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The Impact of Organizational Structure and Lending Technology on Banking Competition*

HANS DEGRYSE[1], LUC LAEVEN[2] and STEVEN ONGENA[3]
[1]*CentER – Tilburg University, TILEC and CESifo;* [2]*International Monetary Fund, CEPR and ECGI;* [3]*CentER – Tilburg University and CEPR*

Abstract. We investigate how bank organization shapes banking competition. We show that a bank's geographical lending reach and loan pricing strategy is determined by its own and its rivals' organizational structure. We estimate the impact of organization on the geographical reach and loan pricing of a large bank. We find that the reach of the bank is smaller when rival banks are large and hierarchically organized, have superior communication technology, have a narrower span of organization, and are closer to a decision unit with lending authority. Rival banks' size and the number of layers to a decision unit soften spatial pricing.

JEL Classification: G21, L11, L14

1. Introduction

The allocation of control within organizations shapes agents' incentives (see e.g. Grossman and Hart, 1986 and Hart, 1995). Although banks are often organized as complex organizations, organizational theories of the firm have only recently been applied to the banking industry. Stein (2002) shows that a centralized hierarchical

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bank offers greater incentives to employ information that is easy to communicate and store within an organization – "hard" information – whereas, in contrast, a decentralized bank provides an environment advantageous to "soft" information. Petersen and Rajan (2002) document that banks that rely more on hard information communicate in more impersonal ways with their borrowers. Hence, the bank's mode of organization influences the type of information used and the lending technology employed.[1]

In addition to organizational setup, distance-related transportation costs also play a role in banking relationships. Banks derive market power from their physical proximity to borrowers. Banks located closer to borrowing firms have lower transportation costs and monitoring costs (Petersen and Rajan, 1995).[2]

We present a stylized model of bank competition that incorporates differences in distance-related transportation costs arising from heterogeneity in organizational structure in a Hotelling (1929) framework. Our model incorporates how bank hierarchy influences distance-related transportation costs incurred by either borrowers or banks, and how differences in bank's communication technology affect branch reach. In the model, banks can perfectly price discriminate their interest rates between borrowers depending on the borrower's location. The model shows that the organizational structure of a bank and its rivals shape its geographical reach and spatial pricing in lending. In particular, when rival banks are more hierarchically layered, the bank's own geographical reach shrinks and spatial pricing softens. The underlying rationale is that hierarchically organized rival banks employ more hard information in reaching their loan decisions, reducing either the borrowers' or their own transportation costs. Also, differences in communication technology between the bank and its rivals affect geographical reach.

To test the key hypotheses emanating from our theory, we combine two unique data sets that contain detailed loan contract, firm, branch and bank information, including information about the organizational form of each bank. The first data set contains detailed contract information, including firm and lending branch location, for more than 15,000 loans of a large bank in Belgium. The second data set includes comprehensive information on all 145 banks operating in Belgium, detailing for 7,477 branches of these banks: (1) physical location, (2) organizational position

[1] Aghion and Tirole (1997) show that the amount of communication in an organization depends on the allocation of authority, suggesting that the information generated at a bank branch depends on the extent to which authority has been delegated to this branch. For a sample of large U.S. firms, Rajan and Wulf (2006) find that organizations have reduced the number of management layers and become flatter in recent years, with more authority being delegated to division managers.

[2] Recent work has indeed found that banks can charge higher loan rates to firms when their branches are located nearby and when alternative providers of finance are further away (see for example Petersen and Rajan (2002), Mallett and Sen (2001), and Bharath, Dahiya, Saunders and Srinivasan (2007)).

and status, and (3) communication technology. The combined dataset encompasses information on the complete set of loans granted to small and medium-sized business borrowers by a single large bank in Belgium, the lending branch's position in the bank's organization, and the organization structure of all the branches of rival banks in the vicinity of the borrower's location, resulting in around 250,000 borrower–rival bank branch observations.

We exploit the heterogeneity in banks' organizational structure to identify the impact of lending technology on the geographical reach and spatial pricing at bank branches. We construct two types of empirical proxies for organizational complexity. The first are bank-specific and identify heterogeneity in rival banks' size and degree of organizational hierarchy. The second are branch-specific characteristics and include the span of organization and the number of levels to a decision unit (telex), capturing the degree to which lending authority has been delegated, and the presence of a fax, capturing the lending technology at each branch. We include local market and bank-firm relationship characteristics to control for the relationship orientation of each individual branch (as in Petersen and Rajan, 1995 and Degryse and Ongena, 2007).

While bank organization itself is in principle centrally determined, and hence exogenous to the reach and price decisions taken at the branch level, bank organization may respond to local circumstances or organizational type may affect entry into local banking markets. Such an endogenous relationship between the banks' organizational structure and the business environment may affect the relationship between organization and spatial pricing of loans that we are interested in. We therefore also estimate instrumental variable models.

We find that the banks' organizational form matters for both branch reach and the degree of spatial pricing. The presence of a large and more hierarchically organized rival bank shrinks the geographical reach of the lending branch, as lending decisions of large banks possibly are more driven by hard information. Also, when branches of rival banks exhibit a greater organizational span of control (relative to the lending branch) and are further removed from a unit with lending authority (as captured by a greater number of layers to telex), the geographical reach of the lending branch increases. The presence of rival banks that are large, have a large span of organization, and have many layers to the telex attenuates spatial pricing. Hence, organizational form of the lending branch, and size and hierarchy of rival banks in the vicinity of a borrower, determine geographical reach and loan pricing.

Empirical work analyzing how the nature of a bank's organization affects the way it does business typically suffers from a lack of data on the organizational form of the banks. Existing work typically uses the size of the bank as a proxy for organizational complexity. Berger, Miller, Petersen, Rajan and Stein (2005), for example, show that small banks are indeed better able to collect and act on soft information. They also report that large banks lend at greater distance and in a more impersonal way than small banks do. Liberti (2004) examines how a change in the organizational form *within* a large bank affects incentives. He finds that the reliance on soft information is higher under decentralized structures. Liberti (2005) analyzes how information flows *within* the organization both across layers and horizontally. He demonstrates that loan applications that pass more organizational layers for approval are based on more hard information. Canales and Nanda (2008) investigate how bank structure determines the terms of lending to small businesses. They employ data from interviews to classify banks as having centralized or decentralized hierarchies, and find that decentralized banks charge higher loan rates in more concentrated markets. However, none of this work takes into account the rivals' organizational structures in the lending decisions. We contribute to this literature by constructing and analyzing a novel dataset that contains information on the hierarchical structure of all banks in one market (Belgium), and by highlighting the role of rival banks' organizational form.

We organize the rest of the paper as follows. Section 1 introduces a stylized model of banking competition. Section 2 introduces the data and variables employed in the empirical analysis. Section 3 presents our empirical results. Section 4 concludes.

2. Model

We model and explore the impact of bank heterogeneity on bank branch reach and loan pricing. We develop a stylized model in which firms can borrow at branches from different banks. Banks themselves differ in their organizational form which influences their comparative advantage in dealing with hard or soft information. Our theoretical model takes the organizational form of the bank and its branch as exogenously given.[3] We then formulate testable hypotheses about the impact of bank type on branch reach and loan pricing. In particular, our model identifies how distance-related costs that are bank (and branch) specific further increase the economic relevancy of geography and spatial pricing.

Our main point of departure is that lending conditions not only depend on the distance between borrower and lender and the distance between borrower and closest competing bank, but also on the characteristics of the banks involved. Our stylized framework builds on location differentiation models following Hotelling (1929) (see Armstrong (2006) for a review). In these models, customers are typically

[3] In models of endogenous hierarchies (such as Garicano, 2000), the impact of lower information costs on the hierarchical structure of firms is in general ambiguous. On the one hand, lower information costs reduce the informational burden of very hierarchical organization, but on the other hand, they also allow for a greater span of the organization.

assumed to incur identical (per unit of distance) transportation costs when visiting the firm.[4,5]

Why would borrower or lender transportation costs depend on the type or organizational form of banks involved? One straightforward explanation consists in the number of visits the borrower has to make to the bank branch to obtain and service a loan. For example, if a borrower knows her loan officer at the branch will insist on three face-to-face visits before granting the loan (say one visit to file the loan application, one visit to negotiate the loan conditions, and one visit to sign the final loan contract), her expected transportation costs will be three times the costs visiting a one-stop bank branch were loan applications are approved on the spot (or by mail afterwards).

Recent theoretical work explains why loan officers working for different banks may handle loan applications differently, causing the number of required visits to vary. Stein (2002), for example, models the collection and transfer of information within hierarchical versus decentralized financial institutions. Stein shows that centralization motivates loan officers located in the branches to compile and transfer hard information (e.g., accounting numbers and default history) to support their demand for internal capital. Decentralization of decision-making on the other hand provides loan officers incentives to collect and rely more on soft information (e.g., impressions of borrower character), information that is more difficult to obtain and transfer in an internal funding request.

If loan officers rely mostly on hard information, face-to-face contact with the borrower becomes less important and more impersonal ways of communicating (such as telephone, fax, or email) will gain ground (Petersen and Rajan, 2002).[6] The number of visits necessary to arrive at a loan decision will become smaller. On the other hand, when more soft information is employed, loan officers may want to

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4 An alternative, but for our purposes strikingly similar, interpretation is developed in Sussman and Zeira (1995). They model spatial pricing based on distance-related monitoring costs faced by the banks. In their model the banks also face identical per unit of distance monitoring costs. While we will formally derive our hypotheses placing the (differential) transportation costs with the borrower, as is done in most models, we also acknowledge the equivalent interpretation in which, as said, it is the lenders that face the distance-related monitoring costs.

5 In banking, in addition to the physical transport cost interpretation we employ in this paper, location models are also often used as an approximation to consumer tastes and horizontal differentiation stemming from specialization in different kinds of loans and services. Furthermore, models of spatial competition are a convenient way to introduce market power in the analysis (see Dell'Ariccia, 2001).

6 Petersen and Rajan (2002) show that in the case of the US, where credit scoring of small business borrowers has become common practice among banks, the distance between small firms and their lenders has been increasing and banks and firms started to communicate in more impersonal ways. In Belgium, however, credit scoring of small firms was virtually non-existent during our sample period (1995–1997), and hence distance still plays an important role for the firms in our sample.

meet the applicant at least a few times to screen the loan application. In this case, distance related costs per loan will be higher.

We introduce different transportation costs into our stylized framework, in which banks can perfectly price discriminate along the borrower's location, to explore its impact on bank branch reach and loan pricing. Our stylized framework assumes that when the transportation costs are incurred, bank officers perfectly solve the asymmetric information problem. We therefore assume that loans are repaid with probability one (as long as the probability of repayment is identical across borrowers and banks, qualitatively the same results hold).[7] Different transportation costs capture the differences in the number of visits borrowers make, partly as a result of the varying bank organizational structure influencing the banks' usage of hard and soft information. We analyze branch reach and loan pricing when firms differ in terms of location, but banks' organizational form implies differences in a bank's usage of hard and soft information.[8]

Formally we assume there are two bank branches from two different banks, denoted A and B, at opposite ends of a line of length L. Borrowers are uniformly distributed across the line with density one. We assume that a borrower located at x faces non-linear transportation costs $t_A x^\alpha$ and $t_B(L-x)^\alpha$ in visiting branch A and B respectively. The slope parameters t_A and t_B are associated with the impact of distance to reach branch A and B, respectively. The parameter α is assumed to be positive. Linear and quadratic transportation costs, for example, happen when α equals 1 or 2, respectively. Bhaskar and To (2004) derive the solution to this non-linear transportation problem for the case where the slope parameters are equal, i.e., $t_A = t_B$. We study the more general case $t_A \neq t_B$, with the difference capturing the fact that branches may have different screening technologies and may rely on a different mix of hard and soft information.

[7] Hauswald and Marquez (2006) specify a model where the quality of information decreases with distance and informational problems linger. In their model the informational signal the bank receives from close borrowers is more precise than the signal from far borrowers. As a consequence the winner's curse problem exacerbates when the bank engages a borrower close to the rival bank. Banks also decide on the level of information acquisition. More information acquisition aggravates the winner's curse problem and increases the association between distance and the loan rate. Their model deals with symmetric equilibria in which banks invest an equal amount in information acquisition. As a result their "transportation costs" are identical, while we allow for differences in transportation costs.

[8] In the Supplement to this paper (that is located at http://www2.wu-wien.ac.at/rof/supmat.html) we develop an extension where the usage of hard and soft information is more valuable for different types of firms. For example, soft information may be more important for risky and innovative firms. In this way, location is also a matching component as distant firms with a hard information advantage will be more inclined to transact with a hierarchical bank using hard information than equally distant firms with a soft information advantage.

In taking a loan at branch A, a borrower located at x incurs a cost $r_{Ax} + t_A x^{\alpha}$, with r_{Ax} the (net of repayment of the initial investment) loan rate charged by branch A to a borrower located at x. Similarly, borrowing from branch B implies a cost $r_{Bx} + t_B(L - x)^{\alpha}$. A borrower located at x is indifferent between borrowing from A or B when $r_{Ax} + t_A x^{\alpha} = r_{Bx} + t_B(L - x)^{\alpha}$.

We assume that borrowers cannot arbitrage among each other in order to benefit from lower loan rates and that their willingness to pay is high enough to guarantee they take a loan in equilibrium. We further assume that both branches have information about the borrower's location before pricing the loan and that both branches have information about the transportation costs the borrowers face to visit either bank, such that branches perfectly price discriminate based upon borrower's location and the difference in transportation costs to visit either bank branch (as in Thisse and Vives, 1988).[9]

For a borrower close by, i.e., $x = 0$, branch A enjoys some local market power, as from the borrower's perspective branch B's best loan rate offer is its marginal cost of obtaining funds plus her own transportation costs to B. We normalize marginal costs for both branches to zero, and assume the same willingness to pay for obtaining a loan at both branches. Later we will relax this assumption to deal with issues of organizational span and internal swiftness. For zero marginal costs at both branches, it is clear then that branch A can charge $r_{A0} = t_B L^{\alpha}$. That is, branch A can appropriate the borrower's transportation cost to branch B. This gives branch A some local market power over borrowers located closer to its branch. Similarly, for $x = L$, branch B charges $r_{BL} = t_A L^{\alpha}$ and appropriates that borrower's transportation cost to branch A.

Let y be the borrower that receives a perfectly competitive loan rate $r_{Ay} = r_{By} = 0$, as: $t_A y^{\alpha} = t_B(L - y)^{\alpha}$. Neither branch A nor branch B enjoy some market power on the borrower located at y. All borrowers x to the left of y $(0 \leq x \leq y \leq L)$ are being serviced by branch A at a loan rate: $r_{Ax} = t_B\,(L - x)^{\alpha} - t_A x^{\alpha}$. That is, branch A charges a borrower at x the savings in transportation costs it makes from

[9] Our model starts from some simplifying assumptions such as a uniform distribution of borrowers and a functional form for transportation costs that is similar for all banks. In reality, however, both assumptions are likely to be violated. While with uniform pricing, the distribution of borrowers indeed affects the equilibrium loan rates, a non-uniform borrower distribution in our price discrimination setting does not modify the main insights from our model. The reasoning is that loan rates are borrower-specific and reflect only the transportation cost and marginal cost differences between the two banks (see e.g. Lederer and Hurter, 1986). The Supplement illustrates this differential pricing when (i) different borrowers at one location exhibit borrower-specific transportation costs, and (ii) borrowers face differential transportation costs in transacting with different banks. A similar result applies when considering non-uniform distributions of heterogeneous borrowers. Moreover, the distance to "furthest away borrower" of a particular type does not hinge on the assumption of a uniform distribution of borrowers. In our empirical setup, we therefore also run specifications where we study the distance to the furthest away customer.

borrowing at A rather than B, and therefore enjoys some market power over those borrowers.

Branch A's total borrower portfolio y or geographical reach is determined by $r_{Ay} = 0$, such that:

$$\frac{y}{L-y} = \left(\frac{t_B}{t_A}\right)^{1/\alpha}, \text{ or } y = \frac{L\left(\frac{t_B}{t_A}\right)^{1/\alpha}}{1+\left(\frac{t_B}{t_A}\right)^{1/\alpha}}.$$

es

For changes in x, the change in interest rate equals:

$$\frac{dr_{Ax}}{dx} = -t_B\alpha(L-x)^{\alpha-1} - t_A\alpha x^{\alpha-1}.$$

Hence, our stylized model yields two testable hypotheses: (1) the geographical reach y of branch A depends on t_A and on t_B, and (2) the slope of spatial pricing $\frac{dr_{Ax}}{dx}$ is negative and depends on t_A *and* t_B. Hypothesis (1) tells us that branch A's reach increases in the rival's transportation costs t_B but decreases in the own transportation cost t_A. The reasoning is that a higher rival's transportation cost or a lower own transportation cost increases branch A's market power as even further away borrowers find it optimal to transact at A. Hypothesis (2) states that the degree of spatial pricing measured by the absolute value of the slope increases in t_A *and* t_B.[10] Higher transportation costs give more market power to close by borrowers. Therefore market power decreases at a "higher speed" when borrowers are located further away and transportation costs are higher. Figure I illustrates these two testable implications of our model for linear transportation costs ($\alpha = 1$) and a line of unit length ($L = 1$).[11]

In sum, differential transportation and marginal costs determine branch geographical reach and loan pricing. In particular, relatively lower transportation costs to a rival bank branch limits the geographical reach of the own branch and the slope of spatial pricing, while higher marginal costs (or inferior technology) at a rival branch extends the own reach. We now turn to testing these theoretical predictions.

[10] In our empirical investigation, we assume logarithmic transportation costs. This yields similar predictions.

[11] An interesting extension sets the marginal cost for branch B equal to $\mu > 0$, while the marginal cost for branch A remains equal to zero. When branch B uses inferior technology, for example, or when its internal organization is such that it does not have the authority or capacity to make quick decisions on loan approvals, its μ would be positive. The market reach of branch A increases in the marginal cost differential μ. Put differently in terms of technology differences, branch reach increases in the technology differential between the own branch and the rival branch. On the other hand, although branch A now appropriates the close borrower's transportation cost to branch B *plus* the marginal cost differential, the rate at which both branches discriminate remains unaltered.

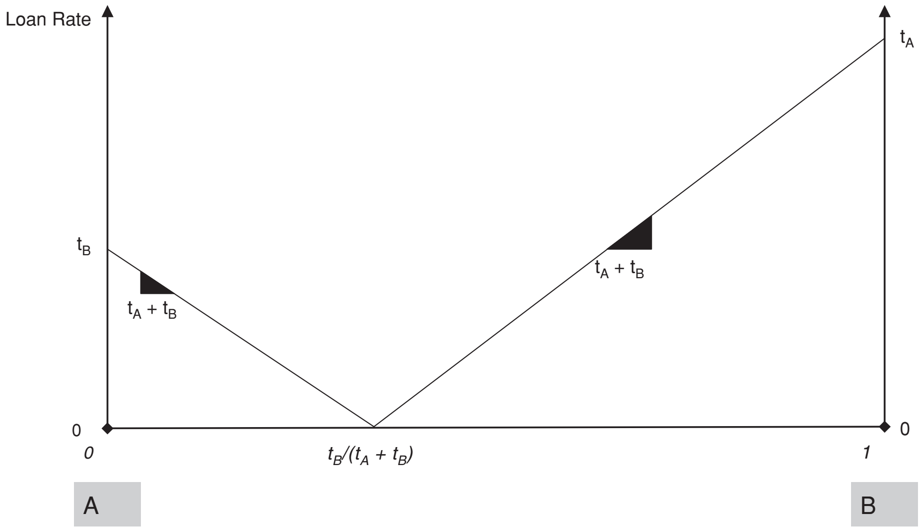

Figure I. Branch Spatial Pricing, Branch Reach, and Profitability.
The figure displays the impact of differential transportation costs on branch reach and branch spatial pricing for linear transportation costs ($\alpha = 1$) and a line of unit length ($L = 1$). The transportation cost to branch A and B are t_A and t_B, respectively.

3. Data and Variables

The dataset we analyze consists of 15,044 loans made to single-person businesses and firms by a major Belgian bank that operates throughout Belgium. Degryse and Van Cayseele (2000) first employed this data set, while Degryse and Ongena (2005) added distance variables and showed that both distance to lender and distance to closest competitor play a role in loan pricing. The sample encompasses all existing small and medium enterprise loans granted by this Belgian bank as of August 10, 1997 that were initiated or repriced after January 1, 1995. The bank is one out a few truly national and general-purpose banks operating in Belgium in 1997. It lends to firms located in most postal zones, and is active in 49 different industries. Around 83% of the firms in its portfolio are single-person businesses and most borrowers obtain just one (relatively small) loan from this bank.

Our model suggests that the mode of organization and the lending technology employed by the lending branch and the closest competitor matters for branch reach and the degree of spatial pricing. The Belgian financial landscape shows substantial heterogeneity in rival banks. In addition to other large banks, a number of smaller banks are also present. To address the impact of organizational structure and technology, we combine the loan information data set employed by Degryse and Ongena (2005) with a new data set on the type and organizational structure of all bank branches in Belgium. We obtain this data from the 1994 annual report

Bankkantoren in België (Bank Branches in Belgium) published by the *Belgische Vereniging van Banken* (Belgian Bankers Association). As of December 31st, 1994, there are 7,477 branches, operated by 145 banks and located in 837 postal zones.

Each postal zone carries a postal code between 1,000 and 9,999. The first digit in the code indicates a geographical region, which we call "postal area" and which in most cases coincides with one of the ten Provinces in Belgium. A postal zone covers on average 26 sq km, and contains on average approximately six bank branches. A postal area covers 3,359 sq km, on average. Not surprisingly, borrowers are often located in more densely banked areas, with on average more than 17 bank branches per postal zone, resulting in around 250,000 possible borrower–competing bank branch pairs.

Table I provides summary statistics for the 15,044 contracts of our variables, broken down into ten sets of characteristics: (1) dependent variables; the transportation cost drivers of interest: (2) bank organization and technology, (3) bank and market type, and (4) geographical distance; and the control variables: (5) postal zone variables (6) relationship characteristics, (7) loan contract characteristics, (8) loan purpose, (9) firm characteristics, and (10) interest rate variables.

Our theoretical model suggests employing dependent variables for branch reach and lending rates. For branch reach, we distinguish *Quartile Reach*, computed as the log of one plus the traveling time of the branch's quartile most remote borrower and the branch itself, in minutes, and *Maximum Reach*, representing the log of one plus the maximum distance between the most remote borrower and the branch.[12] The mean across all branches for Quartile (Maximum) Reach is 2.60 (3.52), translating into approximately 14 (40) minutes traveling time to the remote borrower (see Table I). We will also check the robustness of our findings using the *Number of Loans* as measures of branch size (as branch reach and size are equivalent in our theoretical framework).

The second dependent variable is the *Loan Rate*, the interest rate on the loan until the next revision. For fixed interest rate loans, this is the yield to maturity of the loan. For variable interest rate loans, this is the interest rate until the date at which the interest rate will be revised as stipulated in the contract. The average interest rate on a loan in our sample is 8.12% or 812 basis points. The loan rate varies widely not only nationally (the standard deviation is 236 basis points), but also at the branch level (the average standard deviation at the branch level is still 217 basis points). We will also check the robustness of our findings using the natural logarithm of *Loan Size* as an independent variable (multiplied by 1,000 to get easily readable coefficients). The median loan size is around 300,000 Belgian Francs (7,500 US Dollar).[13]

[12] Degryse and Ongena (2005) provide more details on computational issues related to our distance-variables as well as other minor sample selection issues.

[13] 40 Belgian Francs (BEF) are approximately equal to 1 US$ during the sample period.

Table I. Data description

The table defines the variables employed in the empirical specifications and provides their mean, median (Med.), minimum (Min.), maximum (Max.), and standard deviation (St. Dev.). Variables that are employed in the regressions are bolded. The other variables are auxiliary and are not bolded. The maximum number of observations is 15,044.

Variables	Definition	*C*	*S*	Mean	Med.	Min.	Max.	St. Dev.
Dependent variables								
Quartile Reach	Shortest traveling time to the quartile remote borrower of the branch, in minutes	*i*	*D*	14.06	13	1	87	7.67
Maximum Reach	Shortest traveling time to the most remote borrower of the branch, in minutes	*i*	*D*	40.05	34	1	186	27.81
Number of Loans	Relative size of the lending branch by number of loans, in percent	*i*	*D*	0.25	0.21	0.00	0.90	0.15
Loan Rate	Interest rate on loan until next revision, in basis points	*l*	*D*	812	782	200	2,200	236
Loan Size	Size of loan, in millions of BEF[c]	*l*	*D*	0.88	0.30	0.01	80	1.83
Independent variables								
Variables of interest								
Bank organization/technology								
Size Bank	Average asset size of the quartile closest competitors relative to the asset size of the largest bank	*r*	*A*	0.61	0.67	0.00	1	0.17
Hierarchy Bank	Average number of layers of the quartile closest competitors relative to the bank that is the most hierarchically organized	*r*	*B*	0.36	0.39	0	1	0.20
Span Organization Lender	Number of branches at the same level as the lending branch, in hundreds	*b*	*B*	1.07	1.30	0	8	0.55
Span Organization Competitor	Average number of branches in each bank at the same level as the quartile closest competitors' branches, in hundreds	*r*	*B*	3.69	3.60	0	8	1.61
s(Span Organization)	= Span Organization Lender + Span Organization Competitor	*b,r*	*B*	476	480	10	1,207	183
Span Organization	= Span Organization Competitor/s (Span Organization)	*v*	*B*	0.76	0.76	0	1	0.25
Levels to Telex Lender	Number of layers from the lending branch to a branch with a telex machine	*b*	*B*	1.85	2	0	2	0.35
Levels to Telex Competitor	Average number of layers from the quartile closest competitors' branches to a branch with a telex machine	*r*	*B*	1.33	1.30	0	4	0.31
s(Levels to Telex)	= Levels to Telex Lender + Levels to Telex Competitor	*b,r*	*B*	3.19	3.25	1.20	6.00	0.46
Levels to Telex	= Levels to Telex Competitor/s (Levels to Telex)	*v*	*B*	0.42	0.40	0	1	0.07
Fax Lender	Equals 1 if the lending branch has a fax number	*b*	*B*	0.78	1	0	1	0.41

Table I. (Continued)

Variables	Definition	*C*	*S*	Mean	Med.	Min.	Max.	St. Dev.
Fax Competitor	Proportion of the quartile closest competitors with a fax number		*B*	0.51	0.44	0	1	0.27
s(Fax)	= Fax Lender + Fax Competitor	*b,r*	*B*	1.47	1.66	0	2	0.48
Fax	= Fax Competitor/s(Fax)	*v*	*B*	0.50	0.45	0	1	0.25
Bank and market type								
Urban	= 1 if borrower is located in agglomeration with > 250,000 inhabitants	*i*	*D*	0.09	0	0	1	0.29
Foreign Bank	Proportion of foreign banks among the quartile closest competitors	*r*	*A*	0.03	0	0	1	0.10
Geographical distance								
Distance to Lender	Shortest traveling time, in minutes	*i*	*D*	6.90	4.29	0.00	51.00	7.30
Distance to Competitor	Shortest traveling time to the quartile closest competitor in the borrower's postal zone, in minutes	*i*	*D*	3.82	3.27	0.00	24.00	2.33
Control variables								
Postal zone	*Including 8 Postal Area Dummies*	*i*	*D*					
Herfindahl-Hirschman Index	Summed squares of bank market shares by number of branches in borrower's postal zone	*i*	*B*	0.17	0.15	0.05	1	0.11
Number of Firms	Number of registered firms in the borrower's postal zone, in thousands	*i*	*F*	0.74	0.45	0.00	6.10	0.89
Relationship characteristics								
Main bank	= 1 if bank considers itself as main bank,[a] in percent	*i*	*D*	58.82	100	0	100	49.22
Duration of Relationship	Length of relationship with current lender, in years	*i*	*D*	7.93	7.47	0.00	26.39	5.44
Contract characteristics	*Including 4 Loan Revisability Dummies*	*l*	*D*					
Collateral	= 1 if loan is secured via collateral, in percent	*l*	*D*	26.40	0	0	100	44.08
Repayment Duration of Loan	Repayment duration of loan, in years	*l*	*D*	2.35	0.55	0.00	20.00	3.26
Loan purpose								
Mortgage	= 1 if loan is a business mortgage loan	*l*	*D*	n/a[b]				
Term	= 1 if loan is a business term loan (investment credit)	*l*	*D*	n/a[b]				
Securitizable term	= 1 if loan is a securitizable business term loan (investment credit)	*l*	*D*	n/a[b]				
Bridge	= 1 if loan is a bridge loan	*l*	*D*	n/a[b]				
Prepay taxes	= 1 if loan is credit to prepay taxes	*l*	*D*	n/a[b]				
Consumer credit	= 1 if loan is a consumer credit loan (capturing installment loans)	*l*	*D*	n/a[b]				
Other	= 1 if loan is given for another purpose or its purpose is not specified	*l*	*D*	n/a[b]				
Rollover	= 1 if loan is given to prepay another loan, in percent	*l*	*D*	10.20	0	0	100	30.27

Table I. (Continued)

Variables	Definition	C	S	Mean	Med.	Min.	Max.	St. Dev.
Firm characteristics	*Including 49 Industry Dummies*	*i*	*D*					
Small firm	= 1 if < 10 employees and turnover < 250 mln. BEF,[c] in percent	*i*	*D*	15.99	0	0	100	36.64
Medium firm	= 1 if > 10 employees or turnover > 250 mln. BEF,[c] in percent	*i*	*D*	0.89	0	0	100	9.40
Large firm	= 1 if turnover > 1 bln. BEF,[c] in percent	*i*	*D*	0.14	0	0	100	3.73
Limited Partnership	= 1 if firm is limited partnership, in percent	*i*	*D*	11.97	0	0	100	32.46
Limited Partnership w/ES	= 1 if firm is limited partnership with equal sharing, in percent	*i*	*D*	1.18	0	0	100	10.78
Corporation	= 1 if firm is corporation, in percent	*i*	*D*	3.78	0	0	100	19.07
Temporary Arrangement	= 1 if firm is a temporary arrangement, in percent	*i*	*D*	0.85	0	0	100	9.18
Interest rate variables	*Including 2 Year Dummies*		*D*					
Government Security	Interest rate on a Belgian government security with equal repayment duration as loan to firm, in basis points	*l*	*D*	389	350	305	805	87
Term Spread	Yield on Belgian government bond of 5-years – yield on treasury bill with maturity of 3 months, in basis points	*l*	*D*	179	177	100	268	31

[a]The definition used by the bank to determine whether it is the main bank is: For single-person businesses and small firms, these have a turnover on the current account of at least BEF 100,000 per month and buy at least two products from that bank.
[b]For bank-strategic considerations we cannot reveal the relative importance of the types of loans.
[c]40 Belgian Francs (BEF) are approximately equal to 1 US$ during the sample period. The characteristics (*C*) are specific to the lending branch (*b*), rival branch (*r*), rival branch vis-à-vis lending branch (*v*), borrower (*i*) or loan contract (*l*). The data sources (*S*) include Degryse and Van Cayseele (2000) and Degryse and Ongena (2005) (*D*), *Documenten en Aspecten* (Documents and Aspects) (*A*) and *Bankkantoren in België* (Bank Branches in Belgium) (*B*) published by the *Belgische Vereniging van Banken* (Belgian Bankers Association), and *BelFirst* (*F*).

To measure a bank's internal organization, we use two variables. First, we construct a variable *Size Bank*, which measures the size of the geographically closest bank, in terms of total assets, relative to the largest bank.[14] Size Bank is by construction a continuous variable and goes from almost zero (when the closest bank is very small) to one (when the closest competitor is the largest bank). We obtain data on the total assets of all banks in Belgium from the *Documenten en Aspecten* (Documents and Aspects) published by the *Belgische Vereniging van Banken* (Belgian Bankers Association). Summary statistics reported in Table I show that Size Bank is on average 0.62.

[14] As for the other relevant variables we actually average across the 25% geographically closest competitors.

Second, we measure the Hierarchy of the closest competitor at the bank level (*Hierarchy Bank*). Stein (2002), for example, shows that a centralized hierarchical bank offers an environment advantageous to hard information. For each branch in the bank we follow the 'chain of command' all the way up to the top branch that has no reporting duty (to a higher level) and count the layers traveled. The levels per branch counted in this way range between zero and five. We can construct this variable on the basis of information from the 1994 annual report *Bankkantoren in België* (Bank Branches in Belgium) published by the *Belgische Vereniging van Banken* (Belgian Bankers Association). This document lists to which branch higher up in the hierarchy of the bank each of the 7,477 branches reports.

We then (1) average the counted levels across the branches of each bank, (2) take the value of this measure for the closest competitor, and (3) scale by the maximum across banks (which is around four). This constitutes our measure of hierarchy for each bank. By construction Hierarchy Bank ranges between zero and one, and does not exhibit heterogeneity between branches of the same bank. The average is 0.366 indicating that the competing bank branch has around 1.5 levels of organizational layers above it. But bank size and hierarchy and are only weakly correlated with a correlation coefficient of 0.375 (correlations are tabulated in the Supplement).

While Size Bank and Hierarchy Bank only take information from competing banks into account (as such do not exhibit heterogeneity for the branches of the lending bank), we next also formulate three variables that take into account branch-specific information in the bank's organizational form. This allows us to incorporate information on the organizational form from both the lending branch and the rival branches. For each variable, we first provide a general description; afterwards, we provide more details for rival branches and for the lending bank, respectively.

First, the organizational span is a key dimension of organizational complexity (Rajan and Wulf, 2006). To construct our branch-specific span measure, we count the number of branches at the same level as the branch of the bank. A higher span of the organization may reflect both more reliance on hard information and higher transaction costs due to organizational diseconomies (see Williamson, 1967). Branches of the closest competitors have on average 369 branches at the same level in the bank (*Span Organization Competitor*). The lending branch is surrounded by fewer branches at the same level (only 107 on average) (*Span Organization Lender*).

Second, we measure the number of hierarchical levels to a telex at each branch to proxy for the degree of authority at the branch. Telex communication can be used to confirm financial transactions as messages sent by the telex network can be used in general to create binding legal documents to support and control business dealings. Consequently, this variable proxies for the organizational swiftness by which loans are cleared internally (and may be communicated to the credit register).[15] Banks

[15] By 1997 bank transfers via telex were largely replaced by SWIFT and internet-based transactions. But Belgian banks still frequently used telex communication as a reliable technology for the internal

may be granting real authority to a branch with a telex. A higher number for Levels to Telex may imply higher transaction costs, as decisions take longer. Also, because the information generated at a bank branch depends on the extent to which authority has been delegated to this branch (see Aghion and Tirole, 1997), a higher number for Levels to Telex may imply that the branch is at a informational disadvantage and incurs higher communication costs. In both cases a higher number of the Levels to Telex implies higher transaction costs for the branch. There are on average 1.3 hierarchical levels to cross from the closest competing bank branch to reach the closest telex within that bank (*Levels to Telex Competitor*). The number of hierarchical levels from a lending branch to a telex within the lending bank is 1.85 on average (*Levels to Telex Lender*).

Finally, we also consider whether a branch has a fax in 1994 or not.[16] This information stems from the 1994 annual report *Bankkantoren in België* (Bank Branches in Belgium) published by the *Belgische Vereniging van Banken* (Belgian Bankers Association). The presence of a fax allows for a more impersonal mode of communication and introduces greater possibilities to transfer hard information between borrower and bank (Petersen and Rajan, 2002) as well as within the bank. Advanced communication technologies, such as a fax, may also reduce communication costs and improve the flow of information within a corporate hierarchy (Aghion and Tirole, 1997). About half of the competing branches had a fax at the end of 1994 (*Fax Competitor*), while 78% of the branches of the lending bank had a fax at the end of 1994 (*Fax Lender*).

For the geographical reach regressions our theoretical model suggests taking the ratio of the competitors' branch values and the sum of the competitors' branch values and the lending branch values. We label those newly created variables as *Span Organization*, *Levels to Telex* and *Fax*, respectively. For the loan rate specifications, our theoretical model suggests adding the competitors' branch and the lending branch values; we label these sums as *s(Span Organization)*, *s(Levels to Telex)* and *s(Fax)*.

To control for the type of lending market, we include an *Urban* dummy that equals one if the borrower is located in an agglomeration with more than 250,000 inhabitants, and zero otherwise. Borrowers in an urban setting may face more congestion when traveling to their banks. Urban may further capture heterogeneity in information available to banks. For example, banks in urban areas may rely more on hard information while rural banks may collect more soft information (Klein, 1992).

approval of loans. Even by the end of 2006 the telex network in Belgium still had 200 banks, businesses and embassies as customers. On March 1, 2007 *Belgacom* introduced *RealTelex* enabling telex service through the internet (Source: *Nieuwsblad* December 21[th], 2006).

[16] Although one may expect the fax to be a widespread technology among banks, about half the bank branches in Belgium did not have a fax in the mid-1990's.

To control for geographical distance, we compute for each borrower the distance to the lending bank's branch. We take the natural log of *(1 + Distance to Lender)* to accommodate for potential fixed costs in transportation. To identify the impact of the closest competitor, we compute the distance between the borrower and the branches of all other competing banks located in the same postal zone as the borrower, and take its 25^{th} percentile. We label this variable as *ln(1 + Distance to Closest Competitor)*.

The distance to the lender for the median borrower is around 4 minute and 20 seconds. The distance to the quartile closest competitor for the median borrower is 3 minutes and 50 seconds in the same postal zone. The quartile closest competitor is the bank branch with the 25^{th} percentile traveling time located in the same postal zone as the borrower.

Our dataset further includes postal zone variables, relationship characteristics, loan characteristics and purpose, firm characteristics, and interest rate variables. Local market and bank–firm relationship characteristics control for example for the relationship orientation of the branch Petersen and Rajan, 1995 and Degryse and Ongena, 2007). We calculate both the *HHI* (Herfindahl-Hirschman Index), as the summed squares of bank market shares by number of branches in borrower's postal zone, and the *Number of Firms* registered in the borrower's postal zone (in thousands). The HHI equals 0.17 on average while the Number of Firms is around 750 firms on average in each postal zone.

We control for relationship characteristics using the variables Main Bank and Duration of Relationship. *Main Bank* indicates whether this bank considers itself to be the main bank of that firm or not. The bank's definition in determining whether it is the main bank or not is "having a monthly 'turnover' on the current account of at least BEF 100,000 (U.S. Dollar 2,500), and buying at least two products from the bank". More than half of all borrowers are classified as Main Bank customers. Main Bank captures the scope of the relationship. The *Duration of the Relationship* measures the number of years the firm has had a relationship with that particular bank at the time the loan rate is decided upon. A relationship starts when a firm buys for the first time a product from that bank. The average duration of the relationship in the sample is about eight years.

Our loan contract characteristics encompass four dummies capturing the effect of the "revisability" of the loan, as some loan contracts allow resetting the loan rate at fixed dates subject to contractual terms. Other loan characteristics are Collateral and Repayment Duration of Loan. The variable *Collateral* indicates whether the loan is collateralized or not. Approximately 26% of the loans are collateralized.[17]

[17] We assume, as in Berger and Udell (1995) and Elsas and Krahnen (1998), that collateral and interest rate conditions are determined sequentially, with the collateral decision preceding the interest rate determination.

Another loan contract characteristic is *Repayment Duration of the Loan*. For all loans, we know the 'speed' at which loans are repaid. This allows us to compute the repayment duration of a loan. We include the natural logarithm of (one plus) this variable in the regression analysis to proxy for the risk associated with the time until the loan is repaid.

We also include dummies capturing the *loan purpose*. We have seven types of loans in our sample. While we cannot reveal the relative importance of the types of loans, we include the seven loan purpose dummies in Table I for reference. We further include a separate *Rollover* dummy (also listed in the Loan Purpose category), which takes a value of one if the loan is given to prepay another loan, and is zero otherwise.

The firm characteristics include both proxies for the *size* and *legal form* of the firm. In terms of firm size, a distinction can be made between Single-Person Businesses (82.98% of the sample), Small (15.99%), Medium (0.89%), and Large (0.14%) Firms; and in terms of legal form of organization, a distinction is made between Sole Proprietorships (82.22%), Limited Partnerships (11.97%), Limited Partnerships with Equal Sharing (1.18%), Corporations (3.78%), and Temporary Arrangements (0.85%). In the regressions, we exclude the dummies for Single-Person Businesses and Sole Proprietorships. We include 49 two-digit NACE industry classification dummies to capture industry characteristics.

Interest rate variables are incorporated to control for the underlying cost of capital in the economy. First, we include the interest rate on a Belgian *Government Security* with the same repayment duration as the loan granted to the firm. Second, we include a *Term Spread*, defined as the difference between the yield on a Belgian government bond with repayment duration of five years and the yield on a 3-month Treasury bill. Finally, we incorporate two year dummies for 1996 and 1997 (with 1995 the base case) to control for business cycle effects.

4. Empirical Results

4.1 ORGANIZATIONAL STRUCTURE, TECHNOLOGY AND BRANCH REACH

4.1.1 Main Results

We now turn to testing the first implication of our theoretical model on the geographical reach of branches and the role of the competing and lending banks' organizational structure. We employ two indicators of branch reach. Quartile Reach captures the distance to the quartile most remote borrower and Maximum Reach measures the distance to the most remote borrower of the branch. As branch reach and size are equivalent in our theoretical framework, we will also report the findings using the Number of Loans as a measure of branch size. The three dependent variables we employ are highly correlated.

We start by analyzing the impact of organizational structure on branch reach. The regression results are presented in Table II. The first two indicators of organizational form are bank-specific and measure the impact of the competitors' organizational form on the branch reach of the lending bank. Recall that our bank-specific measures exhibit no variation for the lending bank. Size Bank, a measure employed by Berger et al. (2005), is negative and statistically significant in Model 1. Quartile Reach is reduced by approximately 9% when the closest competitor is a very large bank compared to a very small bank (i.e., from 14 minutes to about 12.8 minutes). More importantly, Hierarchy Bank is statistically significant and negative, in line with our theoretical model. A lending branch that faces the most hierarchical bank as closest competitor has a 10% smaller reach than when the closest competitor is a "flat deck" (i.e. 12.6 minutes versus 14 minutes). Recall that the correlation between Hierarchy Bank and Size Bank is rather low (0.375).

An interesting question then is whether it is Size Bank, Hierarchy Bank, or both that influence branch reach. Our theory highlights that it is not bank size per se that is responsible for geographic reach but a bank's organizational form. Jumping ahead, Model 6 indeed shows that Hierarchy Bank remains significant, whereas Size Bank looses its statistical and economic significance when we include both variables in one regression model. Adding Size Bank squared in Models 1 to 4 in Panel B of Table II (and Size Bank cubed, not reported), or replacing Size Bank by four bank size dummies (based on five equidistant ranges) in Models 5 to 7 in Panel B also does not alter this (or any other) reported finding. These results suggest that Hierarchy Bank may be a more appropriate measure of lending technology stemming from organizational form than simply bank size. Also, these results show that organizational form determines branch reach: a rival that is more hierarchical reduces the reach of the own branch, in line with our theoretical model.

Back to Panel A of Table II, Models 3–4 deal with the impact of Span Organization, Levels to Telex, and Fax on branch reach, respectively. These three measures are branch-specific and are determined by both lending branch and rival branch heterogeneity. As indicated earlier, these three measures are defined as the ratio of the competitors' branch values and the sum of the competitors' branch values and the lending branch values. Span Organization is positive but statistically insignificant. Levels to Telex has a positive coefficient, that is statistically significant and economically relevant. When competitors have relatively larger values for Levels to Telex, the lending bank's branch reach increases. An increase from the minimum to the maximum Levels to Telex increases branch reach with about 29%. More hierarchical layers towards the decision making unit at the rival bank (as captured by the number of vertical layers to the first branch with a telex) implies less rivals'

Table II. Impact of organizational structure on branch reach

Panels A and B in this table list the coefficients from regressions with the indicated dependent variable. *Quartile* (*Maximum*) *Reach* is the log of one plus the shortest traveling time to the quartile most remote borrower of the branch, in minutes. *Number of Loans* is the relative size of the lending branch by the number of loans, in percent. All *independent variables* are defined in Table I. We employ ordinary least squares estimation. *, **, and *** indicate significance at the 10%, 5%, and 1% level, two-tailed.

Panel A: Model	1	2	3	4	5	6	7	8
Number of observations	*15,044*	*15,044*	*13,130*	*13,130*	*15,044*	*13,130*	*13,130*	*13,130*
Dependent variable	Quartile Reach	Quartile Reach	Quartile Reach	Quartile Reach	Quartile Reach	Quartile Reach	Maximum Reach	Number of Loans
Size Bank	−0.09***					−0.01	0.01	−0.07***
	(0.02)					(0.02)	(0.03)	(0.01)
Hierarchy Bank		−0.10***				−0.13***	−0.18***	−0.02***
		(0.02)				(0.02)	(0.03)	(0.01)
Span Organization			0.04			0.06*	−0.09*	0.00
			(0.03)			(0.03)	(0.05)	(0.01)
Levels to Telex				0.29***		0.49***	0.28***	0.32***
				(0.06)		(0.06)	(0.09)	(0.02)
Fax					−0.26***	−0.28***	−0.50***	−0.10***
					(0.01)	(0.01)	(0.02)	(0.01)
Urban	−0.04***	−0.04***	0.00	0.01	−0.05***	0.01	0.03*	−0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.00)
Herfindahl-Hirschman Index	0.12***	0.10***	0.04	0.14***	0.04	0.04	−0.09*	−0.03***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.05)	(0.01)
Number of Firms	0.07***	0.07***	0.07***	0.07***	0.07***	0.06***	0.07***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Main Bank	0.00	0.00	0.00	0.01	0.00	0.01	0.00	−0.01***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Duration of Relationship	−0.02***	−0.02***	−0.02***	−0.02***	−0.02***	−0.02***	−0.02***	−0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.25	0.25	0.26	0.25	0.26	0.27	0.18	0.19

Table II. (Continued)

Panel B: Model	1	2	3	4	5	6	7	8	9
Number of observations	*15,044*	*13,130*	*13,130*	*13,130*	*13,130*	*13,130*	*13,130*	*13,130*	*13,130*
Dependent variable	Quartile Reach	Quartile Reach	Maximum Reach	Number of Loans	Quartile Reach	Maximum Reach	Number of Loans	Quartile Reach	Maximum Reach
Size Bank	−0.57***	−0.21**	−0.15	−0.44***				0.00	0.06*
	(0.10)	(0.10)	(0.15)	(0.04)				(0.02)	(0.03)
Hierarchy Bank		−0.25***	−0.32***	−0.01	−0.24***	−0.31***	−0.01*	−0.25***	−0.30***
		(0.02)	(0.03)	(0.01)	(0.02)	(0.03)	(0.01)	(0.02)	(0.03)
Span Organization		0.38***	0.35***	0.15***	0.38***	0.37***	0.14***	0.30***	0.19***
		(0.03)	(0.05)	(0.01)	(0.03)	(0.05)	(0.01)	(0.03)	(0.05)
Levels to Telex		1.49***	1.30***	0.33***	1.50***	1.28***	0.34***	1.34***	0.88***
		(0.05)	(0.07)	(0.02)	(0.05)	(0.07)	(0.02)	(0.05)	(0.07)
Fax		−0.35***	−0.55***	−0.13***	−0.35***	−0.55***	−0.13***	−0.29***	−0.39***
		(0.01)	(0.02)	(0.00)	(0.01)	(0.02)	(0.00)	(0.01)	(0.02)
Size Bank ˆ 2	0.47***	0.16*	0.12	0.33***					
	(0.09)	(0.09)	(0.13)	(0.03)					
4 Size Bank Dummies					Yes	Yes	Yes		
Number of Loans								0.46***	1.19***
								(0.02)	(0.04)
Urban	0.03**	0.06***	0.03	−0.02***	0.06***	0.03	−0.01***	0.06***	0.04**
	(0.01)	(0.01)	(0.02)	(0.00)	(0.01)	(0.02)	(0.00)	(0.01)	(0.02)
Herfindahl-Hirschman Index	0.47***	0.14***	0.01	−0.03***	0.15***	0.03	−0.02	0.15***	0.03
	(0.03)	(0.03)	(0.05)	(0.01)	(0.03)	(0.05)	(0.01)	(0.03)	(0.05)
Number of Firms	0.03***	0.04***	0.04***	0.01***	0.04***	0.04***	0.01***	0.04***	0.04***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Main Bank	−0.01*	0.00	−0.01	−0.01***	0.00	−0.01	−0.01***	0.00	0.01
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Duration of Relationship	−0.04***	−0.02***	−0.03***	−0.01***	−0.02***	−0.03***	−0.01***	−0.02***	−0.02***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46***	1.19***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.04)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.04	0.16	0.10	0.14	0.16	0.10	0.13	0.18	0.17

branch authority and higher rivals' organizational communication costs, enhancing the lender branch's reach.

Fax exhibits a negative sign and is statistically and economically significant (Model 5). Varying Fax from the minimum to the maximum makes the quartile branch reach drop by almost 26 percent (i.e. from 14 to 10 minutes). Thus when rival branches have more advanced technology and the lending branch does not, transportation costs towards the rival branch decrease, transportation costs to the own bank increase and the relative transaction costs of the rival decrease, all cutting into the lending bank's branch reach. The results on Fax show that lending technology impacts reach: rivals that employ more advanced lending technology reduce the lending bank's branch reach, in line with our theoretical model.

Model 6 incorporates our five bank-specific and branch-specific measures simultaneously. As already mentioned, Size Bank looses its economic and statistical significance. Span Organization becomes marginally significant, suggesting that a larger Span Organization, entailing more transaction diseconomies, increases the lending bank's branch reach. These results are further robust to using the Maximum Reach (Model 7) or Number of Loans (Model 8) as dependent variable, except for Span Organization, which becomes marginally significant with a negative sign in Model 7.

As most control variables remain virtually unaltered throughout the exercises in this paper, we only discuss them once. We tabulate key coefficients in Table II and a complete set of coefficients for selected specifications in the Supplement to this paper. We base our discussion on Model 1 of Table II. The dummy variable Urban shows different signs across the different models. We include the HHI to control for banking competition. As already indicated we resort to using the number of bank branches of each bank in the postal zone to construct market shares. The estimate of the coefficient on HHI (0.12) implies that an increase of 0.1 in the HHI would increase reach by less than 0.5 percent. A doubling from the Number of Firms in the borrower's postal zone, at the mean, would increase reach by 1.25 percent.

The impact of the *bank-firm relationship characteristics* is captured by Main Bank and the ln(1+Duration of Relationship). The coefficient on Main Bank is mostly insignificant, while the coefficient on Duration is negative and significant but economically quite small. Dropping the relationship variables does not alter any of the results. The *loan contract characteristics* include whether the loan is collateralized, its repayment duration, and the loan revisability options (these coefficients are tabulated in the Supplement). Only the coefficient on Collateral is significant but economically close-to irrelevant. Finally, the dummy variable Urban shows different signs across the different models. To conclude, our control variables reveal that in less concentrated banking markets and when more firms are in the postal zone, geographical reach increases somewhat.

In sum, our results support the predictions of our model, suggesting that when rivals' organizational structure is such that transportation costs are lower and decisions are taken more swiftly, the geographical reach of the lending branch reduces.

4.1.2 Robustness: Potentially Omitted Variables, Small Loans and Endogeneity

We conduct a number of robustness checks to deal with the issue of potentially omitted variables, branch reach for small loans as well as potential endogeneity issues.

Motivated by our theoretical framework we feature the *Number of Loans* as a dependent variable in the last Model 8. We recall that if borrowers are uniformly distributed and transportation costs are linear for example, branch reach and the number of borrowers serviced are equivalent. However the size of the loan portfolio of the branch may have an effect on its reach that is currently not included in our model. We therefore include the number of loans – most borrowers take one loan – as an independent variable in Models 8 and 9 in Panel B of Table II. Results are unaffected.

Next, we focus on the *smallest loans* only. Liberti and Mian (2006), for example, find that larger loans are decided at higher levels in the bank hierarchy. To the extent this is also the case here, our organizational form measures might be biased as they incorporate characteristics of the lending branch that might not be relevant. We address this issue by focusing on the smallest loans only, as these are very likely to be decided "locally" for all branches. We replicate all specifications of Table II. The results for the small loans are very similar to the general results in Table II and hence reported in the Supplement.[18]

Thus far we have taken the banks' organizational form as given. In reality, bank organization may respond to local circumstances and banks with a certain organizational setup may prefer to branch out in local banking markets with a particular competitive structure. Regions with many small firms, for example, may be populated by small banks, flatly organized banks, branches with a low span of organization, and branches with substantial personal mode of communication (see Berger et al., 2005 and Brickley, Linck and Smith, 2003). In other words, the local geographic and business environment in which the bank operates may determine the banks' organizational structure. We are concerned that this *endogenous relationship* between the banks' organizational structure and the business environment affects the relationship between organizational structure and spatial pricing of loans that we are interested in.

[18] Size Bank becomes insignificant in Model 1, suggesting that heterogeneity in rival's bank size does not influence branch reach for small loans. Span Organization is now significant in Model 3. Larger transactional diseconomies at rivals relative to our lending branch increase the geographical reach of the lending branch for small loans.

To mitigate these endogeneity concerns, we employ two instrumental variables for organizational structure. We instrument all independent variables of interest with an industry concentration in the borrower postal zone and a bank multi-market contact index of the borrower postal zone.[19] We argue that these variables are proxies for the local business environment in which the bank operates when lending to the borrower, and assume that an individual bank has no effect on firm industry affiliation and competing bank presence in the borrower postal zone making them valid instruments.

The motivation for the multi-market contact index is that many banks are operating in more than one postal zone and often interact with other multi-location banks across zones (Barros, 1999 or Park and Pennacchi, 2008). Edwards (1955) predicts that cross-market contacts among banks increase the incentives for banks to collude. Multi-market contact then facilitates anti-competitive "mutual forbearance", as the punishment for deviation from collusion becomes large (Heggestad and Roades, 1978; Bernheim and Whinston, 1990). Other theoretical work points towards a possible pro-competitive effect of multi-market contact (Scott, 1982). Mester (1987), for example, presents a Cournot competition model in which banks have incomplete information about their rivals' marginal costs. As a result banks claim to have low marginal costs to sway competitors to produce less. If costs are imperfectly correlated across markets, multi-market banks have an incentive to put larger quantities on the market than the profit-maximizing level. Similarly, but in a different setting, Park and Pennacchi (2008) show that the presence of large multi-market banks promotes local competition, in particular in highly concentrated markets.

We construct a state-of-the-art *Multi-Market Contact* measure as proposed in Evans and Kessides (1994).[20] The variable can be defined succinctly as the sum of all bank pairs in the borrower's postal zone weighted by the relative frequency of their bilateral contacts in other postal zones. The variable is bounded between zero (banks in the postal zone have no contact elsewhere) and one (all banks in the zone have contact with all other banks across all other postal zones).

The instrumental variables results are reported in Table III. Panel A reports the first stage regressions of the five variables of interest on the two instruments and all control variables. The bottom row of the panel lists the Bound, Jaeger and Baker (1995) F-test statistic to assess instrument relevancy. Panel B reports

[19] The industry concentration index is the proportion of registered firms in the borrower's postal zone in the industry of the borrower.

[20] We consolidate the branches in 104 banks (sometimes banks comprise distinctly incorporated sets of branches in Brussels, Flanders, and Wallonia). There are 837 postal zones with bank branches. Let $D_{ij} = 1$ if bank i operates in postal zone j, and $= 0$ otherwise, for $i = 1, \ldots, 104$; $j = 1, \ldots, 837$. Let $a_{kl} = \sum_{j=1}^{837} D_{kj} D_{lj}$, and f_j: the number of different banks offering service in postal zone j. The Multi-Market Contact measure is then defined as: $MMC_j = \frac{2}{837 f_j (f_j - 1)} \sum_{k=1}^{104} \sum_{l=k+1}^{104} a_{kl} D_{kj} D_{lj}$.

Table III. Instrumental variable estimation: organizational structure and branch reach

The table lists the coefficients from regressions with the indicated dependent variable. All *variables* are defined in Table I. Panel A reports the first stage regressions of the five variables of interest on two instruments, which are the industry concentration in the borrower postal zone and the bank multi-market contact index of the borrower postal zone, and all control variables. The bottom row of the panel lists the Bound et al. (1995) F-test statistic for instrument relevancy. Panel B reports the coefficients from instrumental variables regressions. *Quartile* (*Maximum*) *Reach* is the log of one plus the shortest traveling time to the quartile most remote borrower of the branch, in minutes. *Number of Loans* is the relative size of the lending branch by the number of loans, in percent. We italicize the coefficients of the instrumented variables. The bottom row of the panel lists the Sargan (1958) Chi^2- test statistic of overidentifying restrictions. Panel C reports the coefficients from ordinary least square regressions that include the instruments as independent variables and all control variables. *, **, and *** indicate significance at the 10%, 5%, and 1% level, two-tailed.

Panel A: First stage model	1	2	3	4	5			
Number of observations	*15,044*	*15,044*	*13,130*	*13,130*	*15,044*			
Dependent variable	Size Bank	Hierarchy Bank	Span Organization	Levels to Telex				
Industry concentration	0.02	−0.06	0.02	−0.06***	0.00			
	(0.04)	(0.05)	(0.03)	(0.02)	(0.06)			
Multi-market contact index	1.02***	0.58***	0.36***	0.06***	−0.50***			
	(0.02)	(0.02)	(0.02)	(0.01)	(0.03)			
Control variables	Yes	Yes	Yes	Yes	Yes			
Adjusted R-squared	0.17	0.04	0.11	0.04	0.06			
Bound et al. (1995) F-statistic	1,334***	271***	291***	19***	135***			
Panel B: Instrumental variables	1	2	3	4	5	6	7	8
Number of observations	*15,044*	*15,044*	*13,130*	*13,130*	*15,044*	*13,130*	*13,130*	*13,130*
Dependent variable	Quartile Reach	Quartile Reach	Quartile Reach	Quartile Reach	Quartile Reach	Quartile Reach	Maximum Reach	Number of Loans
Size Bank	*−0.06****					*−0.03*	*−0.02*	*−0.07****
	(0.02)					*(0.02)*	*(0.03)*	*(0.01)*
Hierarchy Bank		*−0.12****				*−0.25****	*−0.32****	*−0.02****
		(0.02)				*(0.02)*	*(0.03)*	*(0.01)*
Span Organization			*0.50****			*0.37****	*0.35****	*0.13****
			(0.03)			*(0.03)*	*(0.05)*	*(0.01)*

Levels to Telex				*1.48****		*1.51****	*1.31****	*0.36****
				(0.05)		*(0.05)*	*(0.07)*	*(0.02)*
Fax					*−0.36****	*−0.35****	*−0.55****	*−0.13****
					(0.01)	*(0.01)*	*(0.02)*	*(0.00)*
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.03	0.04	0.10	0.10	0.07	0.16	0.10	0.13
Sargan (1958) Chi^2-statistic	6.8	6.9	5.3	12.1	6.6	12.9	20.5	220.7***

Panel C: Including instruments	1	2	3	4	5	6	7	8
Number of observations	*15,044*	*15,044*	*13,130*	*13,130*	*15,044*	*13,130*	*13,130*	*13,130*
Dependent variable	Quartile Reach	Quartile Reach	Quartile Reach	Quartile Reach	Quartile Reach	Quartile Reach	Maximum Reach	Number of Loans
Size Bank	−0.08***					−0.02	0.02	−0.03***
	(0.02)					(0.02)	(0.04)	(0.01)
Hierarchy Bank		−0.12***				−0.25***	−0.32***	−0.02***
		(0.02)				(0.02)	(0.03)	(0.01)
Span Organization			0.50***			0.37***	0.37***	0.16***
			(0.03)			(0.03)	(0.05)	(0.01)
Levels to Telex				1.48***		1.50***	1.30***	0.35***
				(0.05)		(0.05)	(0.07)	(0.02)
Fax					−0.36***	−0.35***	−0.56***	−0.14***
					(0.01)	(0.01)	(0.02)	(0.00)
Industry concentration	0.15	0.14	0.26**	0.35***	0.15	0.33***	0.51***	0.14***
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.16)	(0.04)
Multi-market contact index	0.14**	0.13**	−0.02	0.08	−0.12**	−0.11*	−0.29***	−0.31***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.09)	(0.02)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.03	0.04	0.10	0.10	0.07	0.16	0.10	0.14

the coefficients from instrumental variables regressions. The bottom row of this panel lists the Sargan (1958) test statistic of the overidentifying restrictions. Finally, Panel C reports the coefficients from ordinary least square regressions that include the instruments as independent variables and all control variables. The test statistics support our choice of instruments.

Instrumentation reinforces our findings on the impact of bank organizational form and technology. Models 1 to 5 in Panel B show that for greater Size Bank, Hierarchy Bank, and Fax, and for lower Span Organization and Levels to Telex, the geographical reach of the lending branch is lower. Model 6 includes all variables on banks' organizational form simultaneously.[21] Only Size Bank becomes insignificant, a result which again shows that Hierarchy Bank may be the relevant indicator of lending technology, and not bank size *per se*.[22] Models 7 and 8 focus on two other measures of branch reach, maximum reach and number of loans, respectively. The results are in line with those we discussed in Table II. Finally, in Panel C we regress the dependent variable directly on the instruments. Results again confirm our findings.

4.2 ORGANIZATIONAL STRUCTURE, TECHNOLOGY AND LOAN PRICING

4.2.1 Main Results

Next, we analyze the determinants of the loan rate by regressing the Loan Rate (in basis points) on our "transportation cost drivers", relationship, competition, and control variables, which as already indicated include loan contract characteristics, loan purpose, firm characteristics, and interest rates. We use ordinary least squares estimation. Our first model in Table IV highlights a parsimonious fixed-effects specification containing only distance and control variables and then we turn to specifications containing also the interactions between distance and bank organizational form variables in Models 2 to 6.

Let's first turn to the coefficients on the *distance* variables and their relation with bank organizational form. We employ for each of our distance measures the log of (one plus) the distance, as we conjecture the marginal impact on the loan

[21] The Bound et al. (1995) F-statistics indicate the two instruments are jointly relevant. The Sargan (1958) test statistics suggests no rejection of the null hypothesis of no correlation to the residuals even at the 10% level of significance in all models, except model VIII. The test indicates the instruments' validity according to this criterion.

[22] In unreported exercises, we interact our hierarchy variables with a "small firm dummy", which equals one when the firm is a small limited liability firm, and zero otherwise. Our findings indicate that while reach is negatively affected by the presence of "hard" rivals, i.e. (large) hierarchical rivals with faxes, the effects are partly mitigated when firms are "soft", i.e. small. This result indicates that the reach of banks that specialize in collecting and processing soft information is less affected by rival competition than those specializing in hard information.

Table IV. Banks' organizational structure and the severity of spatial pricing

The table lists the coefficients from regressions with the *Loan Rate* until the next revision, in basis points, and 1,000 times the log of *Loan Size*, in Belgian Francs, as the dependent variables. *Distance to Lender* is the shortest traveling time to the lender, in minutes. *Distance to Competitor* is the shortest traveling time to the closest quartile competitor, in minutes. All *other independent variables* are defined in Table I. We restrict the sample to loans smaller than 200,000 Belgian Francs ($LS < 0.2$) in Model 8, and remove Brussels postal zones in Model 9 (*Outside Bxl*). We employ ordinary least squares estimation. *, **, and *** indicate significance at the 10%, 5%, and 1% level, two-tailed.

Mode l	0	1	2	3	4	5	6	7	8	9
Sample	*All loans*	*All loans*	*All loans*	*All loans*	*All loans*	*All loans*	*All loans*	*All loans*	$LS < 0.2$	*Outside Bxl*
Number of observations	*15,044*	*15,044*	*15,044*	*13,130*	*13,130*	*13,130*	*13,130*	*13,130*	*5,154*	*11,842*
Dependent variable	Loan Rate	Loan Rate	Loan Rate	Loan Rate	Loan Rate	Loan Rate	Loan Rate	ln(Loan Size)	Loan Rate	Loan Rate
ln(1 + Distance to Lender)	−9.98**	−22.75**	−10.52*	−3.10	−63.13***	−4.30	−54.50**	199.84***	−80.61*	−61.02**
	(2.99)	(9.69)	(5.40)	(8.76)	(20.13)	(8.86)	(24.13)	(66.20)	(43.95)	(27.01)
ln(1 + Distance to Competitor)	20.37**	41.20***	22.55***	24.03**	43.00	24.02**	56.13*	−234.83***	109.19**	73.15**
	(4.35)	(12.27)	(6.99)	(11.14)	(27.27)	(10.97)	(31.49)	(86.64)	(55.07)	(34.72)
ln(1 + Distance to Lender)*		23.77					20.45	−127.73**	17.97	11.82
Size Bank		(14.72)					(18.20)	(50.68)	(32.06)	(19.57)
ln(1 + Distance to Competitor)*		−34.85*					−34.56	113.36*	−31.15	−30.77
Size Bank		(18.17)					(22.32)	(65.15)	(37.75)	(23.72)
ln(1 + Distance to Lender)*			7.26				−8.77	84.28**	9.16	−1.00
Hierarchy Bank			(11.98)				(15.07)	(42.46)	(26.43)	(16.19)
ln(1 + Distance to Competitor)*			−8.89				2.07	−82.38	−18.44	−2.09
Hierarchy Bank			(14.85)				(18.60)	(53.46)	(31.01)	(19.70)
ln(1 + Distance to Lender)*				−0.01			−0.03**	0.12**	0.02	−0.04*
Span Organization				(0.02)			(0.02)	(0.05)	(0.03)	(0.02)
ln(1 + Distance to Competitor)*				−0.01			0.01	−0.14**	−0.08**	0.01
Span Organization				(0.02)			(0.02)	(0.06)	(0.04)	(0.02)

Table IV. (Continued)

Mode l	0	1	2	3	4	5	6	7	8	9
Sample	*All loans*	*All loans*	*All loans*	*All loans*	*All loans*	*All loans*	*All loans*	*All loans*	*LS < 0.2*	*Outside Bxl*
Number of observations	*15,044*	*15,044*	*15,044*	*13,130*	*13,130*	*13,130*	*13,130*	*13,130*	*5,154*	*11,842*
Dependent variable	Loan Rate	Loan Rate	Loan Rate	Loan Rate	Loan Rate	Loan Rate	Loan Rate	ln(Loan Size)	Loan Rate	Loan Rate
ln(1 + Distance to Lender)*					15.51**		17.75***	−60.85***	8.41	20.30***
s(Levels to Telex)					(6.16)		(6.71)	(18.48)	(12.20)	(7.52)
ln(1 + Distance to Competitor)*					−7.84		−6.83	61.62**	6.93	−11.86
s(Levels to Telex)					(8.43)		(9.22)	(25.21)	(15.76)	(10.15)
ln(1 + Distance to Lender)*						−2.53	−5.38	3.05	13.38	−3.30
s(Fax)						(5.69)	(5.98)	(17.29)	(10.17)	(6.25)
ln(1 + Distance to Competitor)*						−3.47	−1.53	4.51	−16.74	−3.62
s(Fax)						(7.03)	(7.39)	(20.74)	(12.35)	(7.68)
ln(1 + Distance to Lender)*		−15.58	−16.44	−8.49	−4.27	−7.28	−5.48	28.25	9.01	−6.99
Urban		(8.88)	(8.88)	(9.84)	(10.10)	(9.79)	(10.32)	(27.59)	(17.27)	(11.63)
ln(1 + Distance to Competitor)*		7.26	7.81	15.78	17.88	17.49	20.85	−66.73	−16.02	37.69
Urban		(17.99)	(17.95)	(19.40)	(20.05)	(19.35)	(20.32)	(35.98)	(36.82)	(22.17)
Relationship characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other control variables	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	No
Fixed postal zone effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Adjusted R-squared	0.22	0.22	0.22	0.18	0.12	0.18	0.12	0.65	0.19	0.12

rate to decrease with distance. Model 0 in Table IV is the fixed-effects equivalent of a specification in Degryse and Ongena (2005) (their Table V, Model 3), which we will use as benchmark. The negative and significant coefficients on ln(1 + Distance to Lender) reveal that borrowers located farther away from the lender pay a lower loan rate at the lending bank; an increase of one standard deviation in the distance between the borrower and the lender (i.e. an increase from 0 of 7.3 minutes) decreases the loan rate with 20 basis points. The positive and significant coefficient on the variable ln(1 + Distance to Closest Competitors) shows that the lender's market power increases with the distance between the borrower and the closest competitors:[23] An increase of one standard deviation between the borrower and the closest competitor (i.e. an increase of 2.3 minutes) increases the loan rate with 17 basis points.

Our theoretical model suggests that the *organizational form, and the associated implementation of lending technology*, matters for the degree of spatial pricing. In Model 1, we investigate whether the size of the closest competitor influences the severity of spatial pricing. The results are displayed in the second column of Table IV. We interact Size Bank with ln(1 + Distance to Lender) and ln(1 + Distance to Closest Competitor). We expect that larger banks employ more hard information, implying that the degree of spatial pricing should be substantially lower, all else equal. Our results are in line with this expectation; the interaction term ln(1 + Distance to Lender) * Size Bank is positive (significant at the 12% level) while the interaction term ln(1 + Distance to Closest Competitor) * Size Bank is significantly negative. This suggests that the degree of spatial pricing is lower when the closest competitor is a large bank.

Actually, when the closest (quartile) competitor is the largest bank (Size Bank = 1), then the degree of spatial pricing becomes close to zero as the sums of the coefficients on our distance variables and the interactions between the distance variables and Size Bank reveal. In particular, the sum of the coefficients of ln(1 + Distance to Lender) and ln(1 + Distance to Lender) * Size Bank becomes 0.01, and the sum of the coefficients on ln(1 + Distance to Closest Competitor) and ln(1 + Distance to Closest Competitor) * Size Bank becomes −6.4. In contrast, the degree of spatial pricing when a small bank is the closest rival (Size Bank = 0) becomes substantial, as the coefficients on ln(1 + Distance to Lender) and ln(1 + Distance to Closest Competitor) indicate: a one standard deviation increase of the distance to lender (from 0 to 7.3 minutes) implies a drop in the loan rate of about 48 basis points and an increase of one standard deviation in the distance to closest competitor (0 to 2.3 minutes) yields an increase in the loan rate of about 50 basis points.

[23] The correlation between the variables ln(1 + Distance to Lender) and ln(1 + Distance to Closest Competitor) is low, 0.16, suggesting that these are independent effects.

Model 3 displays the results when interacting the distance variables with Hierarchy Bank. We expect that more hierarchically organized rival banks employ more hard information, and therefore, spatial pricing should soften. The coefficients on ln(1 + Distance to Lender) * Hierarchy Bank and ln(1 + Distance to Competitor) * Hierarchy Bank exhibit the expected sign, are economically relevant, but are not statistically significant.

To summarize, when rivals are large or hierarchically organized, the branches of the lending bank do not practice spatial pricing; in contrast, when rivals are small or organized as a "flat deck", the branches do practice spatial pricing. That is the results for the bank-specific variables suggest that spatial pricing softens when rivals are large and more hierarchically organized.

Models 3 to 5 of Table IV investigate how the impact of lending branch and rival branch specific organizational form shape spatial pricing. Model 3 includes interaction terms ln(1 + Distance to Lender) * Span Organization and ln(1 + Distance to Closest Competitor) * Span Organization. Both are statistically insignificant and economically unimportant, suggesting that heterogeneity in Span Organization does not affect spatial pricing. More interestingly, Model 4 discusses the results of including interaction terms ln(1 + Distance to Lender) * s(Levels to Telex) and ln(1 + Distance to Closest Competitor) * s(Levels to Telex). We expect that when the sum of the lending branch levels to telex and the rivals' branches levels to telex (s(Levels to Telex)) increases, more hard information will be employed. This should dampen spatial pricing. Our results indeed reveal that the degree of spatial pricing softens when s(Levels to Telex) increases. For example, the coefficient on the sum of ln(1 + Distance to Lender) + ln(1 + Distance to Lender) * s(Levels to Telex) equals −13.7 for the average s(Levels to Telex) and drops to approximately zero when adding two standard deviations to s(Levels to Telex). That is, while moving from zero to the median distance to lender implies a drop of 28 basis points for the average level of telex, distance does not have an impact when evaluated at the average s(Levels to Telex) plus two standard deviations. This shows that spatial pricing drops in s(Levels to Telex). Model 5 of Table IV includes Fax. There is no evidence of differences in spatial pricing stemming from heterogeneity in Fax. Both coefficients are close to zero and therefore statistically and economically insignificant. To summarize, spatial pricing becomes independent from distance when rivals as well as the own branch relies on hard information in its decision making, in line with our theoretical model.

Finally, Model 6 includes interaction terms with all five proxies of bank and branch organizational form. Two interaction terms with distance to lender turn significant: s(Levels to Telex) and Span Organization. While s(Levels to Telex) is economically relevant, the impact of Span Organization on spatial pricing seems economically not very large.

As most *control variables* remain virtually unaltered throughout the exercises in this paper, we again discuss them only once (tabulated in Column 3 in the Supplement). The impact of the bank-firm relationship characteristics is captured by Main Bank and the ln(1+Duration of Relationship). Main bank captures the scope of the bank-firm relationship. The loan rate decreases 55 basis points when the scope of the relationship is sufficiently broad (Main bank = 1). Results indicate that the loan rate increases with the duration of the relationship. For example, an increase in duration from the median (7.5 years) to the median plus one standard deviation (13 years) increases the loan rate by around 10 basis points.

The loan contract characteristics include whether the loan is collateralized, its repayment duration, and the loan revisability options. A collateralized loan carries a loan rate that is approximately 38 basis points lower.[24]

The coefficient of ln(1+Repayment Duration of Loan) is significantly negative at a 1% level: An increase in duration from say five to six years reduces the loan rate by 17 basis points. We also include four loan revisability dummies (but do not tabulate these coefficients to conserve space). However, we can reject (at a 1% significance level) the hypothesis of the joint equality to zero of the coefficients of the four loan revisability dummies. The coefficient on the Rollover dummy indicates that if a loan is given to prepay another loan, the loan rate increases by approximately 15 basis points. Term, Bridge, and Consumer Credit loans carry a significantly lower loan rate. However, again we can report the rejection, at a 1% significance level, of the hypothesis of the joint equality to zero of the coefficients of the six Loan Purpose dummies.

The Supplement also shows that Small Firms pay a higher interest rate, while Medium and Large Firms pay a significantly lower interest rate than do Single-Person Businesses (the base case). This non-monotonicity is due to differences in legal exposure. Almost all Single-Person Businesses are Sole Proprietors, and owners thus face unlimited liability for their business debts. On the other hand, all Small Firms are Partnerships, Corporations, or Temporary Arrangements; their owners for the most part face only limited liability. Diversification and reputation effects (due to increased firm size) eventually overwhelm the impact of limited liability, however, and lower the loan rate for the average Medium and Large Firms. Corporations and Limited Partnerships with Equal Sharing pay a significantly lower interest rate than do Sole Proprietorships, possibly reflecting both the effects of limited liability and increased firm size.

[24] This result is in line with the sorting-by-private-information paradigm, which predicts that safer borrowers pledge more collateral (e.g., Berger and Udell (1990) and Berger and Udell (1995)), and Elsas and Krahnen (1998) and Machauer and Weber (1998) who report a positive (though economically small) effect of collateralization on loan rates.

While few individual coefficients on either the eight postal area or the 49 industry dummies are significant, both sets of coefficients are highly significant as a group. The interest rate variables are important in explaining the variation of the loan rate. The change in the loan rate due to a basis point change in the interest rate on a Government Security with the same repayment duration equals 0.34. This coefficient suggests sluggishness in loan rate adjustments, possibly due to the implicit interest rate insurance offered by banks (e.g., Berlin and Mester, 1998) or the downward drift in Belgian interest rates during our sample period. This decrease in interest rates is actually reflected in our sample loan rates, as the (non-tabulated) coefficients on the two year dummies indicate that the average 1995 (1996) loan rate is a significant 127 (18) basis points above the average 1997 loan rate, *ceteris paribus*. A basis point parallel shift of the Term Spread implies a positive 0.57 basis point shift in the loan rate.

4.2.2 Robustness Checks: Loan Size, Small Loans, and Excluding Brussels

We conduct a number of robustness checks. In Model 7, we use the natural logarithm of Loan Size as an alternative dependent variable. Banks can use quantity differentiation as an alternative to price differentiation in the lending process. Increased bank competition may thus benefit firms not only in terms of lower pricing of loans but also in terms of larger quantity of loans. We indeed find, as expected, that our main variables of interest enter the bank size regression with the opposite sign as compared to the loan rate regression. Hence, bank hierarchy interacts with distance to affect not only the price but also the size of the loans. Interestingly, we now find that most of the interaction terms with distance turn significant, including some of the interactions with distance to competitor.

Next, we check if results alter if we focus on small loans or loans granted outside of Brussels, the capital city. These results are presented in Models 8 and 9. The reason for focusing on small loans is that our proxies for bank organizational form as well as technology may be more accurately measured for smaller loans. The results are displayed in Table IV (Model 8). While most variables appear with the expected coefficient, only the coefficient on ln(1 + Distance to Competitor) * Span Organization is significant. The impact of distance to competitor becomes lower when the rival's span organization increases. This result is in line with the use of more hard information when Span Organization increases.

Model 9 excludes the loans that are granted in Brussels. The reasoning is that our proxies for branch organizational form as well as technology may be less accurately measured in the Brussels region as that city hosts most headquarters of banks. But again most coefficients are not significant, with the exception of s(Levels to Telex) interacted with Distance to Lender, which exhibits the expected positive sign.

Overall, we find supporting evidence that the organizational structure of both lending bank and rival banks have implications for the loan pricing of banks. Spatial pricing is more pronounced when branches of small rivals are the closest competitors and when the levels to telex are low.

5. Conclusions

Recent theory highlights that the mode of firm organization determines agents' incentives. Centralized hierarchical firms employ hard information whereas flat decentralized firms exploit soft information. We present a stylized banking competition model incorporating the importance of the own and rivals' organizational structure and the lending technology employed for geographical reach and spatial pricing. Our model predicts that when rival banks are more hierarchically organized, a bank's geographical reach decreases, and the degree of spatial pricing reduces. Also, when lending decisions are communicated more swiftly at rival banks, this negatively affects a bank's geographical reach.

Our empirical analysis employs two unique data sets, allowing us to combine information on firms', lenders', and rival banks' locations, as well as the organizational structure of lending and rival banks. We find that the organizational form of banks matters for both geographical reach and loan pricing. In particular, branch reach is lower when the closest competitors are large, hierarchical, and have fax technology. Also, the geographical reach of the lending bank increases when rivals' span of organization and number of levels to telex is larger than those of the lending branch. Large rival banks and banks with more levels to telex imply substantially lower spatial price discrimination. To summarize, we show that the organizational structure and technology of rival banks in the vicinity determine geographical reach, spatial pricing, and banking competition. These results have important implications for our thinking about what drives banking competition.

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