



Modeling Efficiency, Credit Risk and Performance in a Local Banking System

Cristina Bernini
Department of Statistics
University of Bologna

Paola Brighi
Department of Management
University of Bologna

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ALMA MATER STUDIORUM - UNIVERSITÀ DI BOLOGNA - POLO SCIENTIFICO-DIDATTICO DI RIMINI
IL PRESIDENTE ACCADEMICO È RESPONSABILE DELL'INVIAMENTO DELLE BOLOGNE E NON VERRÀ CONSIDERATO IL RESPONSABILE DI QUALSIASI RESPONSABILITÀ PER IL NOME ISTITUZIONALE



Objectives

- Analyze the impact of crisis on the banking system
 - Recession has uniformly affected banks?
 - To what extent recession impacts on bank efficiency?
- Evaluate the determinants of cost/profit inefficiency
 - What are the main determinants?
 - What is the role of environmental features?
 - Efficiency changes over time?
- Investigate whether determinants differ between bank groups
 - What are the main features influencing bank heterogeneity?
 - Size and/or category?

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Motivation Diversification (1/3)

- Over recent years numerous banks around the world have broadened their portfolio to offer non-traditional services.
- Some authors show that the higher volatility of NII outweigh diversification benefits.
 - DeYoung-Rice, FR 2004; Stiroh, JMCB 2004; Acharya-Hasan, JB 2006; Lozano-Vivas and Paouras, JBF 2010; Berger et al., JBF 2010.
- Some banks more oriented to traditional activities could have suffered less than other banks the “subprime and derivative” crisis, but in the future they could be more credit risk exposed
 - Rossi et al., 2009 JBF, show that although diversification negatively affects cost efficiency, it increases profit efficiency and reduces banks’ realized risk. Moreover diversification seems to have a positive impact on banks’ capitalization.



Motivation Risk (2/3)

- The recent financial crisis seems to have hit all banks differently in respect to their attitude towards traditional or not traditional banking activities:
 - De Jonghe, JFI 2010: “banks that profitably focus on lending activities contribute more to banking system stability than diversified banks. Retail banks, with a relatively high proportion of core deposits and loans in total assets, have a consistently lower systemic risk exposure”.
 - Wagner, JFI 2010: “even though diversification may reduce each bank’s probability of default, it makes systemic crises more likely”.
- A too high traditional loan growth rate could be an important driver of the riskiness of banks (Foos, Norden and Weber, JBF 2010).



Motivation

Size (3/3)

- There could be difference in banking activities related to its size
 - (DeYoung and Hasan, 1998; Akhigbe and McNulty, 2003)
- bank size, distance, relationship lending ...
 - Alessandrini et al. 2009 a, b; Berger and Black, 2010
- ... and to its juridical specification
 - (Angelini et al. 1988; Battaglia et al. 2008; Kontolaimou and Tsekouras, 2010).



Literature review (1/4)

Bank business measures:

- Production approach (cfr. Kuussaari and Vesala 1995)
 - output variables are measured in terms of **factual quantities** (e.g. the number of current accounts or the volume of transactions carried out in a given time period).
- The intermediation approach (cfr. Molyneux and Casu 2003, Casu and Girardone 2004, Beccalli et al. 2006, Fiorentino et al. 2006, Fiorentino et al. 2009)
 - The **loans granted to customers as well as other remunerative assets** are usually defined as output variables, produced by the banks by easily identifiable input variables such as work, fixed assets and collection.
- The value added approach (e.g. Resti 1997, Fiordelisi and Molyneux 2006, Fiordelisi, 2007)
 - which has been applied in more recent studies identifies the bank's output and input variables on the basis of the added value created, regardless of assets and liabilities. **Demand deposits** are considered as outputs, even though they represent a liability in the balance sheet.



Literature review (2/4)

Bank inefficiency determinants:

- Firm specific factors: size, category, capitalization, management
- Environment: GDP, economic structure, socio-demographic condition, local area characteristics
- Market condition: market share, risk share



Literature review (3/4)

Some indicators of efficiency determinants

- Diversification index (cfr. Chiorazzo et al., JFSR 2008):
$$INDIV_i = 1 - (NETs^2 + NII_s^2)$$

- Local market power (cfr. Alessandrini et al., JBF 2008):
$$HHI_i = \frac{\sum_{j=1}^{P_i} \left(\frac{\text{branches}_{ijt}}{\text{branches}_{jt}} \right)^2}{P_i}$$

- Macro provincial non-performance loans index:
$$NPL\ INDEX = \sum_{i=1}^n \frac{\text{branches}_{ij}}{\text{branches}_i} * \frac{npl_j}{\sum_{j=1}^{102} npl_j}$$



Literature review (4/4)

Efficiency measurement:

- Cost or Profit frontier functions and inefficiency models
- Traditional approaches:
 - *Stochastic frontier approach* – SFA (Battese and Coelli, 1992, 1995):
 - stochastic frontier function
 - simultaneous (one-stage) estimation procedure of inefficiency effects (MLE estimator).
 - Data Envelopment Analysis – DEA (Lowell, 1994)
 - Non- parametric mathematical programming approach to frontier estimation
 - ex-post analysis of the efficiency determinants (two-stage regression)
- The Metafrontier approach (Battese et al., 2004; O'Donnell et al. 2008)
 - opportunity to handle the presence of a plurality of cost function associated to heterogeneous "units"
 - the metafrontier model is an envelop of individual stochastic frontiers for different groups, each having their own technological, environmental and specific features.



Data and sample coverage

Sources:

- Bilbank dataset provided by the Italian Banking Association, A.B.I.
- Bank of Italy information on local macro NPL conditions and bank branch locations.
- ISTAT information on provincial population distribution.

Size groups	2009	2008	2007	2006	2005	Total
Large	17	15	18	22	16	88
Medium	28	32	35	32	29	156
Small	100	114	118	117	53	502
Minors	108	494	521	515	22	1,660
Total unbalanced sample	253	655	692	686	120	2,406
Total balanced sample		607	607	607		1,821
Total unbalanced sample	35.84%	91.35%	95.19%	95.41%	16.71%	93.99%
Total balanced sample		84.66%	83.49%	84.42%		84.19%



Descriptive statistics

	Obs.	Mean	Std. Dev.	Minimun	Maximun
Profit (Cost) (in thousand Euro)					
Total cost (TC)	1,821	65,113	326,124	-4,205	6,180,000
Total profit (TP)	1,821	30,816	152,239	-608,080	2,643,000
Output Quantities (in thousand Euro)					
Loans (L)	1,821	2,194,457	10,000,000	0	207,000,000
Demand deposits (DD)	1,821	1,094,788	4,952,635	0	95,400,000
Non-interest income (NII)	1,821	42,013	246,583	-575,765	4,823,807
Equity (E)	1,821	352,649	2,531,713	2,604	51,000,000
Input prices					
Price of funds (w1)	1,819	0.025	0.008	0.000	0.087
Price of fixed capital (w2)	1,811	5.845	24.790	0.077	18.387
Price of labor (w3)	1,821	0.014	0.008	0.000	0.143
Inefficiency variables					
Banking business structure					
Income diversification (INDIV)	1,786	0.301	0.099	0.000	0.500
Asset diversification (ASDIV)	1,821	0.340	0.186	0.013	1.000
In Total assets (SIZE)	1,821	5.701	0.737	3.711	8.633
Cost income (CI)	1,821	0.693	1.947	0.433	0.847
Equity/Assets (EQUITY RATIO)	1,821	0.119	0.064	0.012	0.906
Micro risk conditions					
Loan loss provision/Total credit loans (LLP)	1,816	0.125	4.564	0	9.500
Non performing loans/Total credit loans (NPL)	1,816	0.013	0.014	0	0.115
Past due loans/Total credit loans (PDL)	1,816	0.009	0.014	0	0.276
Relationship lending					
Loans/Employees (LPER in thousand Euro)	1,820	4,261.166	51,185.710	0	2,178,539
Local banking structure					
HHI	1,807	0.002	0.009	0.002	9.070
NPL INDEX	1,816	5.010	15.717	0.329	100



The proposed model

The cost approach

- We estimate efficiency levels by specifying the translog functional form for the cost function

$$\ln C_{it} = \alpha + \sum_k \beta_k \ln q_{kit} + \sum_p \beta_p \ln p_{kit} + \sum_j \sum_{k \geq j} \beta_{jk} \ln q_{jit} \ln q_{kit} + \sum_j \sum_{p \geq j} \beta_{jp} \ln p_{jit} \ln p_{pit} + \sum_k \sum_p \beta_{kp} \ln q_{kit} \ln p_{pit} + \beta_t t + \beta_E \ln E_{it} + (V_{it} + U_{it})$$

- Where:
 - C : total cost
 - Q is a vector of three outputs which are defined at the bank level:
 1. Total loans; 2. Retail deposits; 3. Fee-based financial services (i.e. non-interest income)
 - P is a vector of three market prices for inputs:
 1. The wage rate for labor; 2. the price for borrowed price of funds; 3. the price of physical capital.
 - E: Equity capital defined at the bank level to control (in a rough fashion) for the potential increased cost of funds due to financial risk.
 - U assumed $\ln(u, \sigma_2u)$ and V is the error term



The proposed model

The determinant of cost inefficiency

- The proposed efficiency model is:

$$\begin{aligned} \mu_{it} = & \delta_0 + \delta_{HH} \ln HHI + \delta_{id} \ln INDIV + \delta_{ad} \ln ASDIV + \delta_{size} \ln SIZE + \\ & + \delta_{ci} \ln CI + \delta_{er} \ln EQUITY RATIO + \delta_{llp} \ln LLP + \delta_{npl} \ln NPL + \\ & + \delta_{dpl} \ln PDL + \delta_{npli} \ln NPL INDEX + \delta_{lpr} \ln LPR + \delta_t t \end{aligned}$$

Where:

HHI: defined at provincial level

INDIV: income diversification

ASIV: asset diversification

SIZE: Ln total asset

CI: cost income

EQUITY RATIO: Equity/Total Asset

LLP: Loan loss provision/Total NPL:

Non performing loans/Total credit loans

PDL: Past due loans/Total credit loans

NPL INDEX

LPER: Loans/Employees

t: trend



The proposed model

Group frontiers

- Bank grouped by:
 - Size:
 - Large and medium banks > 9 billions
 - Small banks 1,3 – 9 billions
 - Minor banks < 1,3 billions
 - Juridical category:
 - Mutual banks
 - Cooperative banks
 - Saving banks
 - Other listed banks



Preliminary results (1/2)

Parameter estimates of the inefficiency models: bank groups by SIZE

	FULL	LARGE	SMALL	MINOR
<i>In_HHI</i>	-0.28*	-0.03**	-0.05*	-0.16
<i>In_NPL_Index</i>	0.19*	0.06*	0.00	0.14*
<i>In_INDIV</i>	-0.82*	-0.67*	-0.17*	-0.70*
<i>In_ASDIV</i>	1.31*	0.31*	0.26	1.35*
<i>In_SIZE</i>	0.50*	-0.04	0.33*	0.33*
<i>In_LPER</i>	-0.23*	0.08	0.05	-0.33*
<i>In_LLP</i>	0.01*	0.01	0.01	0.02*
<i>In_NPL</i>	0.04*	0.07*	0.01	-0.01
<i>In_PDL</i>	0.09*	-0.01	0.02	0.08*
<i>In_EQUITY RATIO</i>	-0.47*	-0.02	-0.31*	-0.33*
<i>In_CI</i>	0.34*	0.64*	0.60*	0.69*
<i>t</i>	-0.21*	-0.08*	-0.10*	-0.26*
* p-value 0.05; ** p-value 0.10				
Ce_group	0.83	0.85	0.82	0.85
CE_pool	0.83	0.74	0.78	0.86
LR test of one –sided err	2,195	212	333	1,284
LR_test	868			



Preliminary results (2/2)

Parameter estimates of the inefficiency models: bank groups by CATEGORY

	FULL	MUTUAL BANKS	OTHER LISTED BANKS	COOPERATIVE and SAVING BANKS
<i>In_HHI</i>	-0.28*	0.00*	-0.40*	-0.01
<i>In_NPL_Index</i>	0.19*	0.01*	0.38*	-0.01
<i>In_INDIV</i>	-0.82*	-0.23*	-0.62*	-0.46*
<i>In_ASDIV</i>	1.31*	-0.01	0.85*	0.30*
<i>In_SIZE</i>	0.50*	0.04*	0.67*	0.05*
<i>In_LPER</i>	-0.23*	-0.02*	-0.37*	0.00
<i>In_LLP</i>	0.01*	0.00	0.05*	0.00
<i>In_NPL</i>	0.04*	0.00	0.03	-0.01
<i>In_PDL</i>	0.09*	0.01*	0.05*	0.01
<i>In_EQUITY RATIO</i>	-0.47*	-0.61*	-0.57*	0.52*
<i>In_CI</i>	0.34*	0.50*	0.53*	0.64*
<i>t</i>	-0.21*	-0.07*	-0.18*	-0.04*
* p-value 0.05; ** p-value 0.10				
Ce_group	0.83	0.70	0.67	0.71
CE_pool	0.83	0.88	0.68	0.86
LR test of one –sided err	2,195	1,548	270	332
LR_test	2,977			



Conclusions (1/2)

- Strong heterogeneity in bank cost processes with respect to either size or category
- **Market factors:**
 - **HHI** is heterogenous among groups:
 - Generally a more concentrated market implies more efficiency;
 - Not significant in the case of Minor banks and changes sign in the case of Mutual banks.
 - **NPL_Index:** the efficiency decreases as the provincial credit risk increases.
 - However not significant in the case of Small banks and in the Cooperative & Saving banks.
- **Diversification factors:**
 - **Income diversification** implies greater efficiency. Less important among small banks. More homogenous among categorical groups.
 - **Asset diversification** (all other assets than loans). Non traditional activities – non traditional intermediation model – decreases efficiency.
- **Relationship lending factors:**
 - **Loan per employee** increase efficiency only in the case of minor banks.
- **Micro default risk:**
 - **LLP** (proxy of expected loss); **NPL**; **PDL** all negatively affect efficiency. Much more significant in the case of past-due loans than the case of non-performing loans.
- **Firm specific factors:**
 - **Size** decrease efficiency. Particularly in the case of large listed banks.



Conclusions (2/2)

- Summarizing:
 - **INDIV** and **EQUITY RATIO** positively affect **CE**
 - **ASDIVE**, **SIZE**, **NPL_INDEX**, **LLP**, **NPL**, **PDL** negatively affect **CE**
 - **HHI** generally negative. Not significant in the case of **MINOR BANKS** and opposite sign in the case of **MUTUAL BANKS**.
- An increase in **CE** is detected over the analyzed period – **TREND**
- Large listed banks reveal to be the less efficient group



Future research: *economic perspective*

- Economic perspective:
 - Estimate of the Profit function
 - Analysis of **recession effects** on bank groups (conditioned to availability of data on 2005 and 2009)
- Methodological perspective:
 - Define bank groups simultaneously with respect to size and category
 - Use of **Metafrontier approach**
 - Investigate specific determinants (specific firm features, environmental and market variables) of bank CE and Meta Technology Ratio (MTR)

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ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
SEDE DI RIMINI

Cristina Bernini
cristina.bernini@unibo.it

Paola Brighi
paola.brighi@unibo.it

www.unibo.it

ALMA MATER STUDIORUM - UNIVERSITÀ DI BOLOGNA - POLO SCIENTIFICO-DIDATTICO DI RIMINI