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Bank Size or Distance: What Hampers Innovation Adoption by SMEs?

Pietro Alessandrini
Andrea F. Presbitero
Alberto Zazzaro

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Abstract

A growing body of research focuses on banking organizational issues, emphasizing the difficulties encountered by hierarchically organized banks in lending to borrowers/projects with high intensity of soft information. However, as the two extreme cases of hierarchical and non–hierarchical organizations are typically contrasted, what actually shapes the degree of hierarchy and how to measure it remain fairly vague. In this paper we compare bank size and distance between bank's branches and headquarter as possible sources of organizational frictions. In particular, we study the impact of distance and bank size on the firms' likelihood of introducing innovations and financing constraints on a sample of Italian SMEs. Our results show that firms located in provinces where the local banking system is functionally distant are less inclined to introduce innovations and are more likely to be credit rationed. Conversely, we find that the market share of large banks is only rarely statistically significant and when it is, the economic impact on the probability of introducing innovation and credit rationing is appreciably smaller than that of functional distance.

JEL Class.: G21; G34; O31; R51
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Address: Affiliation for all Authors: Department of Economics – Università Politecnica delle Marche. Corresponding Author: Alberto Zazzaro, a.zazzaro@univpm.it

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1 Introduction

A growing body of research emphasizes the importance of banking organizational form for lending policies. What drives credit allocation, it is typically claimed, is not only the availability of effective information technologies or the possibility of personal face–to–face contacts with borrowers by dislocating branches in the same borrowers' area, but also the organizational complexity of the institution to which the loan office belongs to. Put differently, the local branch of a large, nationwide bank competes and allocates resources differently from the branch of a small, local bank.

Underlying this hypothesis are the assumptions that information is widely dispersed and that communicating it is a costly and imperfect process. A crucial part of information on local borrowers is non–codified and recoverable only by loan officers of local branches with detailed knowledge of the particular environment within which they operate. It is the loan officer who has personal contacts with the borrower, lives in the same community, knows people and firms who do business with the latter, shares a common set of cultural values, social norms and business language. It is his/her effort at combining hard with soft information on which the ability to select worthy projects depends. However, the amount of resources a loan officer devotes to acquiring soft information is not observable (Milbourn et al. 2001, Novaes and Zingales 2004). Furthermore, soft information available to a loan officer cannot be inexpensively and unambiguously passed on to the upper layers of the parent bank (Garicano 2000, Stein 2002, Liberti and Mian 2006). When banks are hierarchically organized, unobservability of information investments and shortfalls in communication channels within the bank generate incentive problems and agency costs (Berger and Udell 2002, Stein 2002, Takáts 2004), and create an opportunity for influential activities and career concerns (Narayanan 1985, Hirshleifer and Thakor 1992, Meyer et al. 1992, Milbourn et al. 2001). *Ceteris paribus*, all such matters should produce a sort of hierarchy liability, with hierarchical institutions allocating few resources to activities absorbing a lot of soft information, such as small business lending or innovation financing.

Many authors appear to consider the number of hierarchical levels as the key determinant of organizational frictions and of bureaucratization in lending decisions. In this spirit, the great bulk of empirical research has used bank size or multi–bank holding

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organization to measure the degree of organizational hierarchy, implicitly assuming that as the size or the complexity of a bank increases so does the number of its hierarchical levels (DeYoung et al. 1999, Berger et al. 2005). Laying emphasis on bank size and the number of intrabank hierarchical levels means conceiving the organizational frictions due to the degree of hierarchy as pertaining to the bank as a whole.

But this assumption is far from obvious. Recently, a few other studies have suggested that the degree of hierarchy pertains to the specific bank-firm relationship, and not to the bank, as being associated to the location of the lending branch (Alessandrini et al. 2006, Jimenez et al. 2007). Following these studies, organizational friction stems from the geographical dispersion of the bank organization by branches and subsidiaries. The conjecture is that incentive problems and the deterioration of soft information in transmission increase with the "distance" between hierarchical levels, rather than with their number. In the absence of detailed information on organizational structure of banks[1], in these studies the distance between hierarchical levels (herein, the "functional distance"[2]) has been reasonably approximated by the distance between the headquarters of the lead bank, where lending policies and ultimate decisions are typically taken, and the local branch, where information is collected and lending relationships are established.

Functional distance reflects different factors. For example, it is reasonable to believe that costs of monitoring loan officers per visit increase with the geographical distance from the bank's headquarters where loan reviewers are employed. Similarly, reliability of communication and trust between managers at the lead bank and local loan officers decrease with the physical and cultural distance between the bank head office and the local branch.

The contribution of this paper is to combine functional distance and bank size in the same model in order to address two questions: (i) Does a bank's organizational form significantly affect behavior and financial conditions of SMEs? (ii) What source of organizational friction has the greatest influence on lending relationships?

More specifically, we first focus on the impact of functional distance and bank size on the firms' likelihood of introducing innovations. If the lower innovative capacity of SMEs borrowing from hierarchical banks is due to a lack of finance, we would expect organizational friction to impact relatively more on innovative than on non–innovative SMEs. This is the second hypothesis we investigate, estimating whether the impact of bank organizational friction on the firm's probability of being credit–rationed is heterogeneous with regard to the firm's attitude to innovate.

We apply our analysis to a large sample of Italian small and medium enterprises, surveyed every three years by an Italian banking group from 1995 to 2003 (Capitalia 2005). Since such surveys do not contain any information concerning individual loans, we can only build aggregate measures of functional distance and bank size at the provincial level. Thus, strictly speaking, we analyze whether the behavior of a firm and its financing constraints are significantly affected by the degree of functional distance of the banking system in the province where it is headquartered and the market share of big banks in that local market. In principle, a firm could be indifferent to the organizational frictions

[1] As we will see below, a notable exception is Liberti and Mian (2006) who, however, focus on a case–study concerning a single bank.

[2] This terminology was introduced by Alessandrini et al. (2005)) and re–used by (Alessandrini et al. 2006). Jimenez et al. (2007) have, instead, suggested the alternative label organizational distance.

of the local banking system, insofar as it is borrowing from a bank branch located in a province other than where it is headquartered. However, since in Italy more than 90 percent of credit to borrowers located in a province is granted by branches located in the same province, in what follows we confidently assume that in each province local SMEs borrow from the local banking system.

To address possible endogeneity problems, we estimate our empirical models with an instrumental variable method. By way of preview, we find that firms located in functionally distant provinces are less inclined to introduce process and product innovations. Furthermore, in such provinces credit rationing is more likely to occur and innovative firms tend to be penalized. Conversely, we find that the market share of large banks is only rarely statistically significant and when it is, the economic impact on the probability of introducing innovation and credit rationing is appreciably smaller than that of functional distance.

The rest of the paper proceeds as follows. Section 2 provides a selective review of the related literature. Section 3 illustrates our data set and the distance variables. Sections 4 and 5 present our empirical exercises, describing for each of them the dependent and control variables, the empirical strategy and the results. Section 6 concludes.

2 Related Literature

2.1 Bank size and lending policies

A large number of studies have analyzed the effect of bank size on credit allocation, loan contract requirements and lending technologies. On the whole, available findings seem to be consistent with the theoretical predictions, suggesting that more hierarchical (i.e., larger) banking institutions find gathering soft information relatively more costly and lending to informationally opaque borrowers less profitable. For example, there is robust evidence for many countries that big banks allocate to small business lending a lower share of their assets, just as there is evidence that large banks involved in consolidation deals reduce loans to small businesses[3]. In their turn, large and informationally transparent firms appear to be more likely to borrow from large banks (Berger et al. 2005, Uchida et al. April). Consistent with the hypothesis of a liability of size in small business lending, others found that the interest rate and collateral requirements of large banks on loans to small firms are lower than those performed by small banks (Berger and Udell 1996), as are the risk–adjusted earnings (Carter et al. 2004).

Bank size has also been found to affect the lending technology. For example, there is evidence that large, hierarchical banks rely more on hard information, credit–scoring technologies and impersonal modes of interaction than small banks do (Scott 2004, Berger and Frame 2005, Uchida et al. 2006). Moreover, large banks make less use of exclusive relationships in small business lending and the impact of such relationships on credit terms is greater when small firms borrow from weakly hierarchical banks (Angelini et al. 1998, Cole et al. 2004, Kano et al. 2006, Uchida et al. April). Interestingly, many of the

[3]For the US banking industry, see Berger and Udell (1996), Peek and Rosengren (1998), Strahan and Weston (1998). For the Italian banking industry, see Sapienza (2002), Alessandrini et al. (2007). For Belgium , see Degryse et al. (2005).

competitive advantages of large banks in using transactional lending technologies seem to hold more strictly once one has controlled for endogeneity problems due to borrower preferences for such technologies (Berger et al. 2005).

The difficulties of small firms in borrowing from large banks are, however, only partially confirmed by studies conducted at the market level. For example, Craig and Hardee (2007) found that in the U.S. banking industry, firms located in markets where the share of deposits controlled by large banks is higher are less likely to use bank debt. By contrast, Jayaratne and Wolken (1999) suggested that for small firms the probability of having a credit line and using trade credit are not significantly affected by the presence of small banks in the market. In the same vein, Berger et al. (2007) found that small firms face a higher probability of having a credit line from a large bank as long as the share of large banks in the local market increases, suggesting that small firms are not penalized by large banks. Working on Italian data, Bonaccorsi di Patti and Gobbi (2001) found that the share of branches held by small banks in Italian provinces does not have a differential effect on loans to large and small firms.

2.2 Functional distance and lending policies

Clear clues of the existence of agency and communication costs related to the functional distance between the parent bank and its lending offices can be gained from several different pieces of research. A number of studies, for example, have provided evidence that both foreign and out–of–market owned banks have a disadvantage in screening small businesses and allocate fewer resources to such companies than domestic and in–market owned banks (Keeton 1995, Cole et al. 2004, Carter et al. 2004, Alessandrini et al. 2005, Carter and McNulty 2005, Mian 2006).

Other studies, consistent with the presence of incentive problems in geographically dispersed banks, found that: (i) the average time spent by a loan officer of nationwide banks in a specific branch is significantly lower (Ferri 1997); (ii) empowering loan officers increases the effort they devote to screening and monitoring borrowers, and improves the performance of the bank (Liberti 2003); (iii) the resources that the parent bank spends on loan reviewing activities is positively correlated with the organisational complexity of the bank and the degree of autonomy of local loan officers (Udell 1989).

The disadvantages of distance and geographical dispersion have also been indirectly confirmed by studies on bank market value and cross-border M&As. For example, Klein and Saidenberg (2005) found that the market–to–book equity ratio of bank holding decreases with the number of chartered bank subsidiaries. In a similar vein, there is broad evidence that geographic diversifying M&As are not value enhancing for dealing banks (DeLong 2001, Amihud et al. 2002, Vennet 1996, Beitel et al. 2004), and that geographical and cultural distance hinders international banking consolidation (Buch and DeLong 2004).

All these studies, however, provide only a very indirect evidence of the importance of distance–related bank organizational frictions. More direct indications were made available by a number of recent studies concerning different countries at different levels of financial and economic development. Using loan-level data from Pakistan, Mian (2006) found that the degree of engagement in relational contracts and lending to informationally opaque firms is greatest for branches of domestic banks, next greatest for branches of

Asian banks and least for branches of non–Asian foreign banks. By contrast, he could find no significant effect of bank size on credit allocation and relational lending.

Consistent with the hypothesis that functionally distant banks specialize in lending to more transparent borrowers, Jimenez et al. (2007) showed that, for Spanish banks, the likelihood of the usage of collateral decreases with the distance between the province where the bank is headquartered and the province of the borrower, irrespective of the level of experience accumulated by the bank in the local market.

Working on Italian data, Alessandrini et al. (2006) found that small firms are relatively more financially constrained if they are located in provinces where a greater percentage of branches belong to banks headquartered in distant provinces and in provinces characterized by different social and economic environments. Also, Alessandrini et al. (2007) found that in Italian bank acquisitions, the greater the cultural distance between the provinces where the dealing partners are headquartered, the greater are the changes in acquired banks' asset allocation in favor of large borrowers and transaction-based financial activities, at the expense of small, opaque borrowers.

Berger and DeYoung (2006), instead, found that cost and profit efficiency of affiliated banks in the U.S. are negatively correlated with the kilometric distance from the parent bank, even if advances in information and communication technologies seem to have decreased this effect over time.

Finally, an interesting attempt to evaluate the relative importance of bank size and distance as a source of organizational problems of efficiency control and communication was provided by Liberti and Mian (2006). They analyzed a large multinational bank operating in Argentina and documented that the sensitivity of the amount of credit facility granted to soft (hard) information decreases (increases) with the hierarchical level at which the credit line is approved. At a first glance, this result is consistent with the idea that what drives communication friction is the number of hierarchical levels. However, the authors also found that the decline in soft information sensitivity is not gradual over hierarchical levels, but takes place just in between levels where the officer who approves the loan sits in a different location from that of the previous level officer, suggesting that what really matters is the functional distance between hierarchical levels.

2.3 Banks and innovation

The third strand of literature with which our paper is concerned is that on financial impediments to innovation adoption faced by firms. A number of recent studies have addressed this question by using the first and second "Community Innovation Survey" carried out by the European Union and Eurostat on firms in EU area countries. From these studies it emerges that the lack of appropriate sources of finance is one of the main obstacles both to the probability of innovating and the intensity of innovating (Canepa and Stoneman 2002, Mohnen and Roller 2005, Savignac 2006). Moreover, insufficient finance shows a high degree of complementarity with other hampering factors like the perceived risk by firms, innovation costs (Galia and Legros 2004) or insufficient skilled personnel, lack of cooperation with other firms and regulatory obstacles (Mohnen and Roller 2005).

Most closely related to our analysis, three recent studies by Benfratello et al. (2007), Ferri and Rotondi (2006), Herrera and Minetti (2007) investigated the effect of local

banking development and relationship lending on the adoption of innovation by Italian manufacturing firms, extracting firm level information from the same source that we use in the empirical exercises below. Benfratello et al. (2007) found that the probability of introducing an innovation is significantly higher for firms headquartered in provinces where the bank branch density with respect to population is higher. Such positive effect of branch density proves to be more robust for process than for product innovation and greater for small and high–tech firms. Moreover, it maintains its statistical significance once endogeneity problems are addressed by using instrumental variable estimations.

Herrera and Minetti (2007) concentrated their analyzes only on the 8th Capitalia survey covering the period 1998–2000. They documented that, once instrumented, the length of the credit relationship firms have with their own main bank is positively correlated with the probability of introducing innovation. Unlike Benfratello et al. (2007), Herrera and Minetti found that it is the likelihood of product innovation which is more sensitive to relationship banking. Moreover, they found that branch density and other variables of local banking development are no more statistically significant.

Ferri and Rotondi (2006) extended the study by Herrera and Minetti by adding data from the most recent Capitalia survey (covering the period 2001–2003), augmenting the model with other control variables and distinguishing industrial district and non–industrial district firms. On the whole, their findings confirmed results obtained by Herrera and Minetti (2007), suggesting in addition that the duration of the bank relationship also strongly affects the likelihood of process innovation.

3 Data and Variables

3.1 Dataset

We construct a large dataset consisting of micro–data on Italian manufacturing SMEs and macroindicators of banking development and organizational structure for the 95 Italian provinces[4]. We draw information on innovation adoption, credit rationing and other firms' characteristics from the widely used Survey of Manufacturing Firms ("Indagine sulle Imprese Manifatturiere") published every three years by the Italian banking group Capitalia (and formerly by Mediocredito Centrale). The survey collects a large set of information on a representative sample (stratified by firm size, industry sector and firm location) of Italian SMEs with 11–500 employees and larger firms with more than 500 employees. Attached to the survey are also balance sheet data covering the entire survey period.

In this paper, we merge the last three waves of the survey covering the following periods: 1995– 1997, 1998–2000 and 2001–2003. The pooling sample has information on 12,667 firms, largely concentrated in the north of Italy and with a predominance of small businesses, in accordance with the structure of Italian manufacturing industries.

[4]Italy is currently divided into 107 provinces, which are grouped into 20 administrative regions. However, since some provinces were recently constituted, we use the old classification of 95 provinces. The 20 regions are then usually grouped into five macro areas: (1) North-West: Valle d'Aosta, Piemonte, Lombardia and Liguria; (2) North-East: Veneto, Trentino Alto Adige, Friuli Venezia Giulia and Emilia Romagna; (3) Centre: Tuscany, Marche, Umbria and Lazio; (4) South: Abruzzo, Molise, Campania, Puglia, Basilicata and Calabria; (5) Islands: Sicily and Sardinia.

Since our empirical exercises focused on SMEs, the sample size was reduced to 12,100 observations. Finally, due to missing data, misreporting and a trimming procedure that excludes extreme values of all firm-level variables, we are left with 7,633 observations. We chose not to exploit the time dimension of data for two main reasons. First, each Capitalia survey has a rotating panel consisting of one third of firms interviewed in the previous survey, such that a panel of firms built on three waves would include only one tenth of the original observations. Secondly, the survey suffers from a high degree of panel attrition, which means that panel members with specific characteristics may opt out of the panel in non–random fashion. This sample selection creates a bias in the estimates and could outweigh the efficiency gains of exploiting unobserved firm–specific heterogeneity (Nese and O'Higgins 2005).

Data on the location of bank headquarters, bank holding composition and the provincial distribution of branches by banks come from the Bank of Italy, for the sample period as well as for 1936 and 1971. These two years ill serve as benchmarks for our instrumental variable estimation (see below, section 4.1). Information on the asset size of banks was taken from Bilbank, a data set produced by the Italian Association of Bankers (ABI) collecting balance-sheets of Italian banks. Finally, data on population at the provincial level are taken from the National Institute of Statistics (ISTAT).

3.2 Dependent variables

Our dependent variables are self-reporting answers to survey questions. With regard to the adoption of innovation, firms had to answer the question: "During the three survey years, did the firm make any product and/or process innovations". Starting from this question we build three dummy variables: (1) INN, which is equal to 1 if the firm adopted a product and/or a process innovation and 0 otherwise, (2) PROCESS, which is equal to 1 if the firm adopted a process innovation and 0 otherwise, and (3) PRODUCT, which is equal to 1 if the firm adopted a product innovation and 0 otherwise.

The second survey question was on credit rationing. In this case, the survey asked firms, "In the last year of the survey would the firm have wanted more credit at the interest rate agreed with the bank?". We then build a dummy variable RAT, which is equal to 1 if the firm answered yes and 0 otherwise. It is worth noting that the survey question that we use to classify a firm as rationed is not able to distinguish quantity from price rationing. Although the survey asked firms more detailed questions to disentangle the type of rationing, we choose to use the more general question on rationing because we are interested in financing constraints to innovation and not in the existence of quantity constraint *per se*[5].

As shown in Table 1, 50% of the firms in our sample stated they had adopted process innovation, while product innovation was adopted by only 28% of firms. In both cases, the likelihood of introducing innovations increases with firm size and is higher for firms that make expenditure on R&D (Table 2). With regard to the RAT variable, 15% of firms stated they were rationed by banks; the percentage decreases with firm size, but is higher for firms that claimed to adopt innovations.

[5]Furthermore, (a) the order in which the other questions appeared in the survey changes with the waves and therefore responses are not perfectly comparable across the three data sets; (b) the number of missing data is much higher.

Table 1: Variables: Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Dependent variables					
INN	7205	0.587	0.492	0	1
$PRODUCT$	7205	0.279	0.449	0	1
$PROCESS$	7633	0.504	0.500	0	1
RAT	7633	0.149	0.356	0	1
Credit markets variables					
FD_KM	7633	3.358	1.045	0.707	6.501
Sh_LB	7633	42.15	14.34	3.744	82.01
OP	7633	5.746	1.447	1.545	10.268
HHI	7633	1.095	0.459	0.356	6.359
Firm-specific explanatory variables					
$INNOVATION$	7393	9.001	20.646	0	100
$R\&D$	7633	0.363	0.481	0	1
RDK	7633	0.022	0.062	0	0.568
ROI	7633	11.199	7.452	-9.573	40.120
$DEBT$	7633	5.870	1.116	2.083	11.788
ML	7584	5.967	3.669	1	30
$EXPORT$	7603	0.725	0.447	0	1
$WORKERS$	7633	69.06	84.91	11	500

Notes: The pooled sample of 7,633 observations is made by 2,947 observation from the first wave, 2,231 from the second one and 2,455 from the last wave.

Table 2: Innovation and Rationing by firm size

	Number of employees					Total	Obs.
	11–20	21–50	51–100	101–250	251–500		
INN	45.75	56.74	66.86	71.43	77.67	58.74	7205
$INN \mid R\&D{=}1$	71.89	77.86	82.74	84.65	87.41	80.48	2546
$PRODUCT$	16.32	25.32	34.83	41.60	45.87	27.90	7205
$PROCESS$	39.68	48.58	56.05	60.65	69.55	50.41	7633
$INNOVATION$	6.23	8.34	10.60	11.62	14.98	9.00	7393
RDK	1.77	1.94	2.79	2.94	2.93	2.24	7633
$R\&D$	20.45	30.90	46.58	55.82	66.59	36.34	7633
RAT	17.55	15.17	14.65	11.96	8.41	14.90	7633
$RAT \mid INN = 1$	18.64	16.38	14.53	11.66	7.76	15.09	4660

Notes: The pooled sample of 7,633 observations is made by 2,947 observation from the first wave, 2,231 from the second one and 2,455 from the last wave.

3.3 Local banking organizational diseconomies

As we stated above, we distinguish two sources of organizational diseconomies within a bank. The number of hierarchical levels, that we proxy with bank size, and the functional distance between hierarchical levels, that we proxy with the kilometric distance between the head office of the parent bank and its own branches.

Lacking individual loan data, we build the organizational variables at the provincial level as the functional distance and the size structure of the local banking system. The

former is computed as the number of branches operating in a province j, each weighted by the logarithm of one plus the kilometric distance between that province and the provinces where parent banks are headquartered[6]:

$$FD\_KM_j = \frac{\sum_{b=1}^{B_j}[Branches_b \times \ln(1 + KM_{j,z_b})]}{\sum_{b=1}^{B_j} Branches_b} \quad (1)$$

where B_j is the number of banks operating in the province j, is the number of branches belonging to the bank b, and z_b is the province where the headquarter of the bank b is located. The size structure of the local banking system is computed by the ratio of branches owned by large banks to the total number of branches operating in each province (Sh_LB)[7] A bank is classified as large if it has total assets of at least 50 million euros computed at 2003 prices[8]. For affiliated banks we assume that the ultimate control of local branches is in the hands of the parent bank of the holding company, so that the headquarter location and the size are those of the holding company[9].

Summary statistics of organizational variables for the pooled sample are reported in Table 1. Although the two indicators are positively correlated (Table 3), they follow a different pattern during the sample period. As shown in the left-hand panel of Figure 1, FD_KM and Sh_LB exhibit a sharp increase from 1995 to 2003, as a result of the intense process of merger and acquisitions that affected the Italian credit markets at the time. On average, the share of large banks in Italian provinces was 31% in 1995, increasing to 48% in 2003. The increase in functional distance was on average more limited (less than 30%). At the same time, the right–hand panel of Figure 1 reveals that the variability of Sh_LB across provinces, measured by the coefficient of variation, experienced a marked reduction over the considered span of time, while the geographical dispersion of functional distance decreased at a much slower pace.

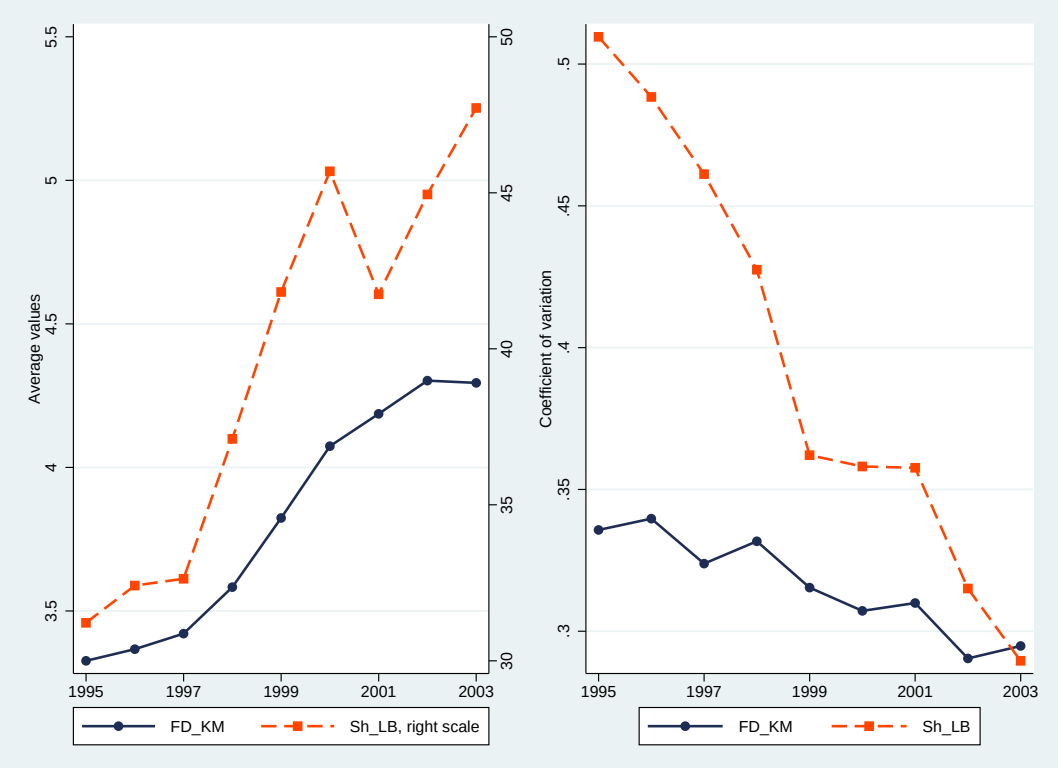
[6]In a previous study, we also use a weighting rule based on cultural and economic distance, captured, respectively, by the social capital and a dissimilarity index of the economic structure of the two provinces Alessandrini et al. (2006). Since kilometric, cultural and economic functional distance indicators have proved to give very similar results, for the sake of space, here we focus only on the kilometric weighting rule.

[7]This indicator was recently used by Berger et al. (2007).

[8]Econometric findings are robust to a change in the size threshold at 25 million euros. Results are available on request.

[9]Actually, our data do not allow us to disentangle how much decisional autonomy a chartered bank loses when it enters a banking group. For robustness, we calculated the organizational structure indicators under the alternative assumption that the ultimate control on lending decisions is taken by the chartered bank. Our estimation results remain substantially unaltered and are available on request from the authors.

Figure 1: Evolution and variability of organizational structure indicators



Notes: The left–hand side diagram shows the average values of the 95 provinces of FD_KM (left scale) and Sh_LB (right scale). The right–hand side diagram plots the coefficient of variation for the 95 provinces, for each of the three indicators.

Table 3: Credit market and instrumental variables: Pairwise Correlations

	FD_KM	OP	HHI	Sh_LB	FD_KM71	OP36	Sh_LB36	CCB36	SB36
FD_KM	1								
OP	-0.7034*	1							
HHI	0.1313	-0.159	1						
Sh_LB	0.4123*	-0.3384*	-0.1636	1					
FD_KM71	0.6903*	-0.5656*	0.3044*	0.3263*	1				
OP36	-0.4895*	0.6321*	-0.1841	-0.1031	-0.3463*	1			
Sh_LB36	0.3494*	-0.5258*	0.0911	0.3591*	0.4826*	-0.4194*	1		
CCB36	0.0341	-0.0133	-0.1388	0.0727	-0.0338	0.0249	-0.2577*	1	
SB36	-0.3578*	0.5196*	-0.0382	-0.1527	-0.3534*	0.2935*	-0.3240*	-0.1073	1

3.4 Local banking development and firm–specific explanatory variables

In our regression we control for the degree of development of the local banking system and a number of firm characteristics.

As local banking development indicators, we use the operational proximity of the local banking system and the degree of market concentration. The operational proximity (OP) is measured by the ratio of bank branches to population. This indicator is widely used in the banking literature and has been recently employed by studies on financial constrains to firms' innovation adoption (see Section 2.3). The degree of concentration of the local credit market is measured by the Herfindahl– Hirschman Index (HHI), computed on the share of branches held by banks operating in a province.

As firm characteristics we consider size, financial structure, export and innovation vocation. More specifically, the size of firms is measured in terms of employee numbers (WORKERS). The firms' financial structure is captured by return on investment (ROI), the degree of leverage (DEBT) and the number of banks from which each firm borrows (ML). The vocation to export is proxied by an indicator variable that has a value of 1 for firms exporting a share of their sales and 0 otherwise (EXPORT). Finally, the propensity to innovate is captured by three different measures: (1) the share of sales coming from innovative products (INNOVATION); (2) an indicator variable equal to 1 if the firm has made expenditure in R&D in the survey period and 0 otherwise (R&D); (3) the ratio of R&D expenditures to the stock of capital (RDK)[10].

4 Innovation Adoption

4.1 Methodology

The basic question we address in this chapter is: "Does the degree of organizational friction in the local banking system hamper the adoption of process and product innovation by local SMEs?" More specifically: "Does the number of and/or the distance between banks' hierarchical levels adversely affect the likelihood of firms to introduce innovations?"

To answer this question we follow two econometric methods. First, we estimate a pooled probit model:

$$Pr(I_{i,j}) = f(FD\_KM_j, Sh\_LB_j, BANKING - DEV_j, FIRM_i) \tag{2}$$

As dependent variable we use, alternatively, the probability of a firm i located in a province j introducing an innovation *tout court*, and then the probability of adopting a process and a product innovation. Local banking development is measured by OP and HHI, while includes ROI, RDK, EXPORT and WORKERS categorized in five classes (11–20, 21–50, 51–100, 101–250 and 251–500) of employees. Furthermore, we also include dummy variables for industries, regions and waves.

[10] A detailed description of these and all other variables used in the empirical analysis is reported in A.

Equation 2 could suffer from endogeneity and omitted variable problems. First of all, we expect that organizational and banking development variables could be driven by the level of local economic development, such that it cannot be considered exogenous with respect to firms' innovative capacity: more innovative firms will grow more, fostering local development and promoting the opening of new branches and the acquisition of local banks. Secondly, it is possible that both banking variables and innovation decision are jointly driven by another unobserved variable. To resolve these problems we instrument FD_KM, Sh_LB, OP and HHI with factors that are likely to be correlated with such variables, but not with innovation decisions. We follow Guiso et al. (2004) and impose the regulatory structure of the Italian banking system of 1936 and 1971 as the true exogenous factor. The geographical distribution of banks and branches in 1936 came about as a response to the 1930–1931 banking crisis and did not follow the strict logic of profit. Guiso et al. (2004) show that the number of branches per person and its distribution by size in 1936 were unrelated to the regional economic development of the time and can be, therefore, considered strictly exogenous with respect to innovation decisions in subsequent years. Moreover, the geographical distribution of branches in 1936 is significantly correlated with the local banking development in the 1990s.

In this spirit, we construct five instrumental variables at the provincial level[11]: (1) the number of branches per inhabitant in 1936 (OP36); (2) the share of branches owned by large banks in 1936 (Sh_LB36)[12], (3) the share of branches owned by cooperative banks in 1936 (CCB36); (4) the share of branches owned by saving banks in 1936 (SB36); (5) a functional distance indicator calculated with respect to the geographical distribution of branches in 1971 (FD_KM71). The choice of 1971 was dictated by the fact that data on the branch distribution by bank were not published before this year. However, since the structure of the Italian banking system remained substantially unaltered until the end of the 1970s, we take the FD indicator at 1971 as a valid instrument[13]. Apart from CCB36, the other instruments appear to be significantly correlated with the average values of FD_KM, Sh_LB and OP variables over our sample period (Table 3).

The second econometric model we use to estimate the probability of innovation is the ordered probit. In this case, we assume that the alternative decisions of not introducing innovation, adopting either process or product innovations and adopting both stem from a unique choice model and are driven by the same latent variables. In other words, we construct a discrete variable INN3 whose value depends on the "propensity to innovate". More specifically, INN3 is equal to 0 when the firm reports no innovation adoption, and 1 when it reports it has adopted either a process or a product innovation, and value 2 when it reports that both types of innovations have been introduced. Then we estimate the impact of our organizational, banking development and firm-specific variables on the probability of these three events.

[11] The Guiso et al. (2004) approach has been extended at the provincial level also by Benfratello et al. (2007), Ferri and Rotondi (2006), Herrera and Minetti (2007).

[12] Since data on bank branches in 1936 are classified by bank institutional type, we consider the "Istituti di Credito di Diritto Pubblico" and the "Banche di Interesse Nazionale" to be large banks.

[13] *The financial system which Beneduce and Menichella in 1933 had to create from the ruins of the previous system remained unchanged and basically accepted until wage and oil stagflation in the 1970s. Today this system no longer exists.* (Ciocca 2001, p.41, our translation).

4.2 Results

Table 4 presents the results of IV estimations of equation 2 regarding the determinants of the likelihood of SMEs introducing innovation. As regards the diagnostic, we know that instrumental variable estimation relies on two assumptions: (1) a significant correlation between the instruments and the endogenous variables (FD_KM, Sh_LB, OP and HHI) and (2) the absence of correlation between the excluded instruments (the credit market variables calculated for 1936 and 1971) and the error term of the structural equation. We verify the validity of the first assumption from the estimates of the first stage regression[14], while, concerning the second assumption, the Sargan overidentification test does not reject the null hypothesis, so that the instruments can be considered valid.

Firm–specific control variables are significant and with the expected signs. More profitable and larger firms, as well as those that invest more heavily in R&D and export part of their production abroad are more likely to adopt innovations. Moving on to credit market indicators, we find that small and medium enterprises located in more concentrated credit markets have a higher probability of introducing innovation. This effect is in line with the beneficial effect of less banking competition that the recent literature ascribes to the fact that it stimulates relation–based lending (Petersen and Rajan 1995, Cetorelli 1999). The number of branches per inhabitant (OP) proves nonsignificant, contrary to the evidence provided by Benfratello et al. (2007). This result is consistent with the findings of Ferri and Rotondi (2006), Herrera and Minetti (2007) , and might be due to the fact that we controlled for other banking variables.

Moving on to the key indicators of organizational diseconomies, the result that clearly emerges is that FD_KM reduces the probability of SMEs introducing innovations, while the market share of large banks (Sh_LB) has no significant effect. This finding is confirmed in all the four specifications reported in Table 4. However, as shown in columns (2) and (4), the adverse effect of functional distance is lower for firms that invest greater resources in R&D. In particular, the coefficient on FD_KM is equal to -0.269 for SMEs not investing in R&D (column (2)), while it decreases to -0.202 for a firm with an average RDK ratio and to -0.082 for firms at the 90^{th} percentile of the RDK distribution. As firms investing in R&D are usually larger (Table 2) and properly organized, this mitigating effect of RDK corroborates the idea that distance of loan offices from decisional centers is especially harmful for firms unable to provide banks with standardized and reliable hard data. The effect of Sh_LB remains statistically non–significant regardless of the firm's attitude to investment in R&D.

To gauge the economic significance of our findings, we calculate the magnitude of the impact of the two local banking organizational variables on the propensity to innovate and their relative importance. Specifically, we investigate two aspects concerning the differentiated effect of FD_KM and Sh_LB relative to: 1) the size of the firms, 2) their capacity to invest in R&D.

First, Figure 2 provides visual confirmation that functional distance is the main channel through which organizational diseconomies impact on innovation adoption by SMEs. Increasing FD_KM from the first to the third quartile of its distribution[15] leads to a

[14]For the sake of brevity, we do not report the results of the first stage regressions, but they are available on request from the authors.

[15]To illustrate, the change in FD_KM from the first to the third quartile is similar to the evolution

Table 4: Adoption of Innovation: Probit with Instrumental Variables (Equation 2)

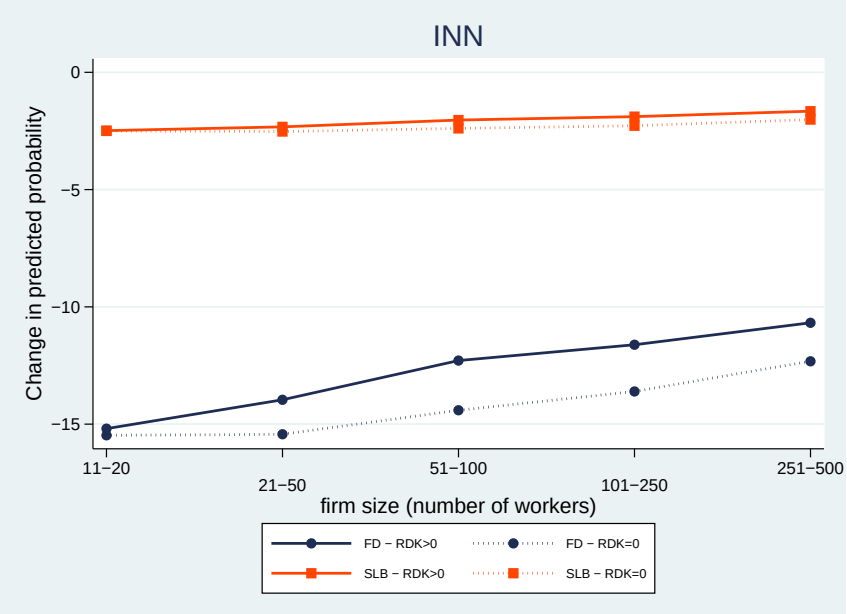
$Pr(INN)$	(1)	(2)	(3)	(4)
FD_KM	-0.223**	-0.269***	-0.220**	-0.275***
	[0.089]	[0.092]	[0.089]	[0.093]
$FD\_KM \times RDK$		3.030***		3.894***
		[1.084]		[1.191]
Sh_LB	-0.003	-0.004	-0.003	-0.003
	[0.005]	[0.005]	[0.005]	[0.005]
$Sh\_LB \times RDK$			-0.003	-0.053
			[0.044]	[0.048]
OP	-0.086	-0.114	-0.082	-0.113
	[0.130]	[0.131]	[0.129]	[0.131]
HHI	0.609**	0.592**	0.596**	0.570**
	[0.274]	[0.276]	[0.273]	[0.275]
RDK	4.900***	-5.062	5.149***	-5.475
	[0.366]	[3.559]	[1.996]	[3.706]
ROI	0.008***	0.007***	0.008***	0.007***
	[0.002]	[0.002]	[0.002]	[0.002]
$EXPORT$	0.218***	0.215***	0.217***	0.215***
	[0.038]	[0.039]	[0.038]	[0.039]
$WORKERS_{21-50}$	0.227***	0.222***	0.226***	0.220***
	[0.040]	[0.041]	[0.040]	[0.041]
$WORKERS_{51-100}$	0.451***	0.454***	0.453***	0.456***
	[0.050]	[0.050]	[0.050]	[0.050]
$WORKERS_{101-250}$	0.570***	0.572***	0.570***	0.574***
	[0.059]	[0.059]	[0.059]	[0.059]
$WORKERS_{251-500}$	0.705***	0.702***	0.703***	0.701***
	[0.081]	[0.081]	[0.081]	[0.081]
Observations	7175	7175	7175	7175
Wald test	0.000	0.000	0.000	0.000
Sargan test	0.230	0.317	0.241	0.341
Regional dummies	0.006	0.004	0.006	0.004

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Additional instruments include CCB36 SB36 OP36 Sh_LB36 and FD_KM71 (when FD_KM is included among regressors). The variable WORKERS is split into five categories, with the reference category being 11–20 employees. Each regression includes (3) wave, (21) sector and (18) regional dummies and a constant, not shown for reason of space. All tests report p–values.

remarkable drop in the predicted probability of introducing innovation. This effect is stronger as the firm size becomes smaller, producing a reduction of more than 15% for firms with 11–20 employees. As stated above, the negative impact of functional distance on the attitude to innovate is lower for firms investing in R&D and the difference in firms that do not carry out R&D is more apparent for those of average size (51–100 employees). Summarizing, the firms which are most penalized in their innovation effort by the functional distance of the local banking system are the smaller firms not investing in R&D, whose predicted probability of adopting innovations decreases from 52% (first quartile of

actually experienced by FD_KM between 1995 and 2003 in the province of Parma, and it is also similar to the difference in 2003 between Brescia (first quartile) and Parma (third quartile) in 2003.

Figure 2: Changes in predicted probability due to variation in FD_KM and Sh_LB on innovation:



Notes: The diagram plots the effects of a variation from the first to the third quartile of FD_KM and Sh_LB on $Pr(INN)$, based on the estimates of column 4 of Table 4, by firm size.

FD_KM distribution) to 37% (third quartile).

As a second step, we distinguish process and product innovations. As suggested by the recent literature (Benfratello et al. 2007, Ferri and Rotondi 2006, Herrera and Minetti 2007), typically the former aims to reduce production costs and typically entails new machinery requiring fixed investments and external finance, while the latter aims to improve product characteristics and entails a lower amount of fixed costs. In principle, it is ambiguous which type of innovation should be more damaged by bank organizational diseconomies. On the one hand, by reducing loans to innovation, hierarchical banks would be especially detrimental to process innovation. On the other hand, by shying away from relation–based lending, hierarchical banks would discourage the innovative vein of their clients, thereby hindering the introduction of product improvements.

Interestingly, the estimation results displayed in Table 5 suggest a differentiated effect of the distance and number of hierarchical levels. The coefficient of FD_KM is negative for both process and product innovations (columns (1) and (3)), but it is statistically significant only for the former. By contrast, the market share of large banks is negatively associated with the probability of introducing product innovations, while it has no effect on the likelihood of adopting process innovations, consistent with the aversion of large banks to relation-based activities. When we discriminate the impact of the organizational variable for the degree of firm's engagement in R&D, the interaction terms are significant, and with a positive sign, only for product innovations. Moreover, FD_KM becomes significant also for product innovations and with an economic impact quite greater than Sh_LB. The market share of large banks further decreases the probability of introducing product innovation while it has no effect on the likelihood of adopting process innovation.

Table 5: Adoption of Process and Product Innovation: Probit with Instrumental Variables (Equation 2)

	$Pr(PROCESS)$		$Pr(PRODUCT)$	
	(1)	(2)	(1)	(2)
FD_KM	-0.204**	-0.228**	-0.156	-0.206**
	[0.086]	[0.089]	[0.095]	[0.099]
$FD\_KM \times RDK$		1.295		2.368***
		[0.805]		[0.851]
Sh_LB	0.001	0.003	-0.016***	-0.014**
	[0.005]	[0.005]	[0.006]	[0.006]
$Sh\_LB \times RDK$		-0.049		-0.064*
		[0.035]		[0.038]
OP	0.107	0.103	-0.300**	-0.317**
	[0.122]	[0.123]	[0.141]	[0.142]
HHI	0.594**	0.579**	0.351	0.340
	[0.253]	[0.252]	[0.290]	[0.291]
RDK	2.333***	0.316	3.739***	-1.153
	[0.270]	[2.588]	[0.289]	[2.640]
ROI	0.010***	0.010***	0.002	0.002
	[0.002]	[0.002]	[0.002]	[0.002]
$EXPORT$	0.135***	0.134***	0.340***	0.338***
	[0.037]	[0.038]	[0.044]	[0.044]
$WORKERS_{21-50}$	0.190***	0.188***	0.283***	0.279***
	[0.040]	[0.040]	[0.047]	[0.047]
$WORKERS_{51-100}$	0.398***	0.399***	0.425***	0.425***
	[0.048]	[0.048]	[0.054]	[0.054]
$WORKERS_{101-250}$	0.506***	0.506***	0.593***	0.596***
	[0.055]	[0.055]	[0.061]	[0.061]
$WORKERS_{251-500}$	0.678***	0.679***	0.726***	0.729***
	[0.074]	[0.074]	[0.078]	[0.078]
Observations	7603	7603	7175	7175
Wald test	0.000	0.000	0.000	0.000
Sargan test	0.958	0.961	0.522	0.447
Regional dummies	0.000	0.000	0.065	0.060

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Additional instruments include CCB36 SB36 OP36 Sh_LB36 and FD_KM71 (when FD_KM is included among regressors). The variable WORKERS is split into five categories, with the reference category being 11–20 employees. Each regression includes (3) wave, (21) sector and (18) regional dummies and a constant, not shown for reason of space. All tests report p–values.

The validity of instruments is still verified in all specifications.

Finally, in Table 6 we report the results of the ordered probit model. In this case, since we do not employ instrumental variable techniques, we are able to report marginal effects for the explanatory variables calculated at their sample averages. The results confirm those discussed above. Control variables are still significant, with RDK and firm size being the variables with the greatest marginal effects. This is especially true for the two extreme categories of WORKERS: as regards the smallest class of businesses, having more than 250 employees raises the probability of adopt innovation by 16%, while it reduces the likelihood of not innovating at all by 17.4%.

Table 6: Adoption of Process and Product Innovation: Ordered Probit model

	PROD & PROC	PROD / PROC	NO INN
FD_KM	-0.010**	-0.006**	0.016**
	[0.005]	[0.003]	[0.008]
$FD\_KM \times RDK$	0.174**	0.101**	-0.274**
	[0.069]	[0.040]	[0.109]
Sh_LB	-0.000	-0.000	0.000
	[0.000]	[0.000]	[0.001]
$Sh\_LB \times RDK$	-0.004	-0.002	0.006
	[0.005]	[0.003]	[0.008]
OP	0.006	0.004	-0.010
	[0.006]	[0.003]	[0.009]
HHI	0.020**	0.012**	-0.031**
	[0.009]	[0.005]	[0.014]
RDK	0.438*	0.254*	-0.692*
	[0.234]	[0.136]	[0.370]
ROI	0.002***	0.001***	-0.003***
	[0.000]	[0.000]	[0.001]
$EXPORT$	0.057***	0.039***	-0.096***
	[0.008]	[0.007]	[0.014]
$WORKERS_{21-50}$	0.062***	0.032***	-0.094***
	[0.009]	[0.004]	[0.012]
$WORKERS_{51-100}$	0.129***	0.041***	-0.169***
	[0.012]	[0.003]	[0.013]
$WORKERS_{101-250}$	0.186***	0.033***	-0.219***
	[0.016]	[0.004]	[0.014]
$WORKERS_{251-500}$	0.254***	0.006	-0.260***
	[0.027]	[0.010]	[0.018]
Observations		7175	
R^2		0.068	
Log–Likelihood		-6972	
χ^2		1359	

Notes: Marginal effects, calculated at sample means, are reported. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors (in brackets) are corrected for intragroup ($province * wave$) correlation. The Table reports the marginal effects calculated at the averages (for dummy variables the coefficient is for discrete change from 0 to 1). The coefficients for (3) wave, (18) geographic and (21) industry dummies not shown for reasons of space. All tests report p–values.

As regards the market-level variables, the degree of concentration is still significant with a positive effect on fostering the adoption of innovations, while OP has no significant impact. Moving on to the organizational variables, once again the estimates suggest that only functional distance impacts on the probability to introduce innovation, while the share of large banks is not statistically influential. The marginal effect of FD_KM for the average firm is almost twice as great for the likelihood to introduce product and process innovations together than for one of them taken singularly. The effect of organizational frictions arising from distance is considerably reduced for firms investing in R&D: the marginal effect of FD_KM on the probability of introducing product and process innovation decreases from -0.010 ($RDK = 0$) to -0.007 for a firm with an average level RDK intensity and to almost zero for a firm at the 90^{th} percentile of RDK distribution.

Similar results hold for the probability of introducing only one type of innovation.

5 Credit Rationing

5.1 Methodology

The negative impact of bank organizational friction, in particular of the functional distance of the local banking system, on the probability of adopting an innovation might be the consequence of two different hierarchical structures. It might be due to the indifference of functionally distant and large banks in encouraging their small borrowers to innovate. However, it might also manifest in higher financial constraints levied by hierarchical banks on firms that wish to introduce innovations. In this latter case, innovative firms in provinces with a local banking system that has great organizational frictions should be relatively more credit–rationed than innovative firms in other provinces. Otherwise, the organizational structure of the local banking system would act on a more general level by reducing the ability of firms to see innovation opportunity and assess its economic benefits.

To disentangle these two channels of influence, we estimate a probit model for the probability of being credit–rationed:

$$\begin{aligned} Pr(RAT_{i,j}) = f(&FD\_KM_j, Sh\_LB_j, FD\_KM_j \times INN_j, \\ &Sh\_LB_j \times INN_j, BANKING - DEV_j, FIRM_i) \end{aligned} \tag{3}$$

where we interact our organizational variables with the indicator variable for innovation INN. Then we control for the same local bank development variables as in equation 2, and for firm–specific characteristics including WORKERS classified by five size classes, ROI, the degree of leverage (DEBT), multiple lending relationships (ML), and the degree of innovation of the firm (INNOVATION). Dummy variables for industries, macro-regions and waves are also included.

As for the innovation model 2, to address endogeneity and omitted variable problems we run IV estimations, by instrumenting banking variables with the same instruments described above in Section 4.1.

5.2 Results

In Table 7 we report IV estimation results of equation 3. With respect to the specification of the model, the first stage estimates and the Sargan test suggest that the instrument set is valid.

Control variables are generally statistically significant and with the expected signs. Firm size is negatively associated with the probability of credit rationing, even if this relationship does not appear to be strictly linear: firms employing from 50 to 100 workers are not significantly less rationed than the smallest firms with less than 20 workers, taken as the reference category, while for the other firms the greater the size class to which the belong, the lower is the probability of being rationed. We then find evidence that less indebted and more profitable SMEs are less credit-rationed, while a multiple lending

Table 7: Credit Rationing: Probit with Instrumental Variables (Equation 3)

Dep.Var.: $Pr(RAT)$	(1)	(2)	(3)	(4)
FD_KM	0.540**	0.542**	0.563**	0.600**
	[0.233]	[0.247]	[0.248]	[0.259]
$FD\_KM \times INN$		0.028**		-0.057
		[0.014]		[0.103]
Sh_LB	0.022*	0.021	0.019	0.017
	[0.013]	[0.013]	[0.013]	[0.014]
$Sh\_LB \times INN$			0.003**	0.007
			[0.001]	[0.009]
OP	0.419	0.419	0.424	0.426
	[0.284]	[0.300]	[0.300]	[0.301]
HHI	-1.142**	-1.208**	-1.219**	-1.228**
	[0.443]	[0.486]	[0.487]	[0.488]
$INNOVATION$	0.002**	0.002*	0.002	0.002
	[0.001]	[0.001]	[0.001]	[0.001]
ROI	-0.017***	-0.018***	-0.018***	-0.018***
	[0.003]	[0.003]	[0.003]	[0.003]
$DEBT$	0.250***	0.251***	0.251***	0.251***
	[0.020]	[0.020]	[0.020]	[0.020]
ML	0.002	0.003	0.003	0.003
	[0.008]	[0.008]	[0.008]	[0.008]
$WORKERS_{21-50}$	-0.111**	-0.113**	-0.115**	-0.116**
	[0.053]	[0.055]	[0.055]	[0.055]
$WORKERS_{51-100}$	0.005	-0.006	-0.008	-0.008
	[0.070]	[0.073]	[0.073]	[0.073]
$WORKERS_{101-250}$	-0.127	-0.118	-0.122	-0.122
	[0.088]	[0.094]	[0.094]	[0.094]
$WORKERS_{251-500}$	-0.309**	-0.273**	-0.278**	-0.281**
	[0.128]	[0.135]	[0.135]	[0.135]
Observations	7346	6919	6919	6919
Wald test	0.000	0.000	0.000	0.000
Sargan test	0.219	0.162	0.163	0.169
Geo dummy	0.029	0.030	0.030	0.033

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Additional instruments include CCB36 SB36 OP36 Sh_LB36 and FD_KM71 (when FD_KM is included among regressors). The variable WORKERS is split into five categories, with the reference category being 11–20 employees. Each regression includes (5) wave, (21) sector and (5) geographic dummies and a constant, not shown for reason of space. All tests report p–values.

relationship (ML) does not have a significant effect on the probability of rationing. However, the positive coefficient of ML, which proves significant once organizational variables are excluded, suggests that multiple lending engenders free riding behavior or Winner's Curse problems that deter each lending bank from supporting the additional financing needs of the firm[16].

As regards the structural characteristics of local credit markets, once again the results suggest a beneficial effect of the Herfindhal index on SMEs, it being negatively associated with the likelihood of credit rationing. The number of branches per capita (OP), instead,

[16]Similar results were found by Angelini et al. (1998), Alessandrini et al. (2006).

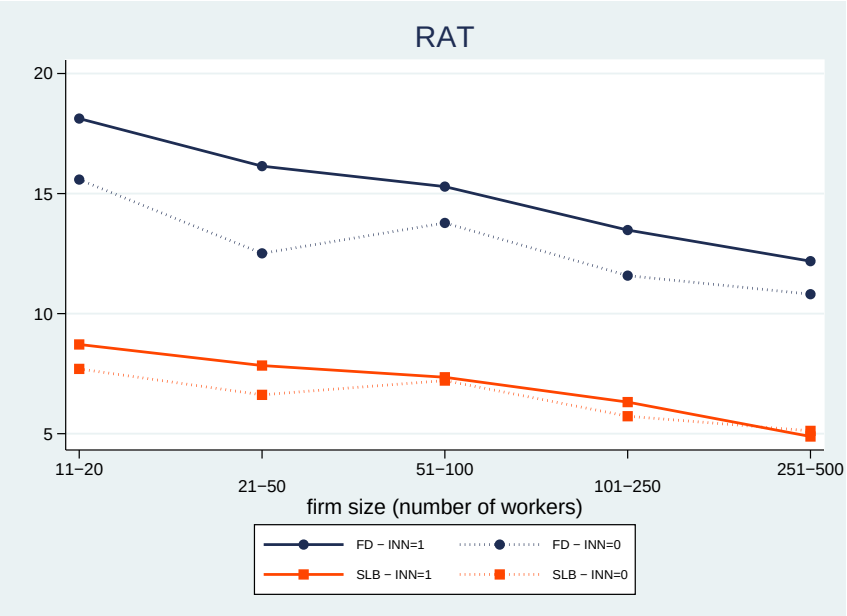
has a positive but not statistically significant effect on RAT. This finding differs from results in Alessandrini et al. (2006) who, however, do not control for the share of large banks and do not correct for the endogeneity bias.

Moving on to the organizational variables, the evidence shows that both the market share of large banks in local credit markets and the functional distance of the local banking system make financing constraints to SMEs more binding (column (1)). In columns (2) and (3) we add, separately, the interaction term between FD_KM and Sh_LB and the indicator variable INN for firms which introduced product and/or process innovations. In both cases, the effect of organizational frictions is exacerbated for SMEs that adopted innovations. This result holds even when controlling for the share of sales coming from innovative products (INNOVATION), whose autonomous effect on $Pr(RAT)$ is sometimes only slightly significant. As we stated, this finding is consistent with the idea that the adverse effect of organizational diseconomies on innovation adoption acts through the financial constraints hierarchical banks impose on innovative firms.

When we add both the interaction terms (column (4)), they lose statistical significance as well as the variable INNOVATION. Given the high correlation between the two interaction variables (0.88), this result can be reasonably ascribed to collinearity problems. In any case, the adverse effect of FD_KM on rationing is once again confirmed.

With respect to financing constraint, we replicate the experiment made for the probability of innovation and compute, alternatively, the impact of a change in FD_KM and Sh_LB from the first to the third quartile of its distribution (Figure 3). As for innovation, the negative economic impact of distance between hierarchical levels on financing constraints to SMEs tends to be much greater than that of bank size. To illustrate this point, the increase in FD_KM raises the probability of being rationed for the smaller innovative firms by around 18% and for larger ones by 12%. Following a similar change in Sh_LB the effect on the predicted probability of being rationed is halved, ranging from 5% to almost 9% according to firm size. For non–innovative firms, the effect of organizational diseconomies related to bank-branch distance is lower than for innovative firms, especially when we look at smaller businesses, while the economic magnitude of diseconomies related to bank size is broadly the same for both types of firms. This suggests that organizational frictions linked to the distance and number of hierarchical levels tend to manifest their adverse effect on SMEs' innovation propensity in different ways.

Figure 3: Changes in predicted probability due to variation in FD_KM and Sh_LB on rationing:



Notes: The diagram plots the effects of a variation from the first to the third quartile of FD_KM and Sh_LB on $Pr(RAT)$, based on the estimates of columns 2 and 3 of Table 7, by firm size.

6 Conclusions

A crucial issue left largely unexplored by the recent literature on hierarchy liability is the basic source of organizational frictions driving the difficulties in information–intensive lending or, put differently, how to measure the degree of hierarchy. Some authors emphasize the size of the bank, implicitly suggesting that the degree of hierarchy pertains to the bank as a whole, depending on the number of intrabank hierarchical levels (Stein 2002, Berger et al. 2005, Degryse et al. 2006). Others, instead, stress the role of the distance between the local branch, where information on borrowers is collected, and the bank's headquarters, where the decision–making authority is located (Alessandrini et al. 2006, Jimenez et al. 2007). In this case, the degree of hierarchy pertains to the specific bank–firm relationship, in that it depends on the location of the lending branch.

In this paper, we conducted our analysis at the aggregate level. We contrasted the effect of bank size and bank–branch distance on innovation adoption by SMEs by constructing two indicators of hierarchy in a local (provincial) banking system, functional distance and size structure. Our results show that the distance between bank decisional authorities is the main organizational feature accountable for the negative impact of hierarchy on innovation financing. More specifically, the functional distance of the local banking system is significantly and negatively associated with the likelihood of local SMEs introducing innovations. This adverse effect operates through the tighter financing constraints that innovative firms experience in provinces with a functionally distant banking system. The hindering effect of the size structure of the local banking system on innovation adoption is much weaker and restricted to product innovations.

In closing, our findings convey two main policy-oriented messages. First, at the aggregate level, they advise against blanket, undifferentiated policies promoting bank consolidation, while they are sympathetic with "regional champion" policies. A thoughtful appraisal of the changes in the geography of local banking systems following the process of merger and acquisitions should balance the benefits of having more efficient and competitive banks with the costs of organizational diseconomies due to the increasing complexity of banking structures. The concentration of bank decisional authority in a restricted number of financial centers has proved to be especially harmful for local economies with their systems of small enterprises, little involved in proper R&D activity. The presence of a strong local bank competitor seems to be critical for sustaining innovative efforts of local SMEs, for lending to informationally opaque borrowers and, more generally, for focusing banking competition on the needs of local economic development. In addition, on increasing the spatial concentration of banking power, it appears urgent to design policies supporting the development of other sources of soft-information-based external financing like venture capitalists, business angels, financial incubators, etc., complementing the lending activity of banks towards innovative SMEs.

The second policy indication is at the bank level. The negative impact of banking hierarchy on soft information firms/projects can be reduced by a more decentralized organization, adapting to the different needs of firms operating in different local systems. Such a flexible approach in bank organization would provide advantages to innovative SMEs, penalized in their financial needs when examined by distant bank centers. What is required is a change in emphasis in bank organization from the search for economies of scale by using standardized, arm's–length lending technologies, to economies of scope by making specialized credit instruments available to the more dynamic innovative SMEs. Once again, therefore, it is not a matter of bank size, but rather of bank strategy and organizational structures.

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A List of variables

FD_KM, by province, is a measure of functional distance, computed as the ratio of branches weighted by the logarithm of 1 plus the kilometric distance between the province of the branch and that where the parent bank is headquartered, over total branches in province j (see Section 3 for details). Source: authors' calculations on Bank of Italy data.

Sh_LB, by province, is computed as the ratio of branches owned by large banks to the total number of branches operating in each province. Source: authors' calculations on Bank of Italy data.

OP, by province, is an indicator of operational proximity, computed as the number of bank branches in province j per 10,000 inhabitants (see Section 3 for details). Source: authors' calculations on Bank of Italy and ISTAT data.

HHI, by province, is the Herfindahl–Hirschman Index (ranging from zero to one) calculated on the number of branches in province j. Source: authors' calculation on Bank of Italy data.

$PRODUCT$, by firm, is a dichotomous variable which is equal to one if the firm introduced a product innovation in the three-year period covered by each survey. Source: MCC Surveys.

$PROCESS$, by firm, is a dichotomous variable which is equal to one if the firm introduced a process innovation in the three-year period covered by each survey. Source: MCC Surveys.

$INNOVATION$, by firm, is the percentage of sales coming from an innovative product. Source: MCC Surveys.

$R\&D$, by firm, is a dichotomous variable which is equal to one if the firm made expenditures on Research and Development in the three-year period covered by each survey. Source: MCC Surveys.

RDK, by firm, is the ratio between investments in R&D in year t and total capital stock at the end of year t–1. Source: Balance sheet data and MCC Surveys.

RAT, by firm, is a dichotomous variable which is equal to one if the firm states it is credit rationed and zero otherwise. Source: MCC Surveys.

ROI, by firm, is the Return on Investment, computed as gross operating earnings on invested capital. Source: Balance sheet data in MCC Surveys.

$DEBT$, by firm, is the measure of leverage, calculated as the logarithm of (1 + Debt–equity ratio). Source: Balance sheet data in MCC Surveys.

ML, by firm, is the number of banks with which the firm does business. Source: MCC Surveys.

$WORKERS$, by firm, is the number of workers. Source: MCC Surveys.