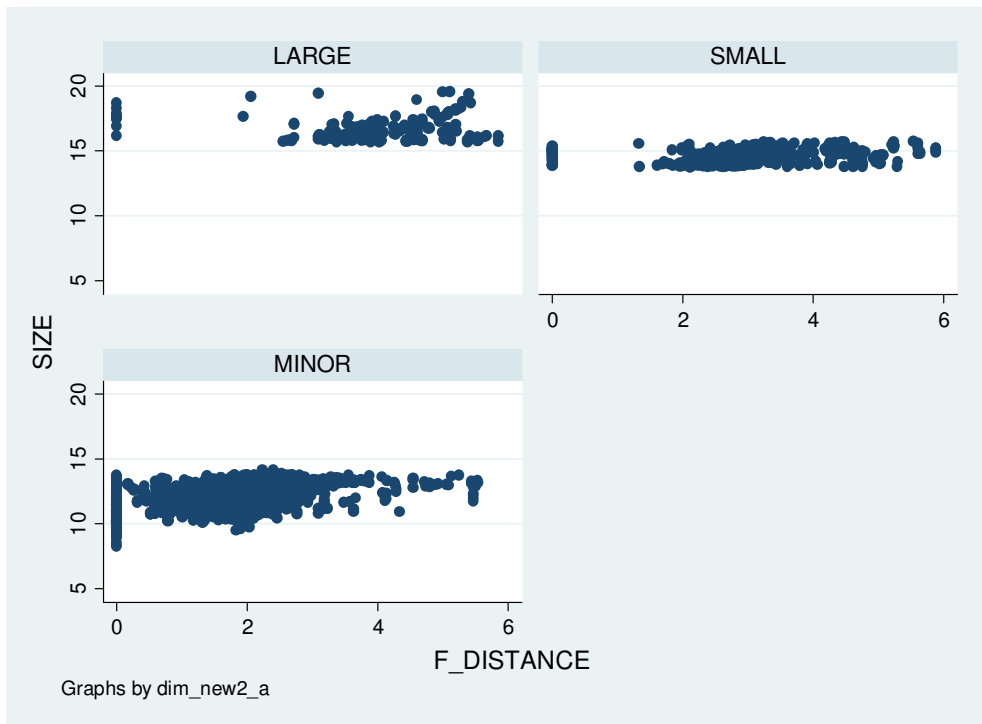
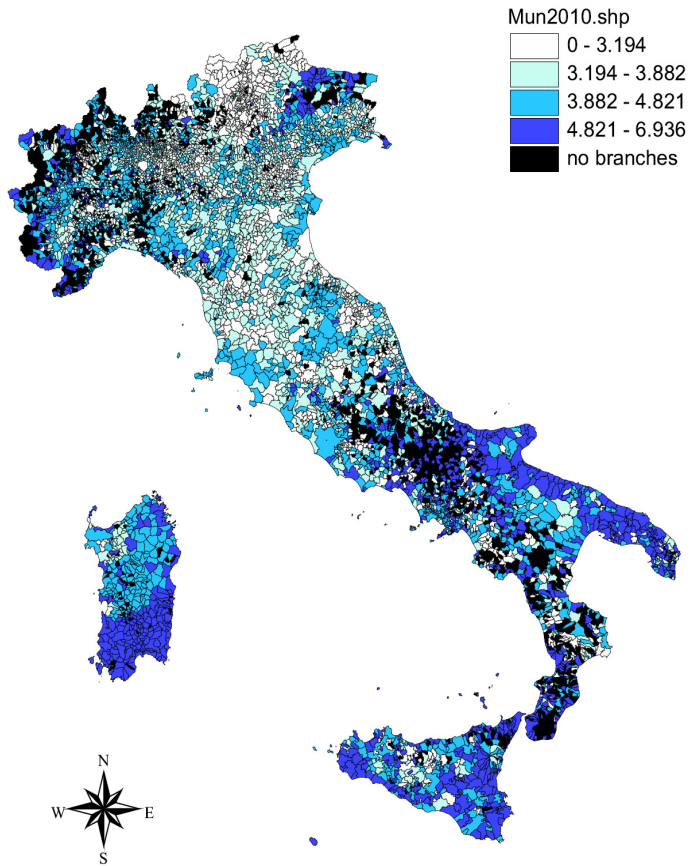


Fig. 2. Functional distance over 2006-2009 period

Functional Distance 2006



Functional Distance 2007

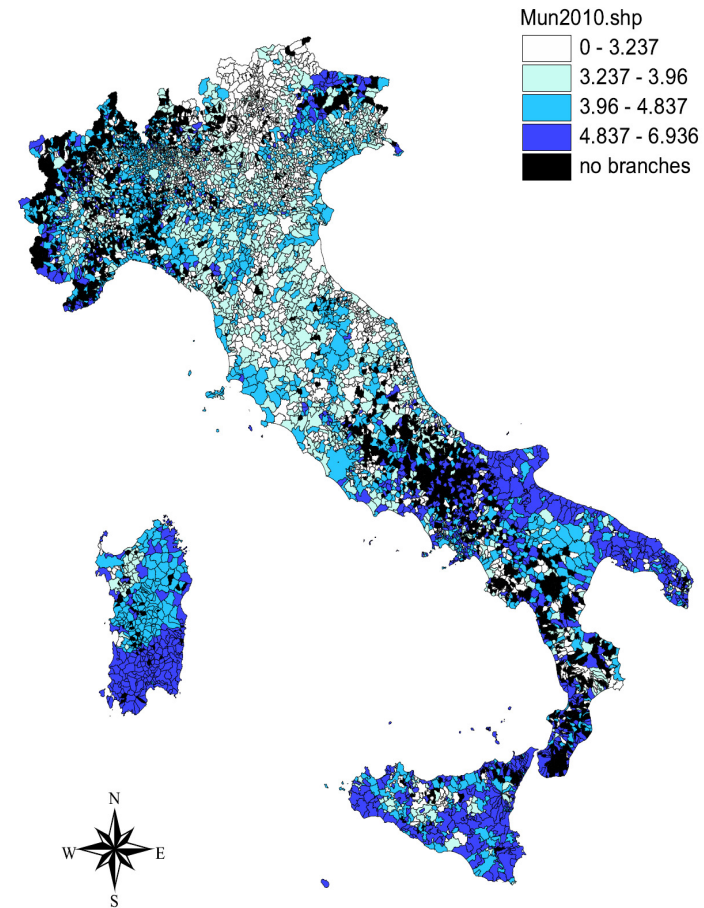
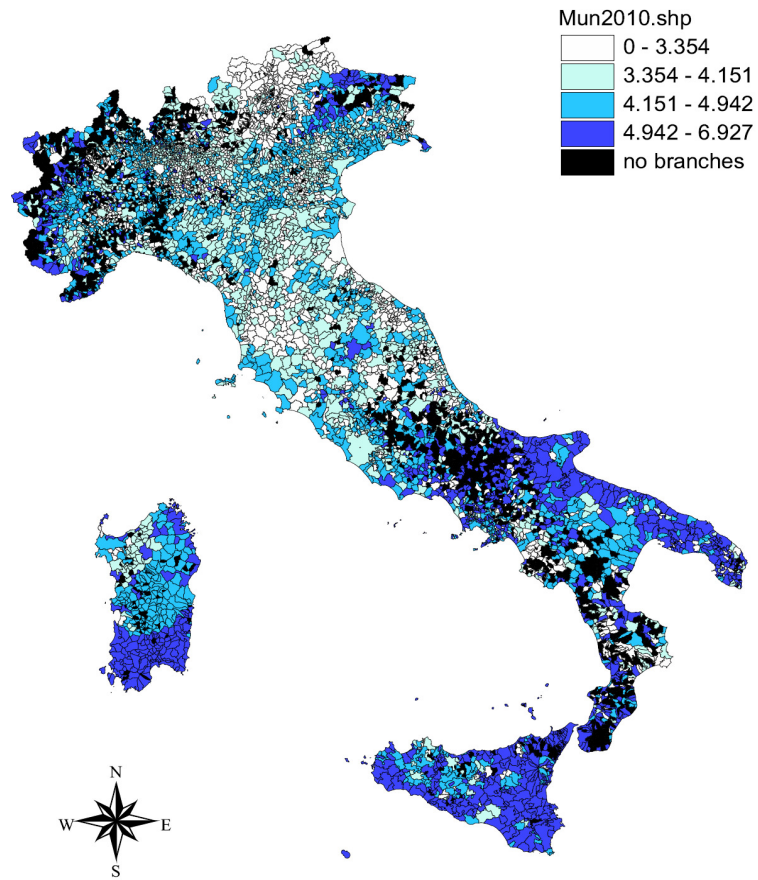


Fig. 2. (continued)

Functional Distance 2008



Functional Distance 2009

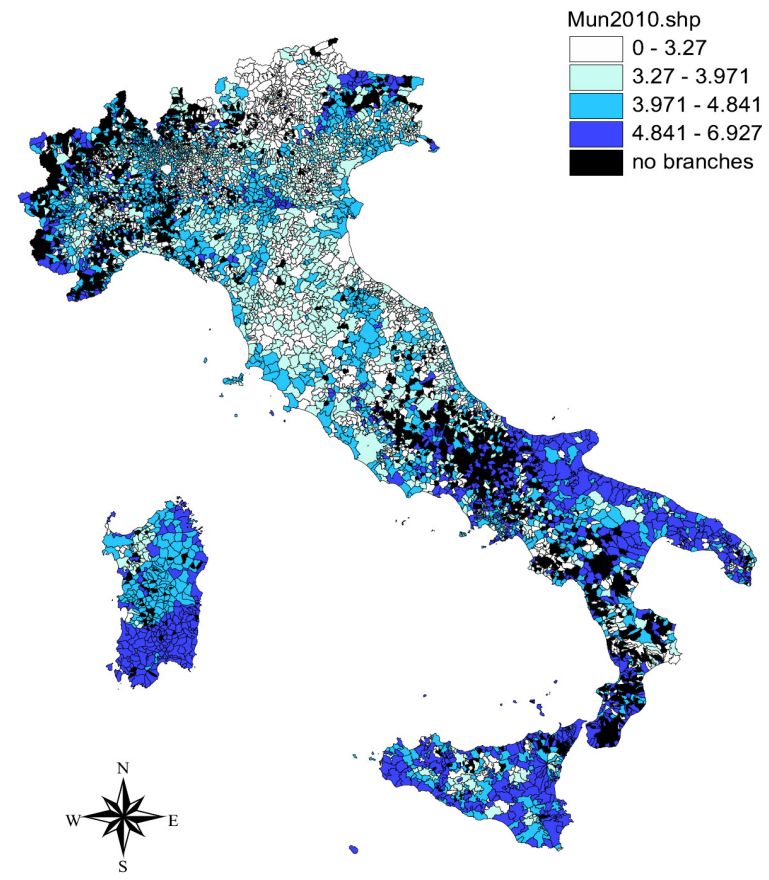
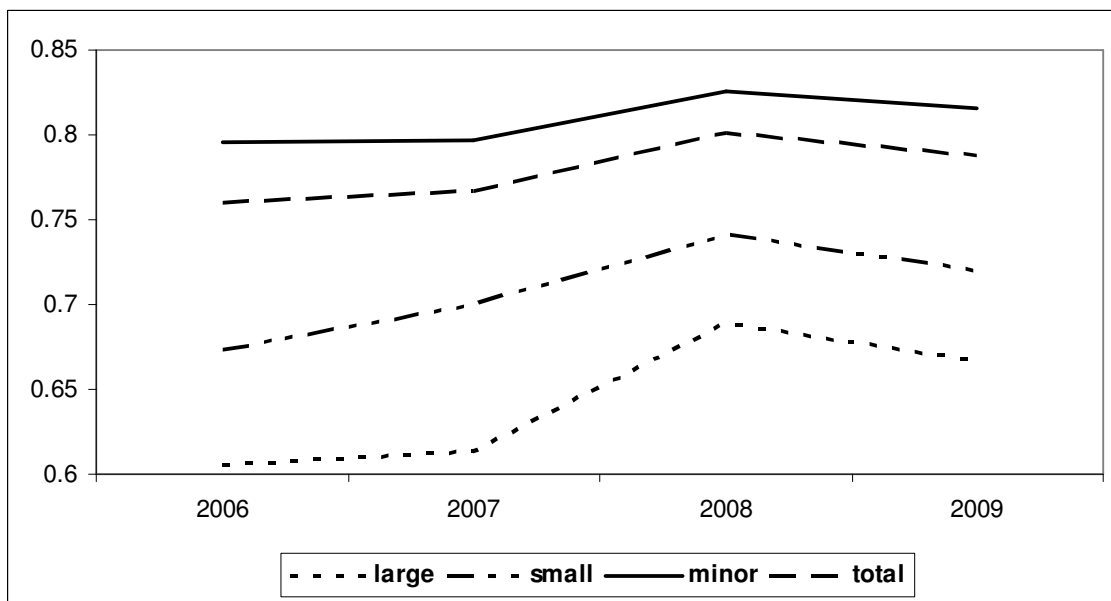
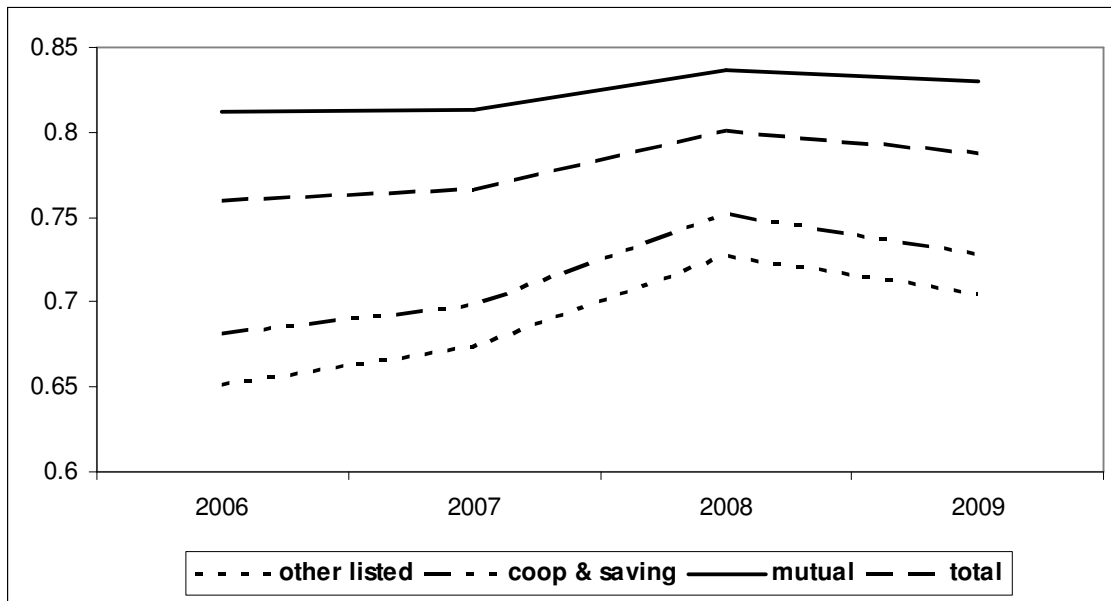


Figure 3. Full sample cost efficiency by size and by type



Note: Kruskal-Wallis tests reject the null hypothesis of equality of the median efficiencies either between groups or over time for each group.

Figure 4. Cost efficiency over 2006-2009 period

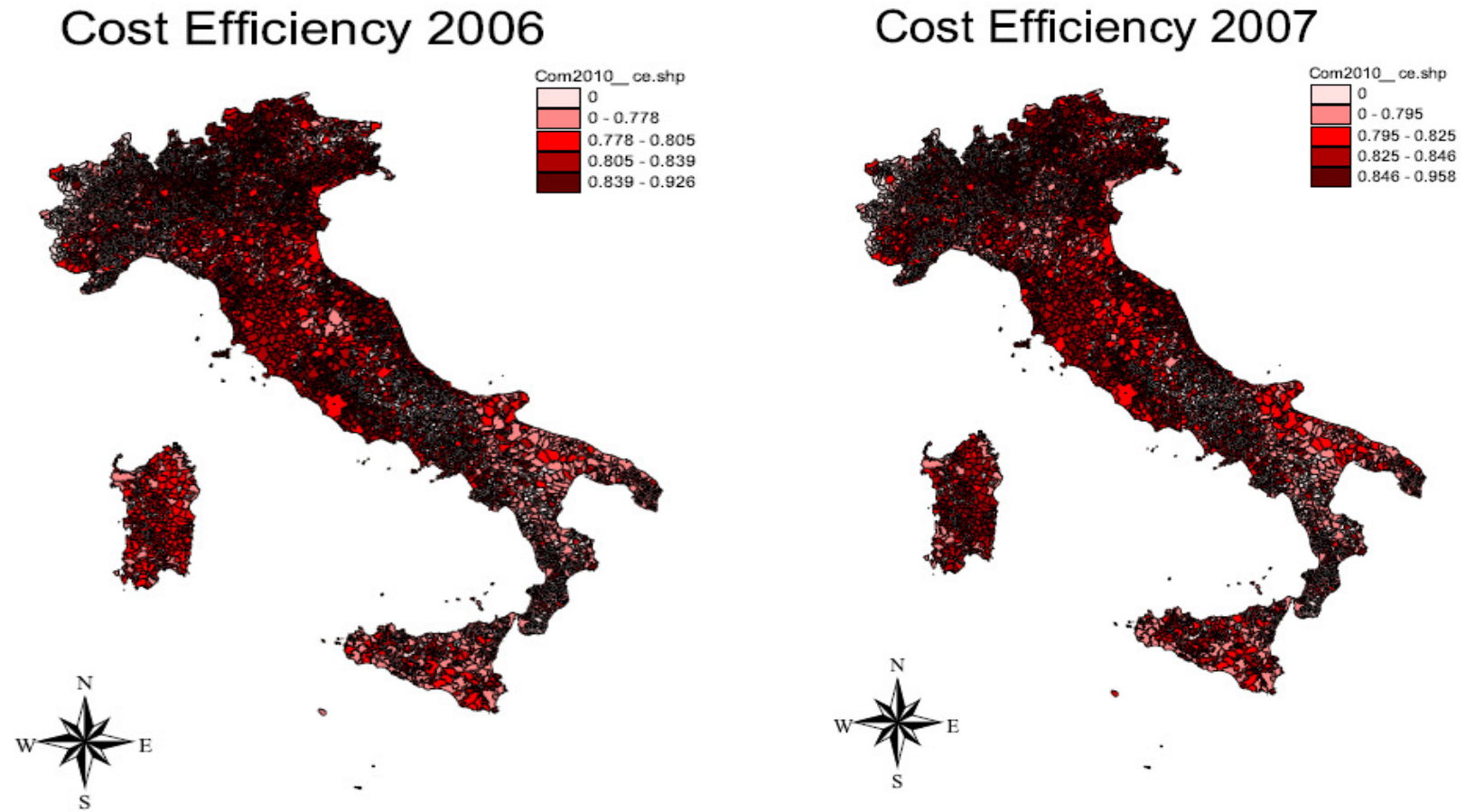


Figure 3. (continued)

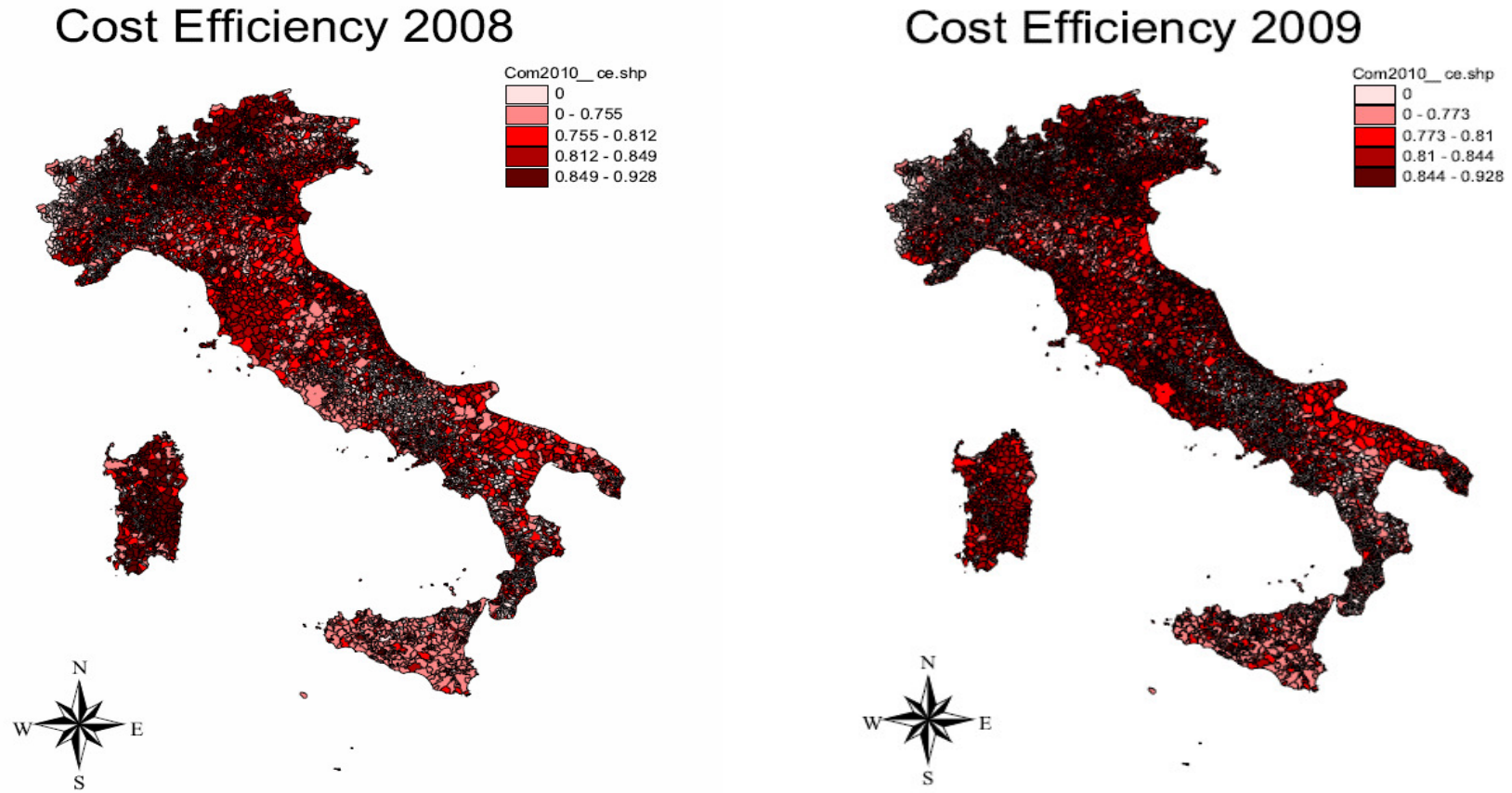


Table 1. Sample size and population coverage

Size groups	2006	2007	2008	2009	Total
Large	45 7.04%	46 7.07%	46 7.06%	46 7.20%	183 7.09%
Small	110 17.76%	110 17.44%	110 17.27%	110 17.76%	440 17.56%
Minor	487 75.19%	499 75.49%	501 75.68%	487 75.04%	1974 75.35%
Juridical groups	2006	2007	2008	2009	Total
Cooperative & saving	85 13.24%	86 13.13%	88 13.39%	86 13.37%	345 13.28%
Other listed banks	140 21.81%	145 22.14%	146 22.22%	147 22.86%	578 22.26%
Mutual banks	417 64.95%	424 64.73%	423 64.38%	410 63.76%	1674 64.46%
Total unbalanced sample	642	655	657	643	2597
<i>Total sample over total national system</i>	<i>89.29%</i>	<i>90.10%</i>	<i>91.50%</i>	<i>90.95%</i>	<i>90.46%</i>

Table 2. Descriptive statistics of input and output variables

Variable	Minor			Small			Large			Total		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Cost (Profit) (in thousand €)												
Total cost (TC)	5,934	4,213	125	50,790	39,494	1,721	440,291	229,486	49,314	46,659	6,389	4,390
Total profit (TP)	2,400	1,491	96	19,274	16,625	1,339	194,436	123,484	22,505	19,908	2,311	1,996
Output Quantities (in thousand €)												
Loans (L)	173,788	114,216	3,807	1,668,936	1,312,245	54,930	15,700,000	9,663,200	1,563,880	1,621,594	186,638	145,055
Demand deposits (DD)	120,553	84,037	2,478	1,075,175	848,196	41,259	9,933,550	6,125,053	1,020,307	1,009,855	122,762	90,978
Other earning assets (OEA)	66,734	45,833	1,624	640,517	364,463	36,213	13,900,000	4,279,767	2,315,034	1,217,314	65,979	190,432
Equity (E)	29,204	20,875	691	211,018	156,099	7,400	2,849,192	994,738	460,980	275,178	31,484	38,055
Input prices												
Price of labor (p1)	51.855	49.707	0.406	54.310	49.756	0.888	65.542	54.520	3.915	53.316	49.920	0.459
Price of funds (p2)	0.012	0.011	0.000	0.015	0.013	0.001	0.019	0.014	0.002	0.013	0.011	0.000
Price of fixed capital (p3)	2.480	0.742	0.331	3.828	0.729	0.658	11.210	1.192	2.332	3.349	0.760	0.327

Variable	Mutual			Saving & Cooperative			Other listed			Total		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Cost (Profit) (in thousand €)												
Total cost (TC)	5,763	4,043	164	79,517	41,137	6,213	141,974	30,247	17,690	46,659	6,389	4,390
Total profit (TP)	2,562	1,502	91	35,120	14,939	3,990	59,628	11,461	7,949	19,908	2,311	1,996
Output Quantities (in thousand €)												
Loans (L)	196,194	114,454	6,094	2,891,087	1,254,740	238,003	4,956,075	921,942	588,912	1,621,594	186,638	145,055
Demand deposits (DD)	132,434	85,739	4,625	1,799,412	864,407	148,637	2,949,291	443,790	357,097	1,009,855	122,762	90,978
Other earning assets (OEA)	66,641	44,221	2,308	1,205,709	287,398	208,399	4,363,544	307,187	785,300	1,217,314	65,979	190,432
Equity (E)	30,696	19,643	866	439,517	145,465	50,553	860,114	129,041	156,369	275,178	31,484	38,055
Input prices												
Price of labor (p1)	50.348	49.323	0.403	50.039	49.391	0.367	63.133	54.336	1.534	53.316	49.920	0.459
Price of funds (p2)	0.011	0.011	0.000	0.013	0.012	0.001	0.018	0.014	0.001	0.013	0.011	0.000
Price of fixed capital (p3)	1.105	0.692	0.053	1.409	0.706	0.140	10.623	1.889	1.357	3.349	0.760	0.327

Table 3. Descriptive statistics of the inefficiency variables

Variable	Minor			Small			Large			Total		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Banking business model												
Functional distance (F-DISTANCE)	1.675	1.753	0.022	3.091	2.969	0.056	4.003	4.097	0.091	2.083	2.009	0.025
Income diversification (INDIV)	0.294	0.298	0.002	0.362	0.396	0.006	0.392	0.441	0.010	0.313	0.317	0.002
Total assets (in thousand €) (SIZE)	249,763	177,321	4,912	2,432,433	2,007,386	66,850	31,200,000	15,100,000	3,602,197	2,977,222	280,074	317,832
Micro risk conditions												
Loan loss provisions/Total net loans (LLP)	0.005	0.004	0.017	0.006	0.005	0.043	0.006	0.005	0.044	0.005	0.004	0.015
Non performing loans/Total net loans (NPL)	0.019	0.012	0.001	0.014	0.011	0.001	0.014	0.011	0.001	0.018	0.012	0.001
Macro environmental conditions												
GDP growth rate (GDP)	99.335	99.179	0.064	98.784	98.654	0.137	98.632	98.117	0.169	99.191	99.092	0.055
Firm default rate (DEFAULT_RT)	2.536	2.160	0.040	2.673	2.335	0.065	3.107	2.605	0.106	2.602	2.190	0.033
Macro NPL (NPL_INDEX)	25.488	1.000	0.925	18.239	1.000	1.413	15.347	8.030	1.546	23.530	1.000	0.753

Variable	Mutual			Saving & Cooperative			Other listed			Total		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Banking business model												
Functional distance (F-DISTANCE)	1.625	1.742	0.019	2.793	2.769	0.053	2.950	3.187	0.071	2.083	2.009	0.025
Income diversification (INDIV)	0.292	0.294	0.002	0.376	0.390	0.005	0.338	0.386	0.006	0.313	0.317	0.002
Total assets (in thousand €) (SIZE)	272,993	171,964	8,426	4,343,028	1,714,980	402,883	9,673,590	1,466,576	1,288,865	2,977,222	280,074	317,832
Micro risk conditions												
Loan loss provisions/Total net loans (LLP)	0.005	0.003	0.016	0.006	0.005	0.035	0.007	0.005	0.041	0.005	0.004	0.015
Non performing loans/Total net loans (NPL)	0.018	0.013	0.001	0.015	0.012	0.001	0.019	0.009	0.003	0.018	0.012	0.001
Macro environmental conditions												
GDP growth rate (GDP)	99.355	99.179	0.071	99.182	98.913	0.166	98.762	98.575	0.102	99.191	99.092	0.055
Firm default rate (DEFAULT_RT)	2.370	2.110	0.042	2.680	2.465	0.075	3.176	2.600	0.066	2.602	2.190	0.033
Macro NPL (NPL_INDEX)	26.481	1.000	1.030	20.609	1.000	1.881	17.144	1.000	1.149	23.530	1.000	0.753

Table 4. Estimate results for the inefficiency cost model: bank groups by size

Variable	Minor	Small	Large	Full
Banking business model				
HQ-DISTANCE	0.223 *	0.042 **	0.023 *	0.088 *
DIV _{REV}	-1.402 *	-0.090 *	0.455 *	0.168 **
SIZE	-0.423 *	-0.089	0.175	0.051 *
Micro risk conditions				
LLP	0.205 *	-0.044	-0.131 **	0.078 *
NPL	0.375 *	0.125 *	-0.054	0.078 *
Environmental macro conditions				
GDP	-5.025 *	0.315	-1.367 **	-0.239
DEF_RT	1.419 *	-0.013	-0.118	0.319 *
NPL_INDEX	0.042 *	0.084 *	0.157 *	0.024 *
CE_group	0.78	0.88	0.66	0.76
CE_pool	0.81	0.71	0.64	0.72
LL	-177.91	-24.66	-71.20	-904.70

p-value: * 0.05; ** 0.10.

Note: LR tests strongly reject the null hypothesis of a single frontier for the Italian banking system either for the size groups. The LR test of the one sided error for the null hypothesis of no technical efficiency is also strongly rejected for all the models.

Table 5. Estimate results for the inefficiency cost model: bank groups by type

Variable	Mutual	Sav&Coop	Other listed	Full
Banking business model				
HQ-DISTANCE	0.137 *	0.105 *	0.058 *	0.088 *
DIV _{REV}	0.098 *	-0.180	0.602 *	0.168 **
SIZE	-0.239 *	0.093 *	0.136 *	0.051 *
Micro risk conditions				
LLP	0.028 *	0.420 *	-0.028	0.078 *
NPL	0.037 *	0.285 *	-0.005	0.078 *
Environmental macro conditions				
GDP	-0.410	-0.431	-0.550 *	-0.239
DEF_RT	0.157 *	0.124	-0.206	0.319 *
NPL_INDEX	0.017 *	0.042 *	0.136 *	0.024 *
CE_group	0.82	0.85	0.74	0.76
CE_pool	0.82	0.72	0.69	0.72
LL	322.50	91.51	-434.35	-904.70

p-value: * 0.05; ** 0.10.

Note: LR tests strongly reject the null hypothesis of a single frontier for the Italian banking system either for the categorical typologies. The LR test of the one sided error for the null hypothesis of no technical efficiency is also strongly rejected for all the models.