Lending technologies, banking relationships, and firms' access to credit in Italy: the role of firm size

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Abstract

This paper analyses the role of firm-level characteristics, lending technologies and various dimensions of firm-bank relationships on firms' credit access in Italy. Using detailed firm-level data, we show that the depth and strength of banking relationships have heterogeneous effects on credit demand and rationing probabilities depending on the size of the borrower. Multiple banking reduces credit constraints problems for small firms, but the opposite is true for medium and large companies. Small and medium firms are less likely to be credit denied when the main bank's share increases, while large enterprises are more likely to be financially constrained when debt concentration is high. Similarly, we find a decreasing trend for SME and an increasing trend for large firms as relationship duration increases. Finally, we find that large companies benefit from transactional lending, while relationships lending reduces the rationing probability of both small and large firms.

Keywords: Credit rationing; Firm-bank relationships; Multiple banking; Debt concentration; Lending technologies.

JEL Classification: D22; G21; G32; L14

1. Introduction

Access to external financing sources significantly impacts on the performances of business activities and is a key determinant of firms' growth. Since the onset of the global financial crisis, there has been renewed attention by policy-makers and academics on the analysis of the main factors hampering access to credit, in particular for small and medium enterprises.

A growing literature (see Gobbi and Sette, 2014; Cenni et al., 2015) emphasizes the relevance of relationship banking in avoiding or at least mitigating firms' financial constraints, especially in periods of systemic financial distress. Information asymmetries between lenders and borrowers represent one of the main determinant of credit rationing and empirical studies have focused on measuring firm-bank information flow to define valid proxies for relationship lending that could exhaustively explain firms' access to credit. These proxies can be related to the technologies that banks use to assess their customers' creditworthiness and other features of firm-bank relationships, such as multiple banking, debt concentration and relationship duration. In countries like Italy, where the banking system represents the most widely used source of external finance, close firm-bank relationships allow to reduce information asymmetries and foster businesses' credit access.

The objective of this paper is to investigate the determinants of firms' access to credit with a particular focus on lending technologies and firm-bank relationships. We use detailed microeconomic data on a large sample of Italian firms, taken from survey conducted within the European Firms in a Global Economy (EFIGE) project. This survey, carried out in early 2010, provides detailed information on firm-bank relationships and firms' access to credit during the global financial crisis. The bank-oriented nature of the Italian financial system, in conjunction with the prevalence of small and medium enterprises characterising the industrial system, makes firms' access to alternative sources of financing (e.g., equity, venture capital and private equity, public funds) very unlikely, thus offering an ideal setting to properly analyses actual financial constraints. In fact, in Italy, banks represent the main source of external financing and factors influencing their credit allocation decisions become extremely important. This issue is particularly relevant for small and medium enterprises, which could face high switching costs and remain "captured" by the main bank.

The EFIGE survey allows to identify firms needing additional financial sources, those applying for additional credit and the results of loan granting decision by banks. Based on this information, we choose to construct a direct measure of "strong" credit rationing by defining as rationed those firms that actually applied for additional external financing but were denied credit. Differently from Becchetti et al. (2010), who adopt a "weak" definition of rationing, we thus do not consider credit discouraged firms (i.e., those needing additional financing, but refraining from applying) as financially constrained.

Using a bivariate probit model with endogenous sample selection, we model firms' access to external financing in terms of both credit demand and rationing probabilities. In particular, controlling for a large set of firm characteristics, we focus on the role of firm-bank relationships across several dimensions: multiple banking, debt concentration at the main bank, relationship duration and lending technologies. Furthermore, we investigate whether firm size has a direct impact on access to external financing and also a "mediated" effect, which depends on the depth and strength of banking relationships.

We find that the probability of rationing for small businesses reduces as the number of banking relationships increases, while the opposite pattern is found for medium and large companies. The estimated probability of credit constraints for large companies is higher than that of small and medium firms, irrespective of the number of relationships. Furthermore, small enterprises show the lowest probability of rationing when the number of banks is above the median. Small and medium firms are less likely to be credit denied when the duration of the relationship with their main bank increases, while larger companies appear to be penalized by long relationships. In particular, medium-sized enterprises benefit more than other firms from long-lasting relationships, whereas large companies show an evident increase in credit rationing probability as relationship duration increases. As regards debt concentration, we find that small and medium firms are less likely to be credit denied when main bank's debt share increases, while an opposite trend is found for large companies. These empirical findings highlight the relevance of strong banking relationships for small and medium-sized businesses, which allow banks to accumulate private information and reduce informational asymmetries. Large companies instead, being characterised to a significantly lesser extent by information transparency problems, show a lower probability of being denied credit when debt concentration is low. However, when the degree of debt concentration increases, credit rationing becomes relevant for large firms. This result can be interpreted in light of the fact that, as large companies tend to apply for loans of larger amounts than other firms to finance their investment projects, firm's main bank may be unwilling or unable to provide the whole amount of credit requested, especially in periods of higher financial distress.

Furthermore, we show that lending technologies have a differentiated effect on rationing depending on firm size. Our empirical evidence shows that larger companies take an advantage from transactional lending. Relationship lending technologies contributes instead to reduce the probability of being credit denied for both for small and large firms. Soft information, despite requiring frequent firm-bank interactions and longer time to be collected, represent an efficient way to assess firms' potentialities and make accurate credit allocation decisions.

The remainder of the paper is organized as follows. Section 2 reviews prior literature. Section 3 describes data and defines the variables included in our econometric model. In Section 4 we present econometric methods, while empirical results are discussed in Section 5. Section 6 offers some concluding remarks.

2. Literature overview

Ongena and Smith (1998) defines a bank relationship as the connection between a bank and a customer that goes beyond the execution of simple, anonymous, financial transactions. It produces the transfer of private information that provides an advantage, with respect to other intermediaries, to continue doing business together and for a long time. They argue that a bank relationship is usually defined along two dimensions: time and scope. The length of the interaction between customer and bank affects the importance of a relationship; the scope pertains instead to the breadth of services (e.g., financial services, loans, deposits, etc.) offered by the bank to its customer.

The literature on firm-bank relationship highlights the relevance of information asymmetries between lenders and borrowers. A firm, having more information about its products or projects than its lenders, has an information advantage that can be used for opportunistic behaviour and that can produce the well-known problem of adverse selection, impeding the flow of credit to profitable firms (Akerlof, 1970). Typically, information asymmetries arise because the costs of searching for financial information can vary among customers or lenders (Stigler 1961). Bhattacharya and Thakor (1993) analyse how repeated firm-bank interactions allow to establish a privileged information channel thanks to banks' abilities of screening and monitoring borrowers. Moreover, bank–borrower interactions over multiple products could generate private information about firm's financial prospects that facilitate bank monitoring of the firm (Black, 1975; Diamond, 1984; Fama, 1985). A bank thus gains an advantage on other creditors from the information flow with its customers; at the same time, the repeated exchange of information over the time fosters the firm-bank relationship, reducing the probability to be credit denied. In this respect, Cole (1998) shows that a lender is more likely to extend credit to a firm with which it has a pre-existing relationship. Coherently, Chakravarty and Yilmazer (2009) show that the likelihood of loan approval is higher for firms having pre-existing loans with the same intermediary and it reduces with the number of credit sources. Boot (2000) and Albareto et al. (2011) provide evidence on the possibility of reducing asymmetric information and resolving free riding problems by means of information reusability over time.

2.1 Multiple banking

In a single banking regime, the bank might exploit its monopolistic position to gain extra-rents. This opportunistic behaviour may lead to credit constraint problems unless the firm establishes a second relationship that creates banking competition and reduces the imbalance in the bargaining power between the lender and the borrower. According to the studies of Sharpe (1990) and Kim et al. (2003), this unilateral dependence could result in hold-up problems and limit firm's credit access, by reducing the amount of financing sources or increasing interest rates. Nevertheless, De Guevara and Maudos (2009) show that an intermediate level of bank market power in financially developed areas decreases firms' financial constraints. However, it is rather clear that the recourse to multiple banking by firms is a strategy at mitigating the hold-up risk (Von Thadden, 1992). In fact, as shown by Cole (1998), multiple relationships reduce the value of private information generated by the potential lender through an exclusive and long lasting relationship with the borrower.

Detragiache et al. (2000) show that multiple banking is also an effective way to decrease the risk of a liquidity shortage. Indeed, a firm that borrows from several lenders is less likely to reduce its investments during financial crises since it has more sources to satisfy its credit needing. Bris and Welch (2005) find that the most profitable firms choose to have few banking relationships in order to signal their high credit quality. Von Rheinbaben and Ruckes (2004) focus on the trade-off between the benefits of multiple banking and the risk to disclose confidential information. On the one hand, banks need to know in detail firm's conditions and growth strategies in order to better assess its credit worthiness. One the other hand, an information leakage towards competitors is likely to happen if the firm has several banking relationships. It is therefore necessary for the firm to define the number of banks and which information to provide. Furthermore, Dewatripont and Maskin (1995) find that the probability of being credit constrained is higher in the presence of a significant number of banks. In a recent study, Gobbi and Sette (2014) show that Italian small and medium enterprises that borrow from fewer banks and those with more concentrated borrowing have a lower probability of being credit-rationed. In particular, banks pay attention to firms' debt structure and an excessive borrowing diversification could be interpreted as a signal of untrustworthiness. By contrast, some studies demonstrate that multiple banking could be the result of banks' strategy, in order to diversify their loan portfolio and reduce the risk of a liquidity crisis (Carletti et al. 2007).

2.2 Relationship strength

The analysis of firm-bank relationship strength is tightly linked to the aforementioned aspects. The measures of relationship strength used in the literature combine different indicators, such as the length, the breadth and the exclusivity of the relationship between the firm and the bank (Cotugno et al. 2013).

If a bank is the exclusive provider of financial services for its customer, it is assumed that there is a strong firm-bank relationship and this is more likely to occur in long-term relationship.

Strong connections may often be needed to extract proprietary soft information and to lend to small firms without sufficient hard information on which to base credit decisions (Berger et al., 2014). However, firms of all types may also benefit from strong banking relationships in which the bank is able to "reuse" hard and soft information gathered over the course of the relationship from loans, deposits, or other services. An important feature of strong firm-bank relationships is the production of soft information by means of the interaction between bank's loan officer and firm's manager (Cosci et al., 2015).

The existing literature provides different interpretations of the effects of relationship duration. Petersen and Rajan (1994) argue that longer or more concentrated relationships reduce firm's flexibility to change banks and provide the lender with monopolistic power to extract rents via higher interest rates. The duration of a financial relationship could even influence non-price terms of loans. The initial screening costs sustained by banks in information collection can be recouped through several repeated transactions over time, so the price of loans would decline in the duration of the relationship. Boot and Thakor (1994) argue that firm-bank information asymmetries are overcome when the relationship gets longer. Sharpe (1990) highlights that the consolidation of firm-bank relationship fosters private information exchange and allows to better assess firm's worthiness. On the other hand, a long relationship creates an information asymmetry between the incumbent bank and competing banks, as the main bank knows deeply its customer and may be able to offer better lending conditions. Ongena and Smith (2001) show that the likelihood of interrupting the firm-bank relationships increases as the time goes by and banks may be willing to extend credit and grant better lending terms in order to prevent firms from going to competitors. At the same time, a long lasting relationship determines a lock-in effect that limits firms' possibilities to leave the relationship. In this case, loan terms could worsen as relationship duration increases. For firms may be thus convenient to maintain a stable relationship with the main bank and short-term relationships with a number of other financial institutions in order to reduce the lock-in effects.

The accumulation of information capital over time and the possibility of an exclusive relationship with the borrower could lead the main bank to lengthen banking relationships. The main bank could exploit its competitive advantage on competing banks and not offer the best lending terms since switching costs limit borrower's financing option. Degryse and Van Cayseele (2000) find that lending terms are not always improving in relationship duration. Cole (1998) shows that a pre-existing relationship is an important factor to reduce the probability of credit rationing, but the duration is not relevant. By contrast, according to Angelini et al. (1998), Elsas et al. (2004),

Hernandéz-Canovas and Martìnez-Solano (2007), relationship duration reduces the probability of credit rationing, but it worsens lending conditions, i.e. higher interest rates are charged by banks.

The literature is discordant on the effects of debt concentration. On the one hand, a high concentration increases the bargaining power of the borrower towards the main bank and allows creating strong firm-bank relationships that could have beneficial effects, especially during periods of financial distress (Gobbi and Sette, 2014). On the other hand, firms have to diversify their debt in order to create banking competition and mitigate the hold-up risk (Von Thadden, 1992).

The structure of firms' debt and the choice between a dispersed or concentrated debt depend on firm's informational transparency. Guiso and Minetti (2010) find a positive relationship between borrowing differentiation and firms' informational transparency. Furthermore, they show a negative relationship between debt restructuring costs and debt diversification. When restructuring costs are sustainable, banks tend to prevent bad firms from defaulting in order to gain their assets during the debt restructuring process. Therefore, enterprises with high-value assets aim at diversifying their debt across several lenders in order to avoid banks' opportunistic strategies and reduce credit rationing.

2.3 Lending technologies and geographical proximity

Firm-bank relationships suffer from informational opacity that can result in credit rationing. Banks can employ lending technologies as a tool to mitigate these informational asymmetries (Steijvers and Voordeckers 2009). Berger and Udell (2006) define a lending technology as a combination of primary information sources, screening and underwriting procedures, loan contract structure and monitoring mechanisms. Lending technologies include a set of transactions technologies and relationship lending, which play a key role in credit allocation decisions. As pointed out by Cenni et al. (2014), technological innovations have allowed banks to process "soft" information, collected by close and long lasting relationships, similarly to quantitative "hard" information, leading to more rapid evaluation processes and improving credit access for opaque firms.

In their pioneering work, Stiglitz and Weiss (1981)**,** focusing on the role of collaterals to reduce the adverse selection problem, show that rationing may arise in competitive credit markets and the supply for loans may be reduced if banks are not able to distinguish between good and bad investment projects. Due to asymmetrical information, banks would prefer denying credit to opaque firms rather than increasing borrowing costs. So, collateral would be an important tool for the bank to mitigate informational asymmetries and thus solve the credit-rationing problem. Hernández-Cánovas, and Martínez-Solano (2010) show that the existence of trust between firm and bank improves access to financing and reduces the borrowing costs, whereas it increases the likelihood that guarantees will have to be provided.

Some studies have focused on the linkage between firm size and the type of screening and monitoring technologies. Stein (2002) proposes a theoretical model predicting that large banks tend to privilege relationships with medium and large companies, whereas they are less likely to grant lending to small businesses. This size discrimination is mainly due to large banks' assessment processes that rely on verifiable hard information, such as financial statements and balance sheets. Small firms' loans are mainly provided by small local banks, which are better able to form strong relationships with informationally opaque small businesses by maintaining close linkages with the entrepreneur and the local community. In line with Stein's model, Cole et al. (2004) find that for large firms a standardized approach is preferred and favours large banks, whereas a personalized approach should be used for small firms and it can be implemented more easily by small local banks. Recently, there have been some relevant refinements to the above paradigm. Hernández-Cánovas and Koëter-Kant (2008) also show that relationship lending increases the likelihood of long-term debt for small and medium enterprises in countries with less competition in the banking sector. Berger and Black (2011) show that large banks are not always advantaged in using hard technologies with large firms, while the comparative advantage of small banks in relationship lending is increasing in firm size.

Cotugno et al. (2013) argue that the distance between the bank and the firm influences credit availability, impairing bank's ability to collect soft information on borrowers. Several authors have analysed firm-bank proximity in terms of both geographical distance (i.e., the distance between the bank and the borrower) and functional distance (i.e., the distance between bank's local branches and headquarters). Petersen and Rajan (1995) show that geographical distance between borrowing firms and banks plays a key role on determining market power. Alessandrini et al. (2009) provide evidence that functional distance increases credit rationing probability, especially for small firms, while geographical distance does not impact on credit availability. Functional distance seems to be more appropriate to proxy cultural and social distance. In particular, the distance between bank's headquarters and operating branches is a proxy for organizational complexity and cultural distance inside the bank. In line with spatial price discrimination models, Degryse and Ongena (2005) also show that loan rates decrease with the distance between the firm and the lending bank and increase with the distance between the firm and competing banks. Monitoring costs are also related to physical distance, as banks sustain higher communication costs when the lender-borrower distance increases. Furthermore, even soft information deteriorates in the transmission within the bank organisation as the functional distance between hierarchical levels increases (Alessandrini et al., 2010). Sussman and Zeira (1995) highlight that lenders gain extra rents from close borrowers since more distant competing banks face higher monitoring costs and have to take them into account in their loan rate offers.

3. Data

3.1 Data sources

Our main data source was the dataset collected within the EFIGE project (European Firms in a Global Economy: internal policies for external competitiveness) supported by the Directorate General Research of the European Commission through its seventh Framework Programme and coordinated by Bruegel. The survey was conducted by GFK in 2010 and covers the years from 2007 to 2009. It allowed to create a harmonized European cross-sectional database in order to analyse a broad range of variables influencing firms' competitiveness, make analysis across countries and address policy making in Europe. The sample is composed of around 15000 manufacturing firms above ten employees from seven European economies (Germany, France, Italy, Spain, United Kingdom, Austria and Hungary). For the aims of our analysis, we focus on subsample of Italian firms for a total of 3021 observations. In order to guarantee representativeness of the collected data, the sample is stratified by taking into account industries, regions and firm size. Moreover, given their relevance, large firms were oversampled doubling their weight. The EFIGE dataset contains quantitative and qualitative information about R&D and innovation, labour organisation, financing and organisational activities and pricing behaviour. In particular, the section F of the survey – financial structure and bank-firm relationship – collects details on firm-bank relationship and credit rationing such as the number of banks financing firms, the length of the relationship with the main bank, the share of debt held by the main bank. Furthermore, we complement the survey with additional data from Bank of Italy and ISTAT not to neglect other Italian banking market factors accounting for regional and organisational dissimilarities.

3.2 Measurement

3.2.1 Credit access variables

Section F of the EFIGE survey provides detailed information on firms' financial structure and on their use of external financing. Before discussing the measures of firm's credit access used in the empirical analysis, it is worth remarking that all the questions related to external financing (and most of the questions of Section F) are asked only to those firms replying *'Yes'* to question F0 (*'Did your firm recur to external financing in the period 2008-2009? By external financing we mean funds not generated internally (not self-financing)'*). The specific structure of the questionnaire thus forces us to restrict the estimation sample of our model of credit demand and rationing to the 1860 firms (out of 3020) already having at least one source of external financing in the period 2008-2009. This may generate a first sample selectivity issue that should be properly assessed, as discussed in Section 4.

Conditional on external credit use, we define indicators of actual credit demand and financing constraints, based on firms' responses to the following questions:

(i) *'During the last year, was the firm willing to increase its borrowing at the same interest?'* (question F13)

(ii) *'During the last year, did the firm apply for more credit?'* (question F14).

In particular, we define a binary of actual credit demand (*Credit demand*) equal to one if the firm was willing to increase credit at the same interest rate of its current credit line in 2009 (i.e., it replies *'Yes'* to the question F13) and it actually applied for it (irrespective of the result of loan application). Conditional on credit demand, we define a second binary variable (*Credit rationing*) identifying those firms having their loan application rejected by financial intermediaries (i.e., those firms for which *Credit demand* is equal to 1 and replying *'Yes, applied for it but was not successful'* to question F14). As in Minetti and Zhu (2011), this latter variable provides a direct measure of what is usually labelled as "strong credit rationing" and allows to exactly identify firms that have been shut out from the credit markets because their loan applications were turned down.

Differently from other studies using similar survey data (Becchetti et al., 2010), we do not consider as rationed those discouraged firms abstaining from applying for a loan, despite they need additional financing. To the aims of our analysis this "weak" definition of rationing would have not allowed us to properly assess the determinants of banks' loan granting decision. It is also worth remarking that, differently from Cenni et al. (2015), we choose to treat discouraged borrowers as non-applying firms (for which *Credit demand* is equal to 0) and therefore we do not consider them in the estimation of the credit rationing equation. By focusing only on those firms that have actually applied for additional credit, we are able to more adequately analyse the conditional probability of bank's credit application denial against the probability of obtaining additional financing.[1]

3.2.2 Firm-bank relationship variables

Given the relevance of banking relationships for firms' access to credit in Italy, we focus on several variables capturing different aspects of firm-bank relationships. First, we consider the number of banking relationships a firm maintains, in order to assess how the probability of credit rationing varies as the number of banks increases. Second, we use firm's total bank debit held at its main bank to verify whether a high loan concentration mitigates rationing problems or it hinders the possibilities of gaining additional credit. Then, we consider the length (in years) of the relationship with the main

[1] To put it differently, in our analysis *Credit rationing* is observed only when *Credit demand*=1 and equals 1 when loan application was not successful or 0 when it was successful. Conversely, in Cenni et al. (2015) the binary indicator of rationing is observed only for firms desiring more credit and not conditional on actual credit demand. For this reason, this indicator is equal to 1 when the firm declared it had applied for credit but was rejected, but it equals 0 either when loan application was successful or when the firm decided not to apply despite needing additional funding.

bank to test the effects of long-lasting relationships on banks' credit granting decisions. As a confirmation of the significant role of bank relationships in supporting businesses, in our sample firms are characterised by an average number of banking relationships equal to 4, more than 45% of their debt is concentrated at their main bank and the average duration of their relationship with the main bank is of about 15 years.

3.2.3 Lending technologies

We consider three binary indicators for assessing the role of lending technologies on firm's access to external credit. We define this lending technology based on replies to question F16: *'Which type of information does the bank normally use/ask to assess your firm's credit worthiness?'*. In answering to this question, the firm was required to choose from a list of options, with multiple answers allowed.[2]

We considered a firm-bank lending relationship as based on a transaction lending technology if the firm indicates that balance sheet information and historical records of payments and debt service are normally used by banks to evaluate its credit worthiness. As pointed out by Cosci et al. (2015), this type of lending technology is thus characterised by lenders' use of quantitative and backward-looking "hard information", which is easy and relatively less costly to obtain, but can be insufficient to properly assess creditworthiness of innovative firms.

We further define a binary indicator of relationship lending technologies to assess the importance of soft information, collected by the bank through contacts over time with firm's owners and managers, to address information opacity issues. To construct this variable, in line with Cosci et al. (2015), we thus focus on factors related to private information accumulation. In particular, as in Ferri et al. (2016), our relationship lending variable equals one when firm's credit worthiness is assessed based on interviews with the management and on brand recognition.

Finally, we define an indicator for collateral lending technology if personal or asset-based guarantees are usually asked by banks when the firm applies for credit. As pointed out by Berger and Udell (2006), the pledging of collateral is often associated with financial statement lending, relationship lending, and credit scoring, and is used a secondary source of repayment. For this reason, following Berger and Black (2011) and Bartoli et al. (2013), we have decided to distinguish collateral lending from other hard technologies in order to disentangle its impact on firm's credit access.

[2] It is worth remarking that a possible shortcoming of these proxies is that they are based on firms' replies on banks' use of different information to assess their credit worthiness and thus may not capture the real screening processes adopted by financial intermediaries.

3.2.4 Control variables

In order to properly analyse the determinants of firms' access to external financing and mitigate omitted variable bias, we control for a large set of firm characteristics.

Firstly, we consider variables related to the structure of the firm and relate credit demand and rationing probabilities to firm age (in years) and size, proxied by two dummies for medium (with more than 50 to less than 250 employees) and large enterprises (with 250 or more employees). These variables are usually considered as standard proxies of a firm's riskiness and informational opacity. As pointed out by Presbitero et al. (2014), larger and older firms may not only have different external financing needs than small newly established firms, but they may also have better reputations and credit histories and may be more likely to provide verifiable information about their activities to banks.

We control for firm's export activity before 2008. There is ample evidence that exporters are more efficient and productive than domestic companies (Bernard and Jensen, 2004). Thus, we expect a positive impact on credit demand and a negative effect on the probability of being credit denied.

Firm's innovative activity is proxied by the average percentage of turnover invested in R&D during the 2007-2009 period. Since R&D activities need large financing sources and their result is uncertain, we expect businesses which invest a large share of their turnover in R&D to be more likely to apply for external credit and to be financially constrained.

We account for concentration of production activities, proxied by the percentage of 2008 turnover coming from firm's core. his variable provides a direct measure of a firm's exposure to business fluctuations (Muravyev et al., 2008). Credit constraints are thus expected to be more likely in firms which did not diversify their production activities. We include a further dummy indicating whether the firm has any form of quality certification, which certificates the efficiency and quality of production and hence it could be a good evidence of financial stability.

Firm's financial transparency is captured by a dummy for having received public subsidies. Businesses which manage to receive public funds may be perceived as more credit-worthy by banks and thus may have a lower rationing probability. At the same time, they have higher liquidity for their working capital and long-term investments and thus they may be less likely to apply for credit.

The structure of the market in which the firms operate is proxied by means of a dummy variable indicating that firm's main competitors are located in the European Union. The impact of this variable on external credit access is mixed. Operating in highly competitive markets may increase firms' efficiency and productivity, but it may lead to higher uncertainty, thus increasing the likelihood of financial constraints.

With respect to corporate governance, we used several controls on firm's shareholders, ownership and management. Firstly, a relevant distinctive feature in Italy is the prevalence of individual and domestic firms: in our sample, around 80% of the firms are individual and 95% are domestic. Thus, we add two dummies indicating whether the first shareholder is an individual or a

group of individuals and whether the first shareholder is domestic. We account for the degree of ownership concentration among the top three shareholders, measured by the Herfindahl-Hirschman index of firm's capital shares, and control for managers' decision-making autonomy, by means of a dummy indicating whether managers can take autonomous decisions in some key business areas. As pointed out by Atzeni and Piga (2007), a high concentration of decision-making power in the hands of one or few shareholders increases the attitude to pursue high-risk projects and may thus affect credit demand and rationing probabilities. We also include a dummy to control whether group membership influences firm's access to external. In fact, belonging to a group could allow firms to access internal financing network and makes them less likely to apply for external financing.

We further investigate whether the demographic characteristics of firm's Chief Executive Officer (CEO) are relevant in the assessment of a firm's creditworthiness. Thus, as in Aristei and Gallo (2016), we verify whether CEO gender influences firms' credit access and we further assess whether younger CEOs are penalized in banks' credit granting decisions.

We also investigate the importance of credit market characteristics on firms' credit demand and financing constraints. In particular, we consider the regional Herfindahl-Hirschman concentration index of bank and the number of bank branches on the resident population in each region, as proxies for concentration of lending and spatial competition of the regional banking systems, respectively. Similarly, following the recent literature on the role of bank proximity on credit allocation (Alessandrini et al., 2009), we use an aggregate measure of functional distance in local banking systems (i.e., the distance between decision-making centres and local branches), defined as the average distance between banks' headquarters and local branches at the regional level. Finally, we include industry fixed effects to control for sectoral heterogeneities.

Table A1 in the Appendix reports complete variable definitions, while Table A2 presents descriptive statistics of all the explanatory variables considered for the whole estimation sample and for the subsamples of firms using external finance, for those having applied for additional credit and for those firms being credit denied. Table 1 provides some descriptive evidence on access to credit and firm-bank relationships disaggregated by firm size. As we can notice in panel a), more than 60% of the enterprises in our sample recur to external financing and, when disaggregating by firm size, this trend is more evident and pronounced for medium enterprises. Conditional on the use of external financing, approximately one third of the firms applied for more credit at the same interest rate of their current credit line in 2009. Large companies are characterised by a slightly higher propensity to demand credit (34.7%) than small (32.1%) and medium firms (29.3%). As regards financing constraints, more than 38.4% of the firms that applied for additional external credit were denied. When disaggregating by firm size, we notice only minor differences in credit rationing frequencies among the three size classes, with medium sized enterprises showing the highest frequency of credit constrained firms (42.2%).

Table 1 – Credit access, lending technologies and banking relationships: descriptive statistics by firm size

	All Firms	Small	Medium	Large
a) Access to external financing				
External finance use	0.6129	0.6051	0.6719	0.6204
Credit demand	0.3182	0.3213	0.2928	0.3465
Credit rationing	0.3846	0.3794	0.4219	0.3997
b) Lending technologies and firm-bank relationships				
Collateral lending	0.4610	0.4805	0.3407	0.3521
Transactional lending	0.9473	0.9460	0.9552	0.9562
Relational lending	0.3405	0.3139	0.4976	0.5462
Number of banks				
Mean	4.01	3.71	5.87	7.44
Min	1	1	1	1
Median	3	3	5	6
Max	30	20	30	30
Main bank's debt share				
Mean	46.16	47.15	40.34	38.18
Min	0	0	1	1
Median	40	40	35	30
Max	100	100	100	100
Relationship duration				
Mean	16.18	16.12	16.67	15.67
Min	1	1	1	1
Median	13	13	15	10
Max	99	99	70	99

Notes: the proportion of credit demanding firms and all the descriptive statistics on lending technologies and firm-bank relationships are conditional on the use of external finance (i.e., External finance use = 1). The proportion of rationed firms is instead conditional on credit demand (i.e., Credit demand = 1). Descriptive statistics are computed using sample weights.

From panel b), we notice that transactional lending is the most used lending technology: on average, around the 95% of the firms are usually evaluated based on balance sheet information, historical records of payments and debt service. This is true both for small, medium and large companies. Furthermore, if it is common to recur to transactional lending, the diffusion of close firm-bank relationships appears to increase in firm size. In fact, while around one third of small firms' lending relationships are based on a relational lending technology, more than the half of medium and large enterprises in our sample are usually assessed by banks through private information gathered through contact over time. As regards collateral lending, around the 46% of firms have to pledge their assets when requiring external funds. The proportion is higher for small businesses, whereas medium and large enterprises are less likely to be asked to provide additional collateral guarantees.

Finally, firm-bank relationships are very heterogeneous across size classes. It is not surprising that in a bank-oriented system like Italy there is an ample diffusion of multiple banking. On average, Italian firms have on average around 4 banking relationships (with some firms maintaining 30 relationships) and the number increases in firm dimension. Notwithstanding the ample spread of multiple banking, firms' tendency to concentrate debt at their main bank is also evident. This is true especially for small firms that hold almost 50% of their loans at their main bank. This share decreases in firm size and the reduction appears to be connected to the progressive increase in the

mean number of banks for medium and large companies. Finally, average relationship duration with the main bank is rather long and amounts to around 16 years. On the one hand, Italian firms tend to hold stable relationships with the main bank; on the other hand, they recur to a large number of different banks. In line with Ongena and Smith (2001), this seemingly conflicting evidence could be a strategy adopted by the firms: long-term relationships appear valuable to multiple-bank firms, as the availability of alternative financing sources reduces holdup threats from one monopolistic bank.

4. Econometric methods

4.1 Sample selection bias and empirical model specification

We define a firm as credit rationed if it demanded for more credit and its application was not successful. Therefore, we can observe the denial of additional external funds only if the firm actually applied for additional external financing. This may cause a substantial selection bias since firms that are more likely to have an application rejected are also more likely to refrain from applying (Brown et al., 2011). To cope with this selectivity issue, we use a bivariate probit accounting for endogenous sample selection (Wynand and van Praag, 1981). This binary choice model is composed by two equations: a selection equation to model the probability of applying for more credit and an outcome equation to model the probability of being credit rationed. Formally:

Selection equation (*credit demand*):

$$D_i = \mathbf{1}(\boldsymbol{z}_i'\boldsymbol{\alpha} + \nu_i > 0) \quad (1)$$

Outcome equation (*credit rationing*):

$$R_i = \mathbf{1}(\boldsymbol{x}_i'\boldsymbol{\beta} + \mu_i > 0) \quad (2)$$

the first equation is the selection equation and the outcome variable R is observed only if $D_i = 1$. $\boldsymbol{x_i}$ and $\boldsymbol{z}_i$ represent the vectors of explanatory variables for R_i and D_i, respectively, and $\boldsymbol{\beta}$ and $\boldsymbol{\alpha}$ are the corresponding vectors of parameters. The error terms ν_i and μ_i are assumed to follow a standard bivariate normal distribution with unit variances and correlation ρ.

Within this framework, selectivity operates through error correlation. If $\rho \neq 0$, estimates of the outcome equation will be biased if we do not account for selection. The sub-sample of credit rationed firms is in fact non-random and selectivity produces systematically biased parameters (Greene, 2012). Conversely, when $\rho = 0$, the system of equations (1) and (2) can be consistently estimated by means of a probit for the probability of requiring more credit and a separate probit for the probability of being credit denied, estimated on the sub-sample of firms that applied for additional funds.

The endogeneity of the sample selection mechanism implies that the probability of being credit rationed, conditional on applying for more credit, is given by:

$$Prob(R_i = 1|D_i = 1) = Prob(\boldsymbol{x}_i'\boldsymbol{\beta} + \mu_i > 0|D_i = 1) = \frac{\Phi_2(\boldsymbol{x}_i'\boldsymbol{\beta}, \boldsymbol{z}_i'\boldsymbol{\alpha}, \rho)}{\Phi(\boldsymbol{z}_i'\boldsymbol{\alpha})} \quad (3)$$

where $\Phi(\cdot)$ and $\Phi_2(\cdot)$ denote univariate and bivariate standard normal CDFs, respectively.

The parameters of the system of equations (1) and (2) can be estimated by means of a maximum likelihood estimation approach. The corresponding log-likelihood function can be defined as:

$$logL(\boldsymbol{\beta}, \boldsymbol{\alpha}, \rho) = \sum_{D_i=1,R_i=1} \Phi_2(\boldsymbol{x}_i'\boldsymbol{\beta}, \boldsymbol{z}_i'\boldsymbol{\alpha}, \rho) + \sum_{D_i=1,R_i=0} \Phi_2(-\boldsymbol{x}_i'\boldsymbol{\beta}, \boldsymbol{z}_i'\boldsymbol{\alpha}, -\rho) + \sum_{D_i=0} \Phi(-\boldsymbol{z}_i'\boldsymbol{\alpha}) \quad (4)$$

If $\rho = 0$, the log-likelihood for the probit model with sample selection reduces to the sum of the log-likelihoods of two simple probit models.

In our analysis, we assess the effects of firm-bank relationships on credit demand and rationing probability, with a particular focus on the role of firm size. To this latter aim, we added interaction terms to link banking variables to firm size. Formally, our empirical specification for the selection and output equations is as follows:

$$D_i = \alpha_0 + \alpha_{0,M} Medium_i + \alpha_{0,L} Large_i + \boldsymbol{BV}_i'\boldsymbol{\alpha_1} + Medium_i \times \boldsymbol{BV}_i'\boldsymbol{\alpha_{1,M}} + Large_i \times \boldsymbol{BV}_i'\boldsymbol{\alpha_{1,L}} + \boldsymbol{Z_2}_i'\boldsymbol{\alpha_2} + \nu_i \quad (5)$$

$$R_i = \beta_0 + \beta_{0,M} Medium_i + \beta_{0,L} Large_i + \boldsymbol{BV}_i'\boldsymbol{\beta_1} + Medium_i \times \boldsymbol{BV}_i'\boldsymbol{\beta_{1,M}} + Large_i \times \boldsymbol{BV}_i'\boldsymbol{\beta_{1,L}} + \boldsymbol{X_2}_i'\boldsymbol{\beta_2} + \mu_i \quad (6)$$

where firm size indicators (*Medium*; *Large*) are fully interacted with the vector of banking variables $\boldsymbol{BV}$, which includes lending technologies indicators (*Collateral lending*; *Transactional lending*; *Relationship lending*) and firm-bank relationships variables (*Number of banks; Main bank share*; *Main bank length*), in both the outcome and selection equations. We also control for a wide range of observable characteristics, reflecting firm's economic fundamentals, solvency and creditworthiness. Specifically, the sets of additional explanatory variables $\boldsymbol{Z_2}$ and $\boldsymbol{X_2}$ include firm's characteristics, corporate governance indicators, sectoral dummies and regional credit market variables. A standard approach to improve model identifiability is to impose exclusion restrictions. Following Brown et al. (2011), we include only in the selection equation (i.e., only in $\boldsymbol{Z_2}$) a variable for firm's perception of the financial dependence of the sector in which it operates and a dummy variable indicating whether the firm perceives labour market regulations and legislative or bureaucratic restrictions as main factors preventing growth. This identification strategy is based on the assumption that firm's perception on sectoral financial dependence and factors hampering growth affect its loan demand behaviour, but they do not directly influence banks' loan granting decision.

4.2 A further possible source of sample selection bias

An additional possible problem of sample selection that can bias our estimates stems from the way survey questions were designed. In particular, most questions of section *F* of the EFIGE questionnaire (and in particular those related to the need of additional external funds, actual credit demand and results from loan application) are asked only to firms that already recur to external financing in the period 2008-2009. In particular, since firms applying for additional external

financing can be observed only if they have a pre-existing credit relationship, the estimation sample of our model of credit rationing may not be considered as a random draw from the underlying population. This may cause a further potential selectivity issue that can bias our estimates. Therefore, it is necessary to verify whether recurring to external financing and applying for additional credit can be considered as two independent decisions. To this aim, we consider the following additional bivariate probit model with sample selection:

Selection equation (*external finance use*):

$$U_i = \mathbf{1}(\boldsymbol{r}_i'\boldsymbol{\gamma} + \xi_i > 0) \quad (7)$$

Outcome equation (*credit demand*):

$$D_i = \mathbf{1}(\boldsymbol{z}_i'\boldsymbol{\alpha} + \nu_i > 0) \quad (8)$$

and test the statistical significance of the correlation coefficient between ξ_i and ν_i. Failing in rejecting the null hypothesis of no errors correlation allows ignoring the additional sample selectivity issue and provides support to the appropriateness of estimating the credit rationing model on the subsample of firms already recurring to external finance.

4.3 Graphical analysis and marginal effects

In binary choice models, raw coefficients are often not of primary interest, as researchers are mainly interested in quantifying the impact of explanatory variables on outcome probabilities (Jann, 2014). Moreover, in non-linear regression models interpretation of estimation results can be challenging, especially if there are interaction effects and categorical variables. In particular, non-linearity of our bivariate probit models does not allow us to directly interpret the interaction effects cannot be directly interpreted as they would be in linear models. As pointed out by Ai and Norton (2003), interaction effects may have different signs for different values of explanatory variables and the corresponding coefficients are not necessarily indicative of the direction of the effects and their statistical significance should not be tested with a simple *t*-test.

Since one of the main aims of our analysis is to assess the impact of banking relationships on firms' access to credit and test whether it varies according to firm size, we follow Long (2009) and focus on differences in predicted probabilities across groups. For discrete explanatory variables, like the three lending technology indicators considered, discrete change effects (i.e., the impact of a discrete change of the covariate) coincide with differences in predicted probabilities and can be directly used to assess differences across groups. For continuous regressors, marginal effects measure the change in predicted probability due to a marginal change in the explanatory variable (i.e., the partial derivative of the response with respect to the covariate) and, despite allowing to assess how estimated impacts varies across groups, they may be not fully informative for group comparison purposes (Greene, 2010). Long (2009) suggests examining differences in predicted probabilities across groups at different levels of the

explanatory variable of interest: since predicted probabilities are unaffected by differences in residual variation, groups can be compared by testing the equality of predicted probabilities at multiple values of the independent variables. Furthermore, Greene (2010) points out that the graphical representation of these differences is one of the most effective ways to describe interaction effects and inform on model implications. We thus follow this approach in order to correctly analyse the effects of the number of banks, main bank's debt share and relationship duration on the probabilities of credit demand and rationing across different firm size classes. In particular, in Section 5.3 we present the graphical representation of the predicted probability profiles (in levels and differences) of our firm-bank relationship variables across small, medium and large firms.[3]

5. Results

Main estimation results on the determinants of access to external financing for Italian firms are presented in Table 2. First of all, it is worth remarking that the additional selectivity issue between recurring to external financing and demanding for additional credit is not relevant. Results from bivariate probit model with endogenous selectivity (presented in Table A2 in Appendix A) point out that errors correlation coefficient is equal to -0.1804 and is not statistically significant. Recurring to external financing and applying for additional credit are two independent decisions and the subsample of demanding firms can be thus considered as a random draw from the population of interest. Second, we notice that in our main model credit demand and rationing cross-equation error correlation is equal to -0.7216 and it is statistically significant at the 1% level. Coherently with Brown et al. (2011), this confirms that loan rejection probability is affected by an endogenous selection effect, with firms that are more likely to be denied credit being also less likely to apply in the first place, and supports the necessity of properly correcting for selectivity bias.

5.1 Firm-level control variables and regional banking market factors

We find that firms with a young CEO, as well as those characterised by high levels of product concentration and facing EU competitors, are more likely to be denied credit. Moreover, firm's age has a positive and decreasing effect on rationing probability, as highlighted by the negative sign of the squared term, which is however significant only at the 10% level. By contrast, firms with a domestic first shareholder, companies that exported before 2008 and those that have received public incentives are less exposed to financial constraints.

[3] All the graphs have been produced using the package *coefplot* (Jann, 2014) in Stata. In the Supplementary Appendix B, we report the values (and the corresponding group differences, together with their robust standard errors) of the estimated credit demand (Tables B1, B3 and B5) and rationing (Tables B2, B4 and B6) probabilities, used to construct the graphs reported in Figures 2, 3 and 4.

Table 2 – The determinants of credit demand and rationing

	Credit rationing		Credit demand	
Variables	Coefficient	Standard Error	Coefficient	Standard Error
Age	0.0131*	0.0067	-0.0087***	0.0030
Age^2	-0.0001*	0.0001	0.0001**	0.0000
Medium	1.0829***	0.3205	-0.3850	0.4604
Large	5.0915***	0.4062	-0.2582	0.2353
Individual first shareholder	-0.2173	0.1535	0.0518	0.1076
Domestic first shareholder	-0.6680*	0.3431	0.4543*	0.2327
Group	0.0598	0.1690	0.1160	0.0818
Ownership concentration	-0.1222	0.1451	0.2293***	0.0634
Family managed	-0.0051	0.0974	-0.0425	0.0735
Decentralized management	-0.0214	0.1148	0.0359	0.0445
Export before 2008	-0.1651***	0.0541	-0.0342	0.0830
RD investment share	-0.0007	0.0030	0.0149***	0.0036
Young CEO	0.3070***	0.0855	-0.1287	0.1183
Female CEO	0.0036	0.0853	0.0054	0.0717
Public incentives	-0.1739***	0.0480	-0.0112	0.0864
Quality certification	0.0342	0.0755	0.0427	0.0882
Product concentration	0.0066***	0.0018	-0.0034	0.0021
EU competitors	0.1897***	0.0466	0.0289	0.0388
Branch density	0.2005	0.3214	-0.2847	0.2053
Bank loans concentration	0.0002	0.0004	0.0001	0.0003
Functional distance	0.1666	0.1457	0.0306	0.0495
Collateral lending	0.2043**	0.0947	0.4234***	0.0775
Collateral lending × Medium	-0.2571	0.2944	0.0883	0.3155
Collateral lending × Large	-0.3285**	0.1661	-0.0181	0.0736
Transactional lending	-0.0508	0.0786	0.1620**	0.0746
Transactional lending × Medium	-0.7695**	0.3425	-0.2157	0.3590
Transactional lending × Large	-6.2862***	0.2707	-0.5153***	0.0419
Relationship lending	-0.0645	0.0720	-0.0587	0.0671
Relationship lending × Medium	0.0332	0.2592	0.0982	0.1864
Relationship lending × Large	-0.2835*	0.1580	0.3288***	0.0945
Number of banks	-0.0435***	0.0111	0.0434**	0.0191
Number of banks × Medium	0.0472**	0.0216	-0.0145	0.0326
Number of banks × Large	0.0534***	0.0160	-0.0336*	0.0195
Main bank's debt share	-0.0038**	0.0016	0.0072***	0.0024
Main bank's debt share × Medium	-0.0047	0.0063	0.0216	0.0131
Main bank's debt share × Large	0.0168***	0.0034	0.0291***	0.0024
Main bank's $debt\ share^2$			-0.0001*	0.0000
Main bank's $debt\ share^2$ × Medium			-0.0002**	0.0001
Main bank's $debt\ share^2$ × Large			-0.0003***	0.0000
Relationship duration	-0.0015	0.0024	-0.0080	0.0062
Relationship duration × Medium	-0.0145***	0.0040	0.0083	0.0185
Relationship duration × Large	0.0236***	0.0090	0.0436***	0.0101
$Relationship\ duration^2$			0.0001	0.0001
$Relationship\ duration^2$ × Medium			-0.0001	0.0002
$Relationship\ duration^2$ × Large			-0.0009***	0.0001
Sector financing dependence			0.2583***	0.0154
Growth obstacles perceived			0.1448***	0.0170
Intercept	0.2314	0.7060	-2.4106***	0.4420
ρ	-0.7252***	0.1061		
Sector fixed-effects	Yes [0.0000]		Yes [0.0000]	
Number of observations	1860			
Log-likelihood	-1386.19			

Notes: robust standard errors, clustered at the sectoral level, are reported next to parameter estimates. P-values for the joint significance of sector fixed effects are reported in square brackets.
***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Demanding additional credit depends positively on first shareholder's domestic origin, ownership concentration, R&D investments. Conversely, credit demand probability reduces, at a decreasing rate, as firm's age increases.[4] Perceived business obstacles sectoral and financial dependence significantly increase the likelihood of applying for additional external financing, supporting the validity of out identification strategy. Results from the Wald tests for the joint significance of sector fixed effects highlight the presence of significant heterogeneities of both credit demand and rationing probabilities at the sectoral level.

With respect to the regional-level banking market characteristics, neither branch density nor the Herfindahl-Hirschman concentration indexes of bank loans display significant coefficients. Thus, the spatial proximity and the competitiveness of the regional banking market does not seem to affect firms' access to credit. Moreover, even the regional functional distance indicator, measuring the average distance between customers and the banks' decision centres, does not exert any significant effect on credit demand and rationing. As pointed out by Cenni et al. (2015), the insignificance of the proximity and functional distance variables is somewhat expected and is related to the lack specific information on the organizational structure of the banks with which the firm actually has relationships.

5.2 Firm size

Results reported in Table 2 highlight that firm's dimension matters in explaining demand dynamics and rationing problems. Furthermore, size has also a non-negligible "mediated" effect on the depth and strength of relationships, as pointed out by the significance of most of the interaction effects. However, from the estimated coefficients reported in Table 3, it is not possible to correctly assess the role of firm size on access to credit, due to the non-linearity of the model and to the inclusion of interaction terms. For this reason, we firstly evaluate the average marginal effects of firm size, computed for each factor level (*Medium* and *Large*) as the discrete changes of both credit request and rationing probabilities from the base level (*Small*). Results are presented in Figure 1. As it can be noticed, medium-sized businesses show a lower probability (-3.1%) of applying for additional funds than small firms, whereas no significant differences in rationing probability can be pointed out. Large companies do not significantly differ from small firms in terms of both loan demand and denial probabilities. The evidence obtained may be indicative of the significant role of lending technologies and firm-bank relationships in reducing information asymmetries and mitigating financing constraints of small-sized enterprises.

[4] It is worth remarking that the average marginal effect of age on the probability of demanding additional credit is equal to -0.0016 and is statistically significant at the 1% level. Conversely, the average marginal effect of age on the conditional rationing probability is equal to 0.0017, but it is not statistically significant.

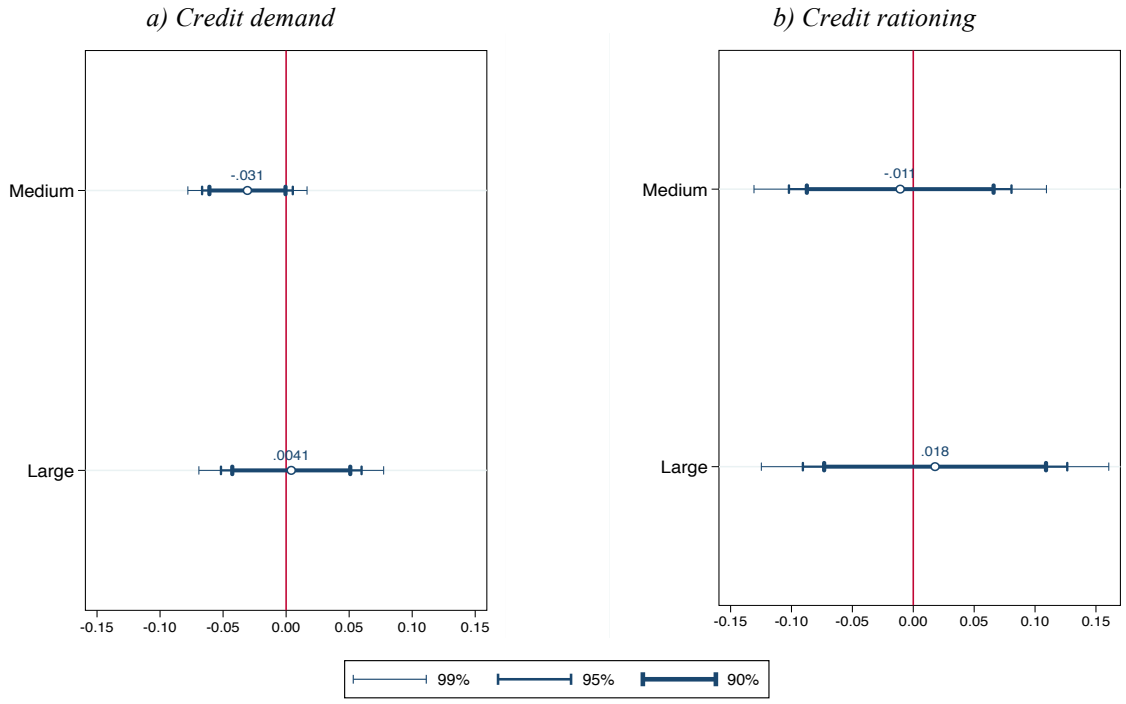

Figure 1 – Firm size and credit demand and rationing probabilities: average marginal effects

Despite firm size does not seem to have a significant direct impact on credit demand and rationing probabilities, it may exert an indirect effect on the role of banking relationship variables on firms' credit access conditions. Therefore, in the next sub-sections we will explicitly assess the role of lending technologies and firm-bank relationships for each firm size group and test for the existence of significant differences across different size groups in their effects on loan demand and credit rationing probabilities.

5.3 Lending technologies

Table 3 reports average marginal effects of lending technologies on credit demand and rationing probabilities. Overall, firms that are usually asked to provide collateral or are evaluated based on a transactional lending technology have a higher probability of applying for additional funds. The overall marginal effect for relationship lending is instead not statistically significant. When considering average marginal effects mediated by firm's size, we observe that small and large firms that are evaluated based on a collateral lending technology are more likely to require additional credit, while the marginal effect is positive but statistically significant only at the 10% level for medium-sized firms. As regards transactional lending, we found statistically significant evidence that large companies are less likely to require more financing when their creditworthiness is evaluated based on hard information. The use of transactional lending technology increases instead

credit demand probability of small firms. Finally, relationship lending increases the probability of applying for additional funds for both small and large enterprises.

As regards conditional rationing probabilities, we find an overall positive and statistically significant relationship between recurring to collateral lending and being credit denied, while an opposite evidence for transactional and relational lending. Firms that are usually asked to provide collateral guarantees when applying for external financing show a 17.1% higher probability of being credit constrained. In particular, being asked to pledge collateral guarantees increases the probability of rationing for small businesses by 18.5 percentage points, while we do not find a statistically significant impact for medium and large companies. Providing collateral does not seem to be effective in mitigating informational asymmetries and thus solving credit rationing issues. As pointed out by Berger and Udell (2006), banks tend to assess firms' credit worthiness using soft and hard information and collateral is used as a secondary source of repayment. Moreover, several empirical studies (see Steijvers and Voordeckers, 2009) show that the pledging of collateral is positively associated with the observable firm risk. In this respect, firms may be usually asked to provide personal or asset-based guarantees as they are perceived by banks as riskier and less creditworthy. This leads, all other things being equal, to a significant increase in the actual probability of credit rejection, especially for small-sized enterprises.

Analysing average differences in rationing probabilities mediated by firm size, we observe that medium and large companies significantly benefit from transactional lending, while the use of this technology does not affect the rationing probability does not vary significantly of small businesses.

Table 3 – Lending technology indicators: marginal effects on credit demand and rationing probabilities

	Overall	Small	Medium	Large
a) Discrete change effects on credit demand probability				
Collateral lending	0.1413***	0.1384***	0.1624*	0.1323***
	(0.0240)	(0.0250)	(0.0967)	(0.0084)
Transactional lending	0.0390*	0.0500**	-0.0163	-0.1165***
	(0.0224)	(0.0225)	(0.1059)	(0.0240)
Relationship lending	-0.0132	-0.0186	0.0118	0.0852***
	(0.0184)	(0.0212)	(0.0496)	(0.0107)
b) Discrete change effects on the conditional probability of being rationed				
Collateral lending	0.1709***	0.1847***	0.0935	0.0333
	(0.0364)	(0.0374)	(0.0835)	(0.0593)
Transactional lending	-0.0417***	0.0154	-0.3556***	-0.6649***
	(0.0161)	(0.0126)	(0.0960)	(0.0204)
Relationship lending	-0.0350*	-0.0388**	-0.0039	-0.0730*
	(0.0211)	(0.0184)	(0.1252)	(0.0414)

Notes: the marginal effect of each lending technology variable has been computed as the discrete change in demand and rationing probabilities when the binary indicator shifts from 0 to 1. Robust standard errors, clustered on industry sectors, are reported in brackets under parameter estimates.
***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

As regards relationship lending technology, both small and large firms obtain a significant advantage when banks assess them through collection of soft information. Access to credit is significantly improved for small and large firms (with a reduction of rationing probability of 3.9 and 7.3 percentage points, respectively) whose creditworthiness assessment is based on interviews with the management and on brand recognition. This result may be also indicative of a strategic behaviour adopted by those firms that are more dependent on external financing, which are willing to disclose confidential information to lenders in order to obtain better lending conditions and reduce the probability of being credit constrained.

5.4 Firm-bank relationships

In analysing the role of firm-bank relationship variables on firms' access to credit, we first analyse average marginal effects for number of banking relationships, debt concentration and duration. Then, we focus on the patterns of predicted probabilities of applying for additional financing and credit rationing for different levels of our banking relationship variables. Moreover, following the approach suggested by Long (2009) and Greene (2010), we analyse graphically the effects of number of banks, main bank's debt share and relationship duration mediated by firm size. Specifically, for each of the three size classes, we show how predicted probabilities vary as banking variables range from the 1st to 99th percentiles and assess the statistical significance of the differences in predicted probabilities for both large and medium-sized enterprises against small firms.

Before analysing predicted probability patterns, in Table 4 we report the average marginal effects of banking variables on the probability of applying for additional funds and being denied credit.

Table 4 – Firm-bank relationship variables: marginal effects on credit demand and rationing probabilities

	Overall	Small	Medium	Large
a) Marginal effects on credit demand probability				
Number of banks	0.0130***	0.0139**	0.0087	0.0031***
	(0.0050)	(0.0061)	(0.0079)	(0.0011)
Main bank's debt share	0.0009***	0.0007***	0.0018	0.0025***
	(0.0003)	(0.0002)	(0.0014)	(0.0004)
Relationship duration	-0.0015	-0.0019	-0.0001	0.0041***
	(0.0013)	(0.0041)	(0.0032)	(0.0008)
b) Marginal effects on the conditional probability of being rationed				
Number of banks	-0.0059**	-0.0081***	0.0079	0.0054**
	(0.0028)	(0.0030)	(0.0055)	(0.0023)
Main bank's debt share	-0.0010**	-0.0010**	-0.0017	0.0054***
	(0.0005)	(0.0005)	(0.0016)	(0.0005)
Relationship duration	-0.0022**	-0.0019	-0.0063***	0.0099***
	(0.0011)	(0.0012)	(0.0010)	(0.0020)

Notes: robust standard errors, clustered on industry sectors, are reported in brackets under parameter estimates
***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Overall, we find a positive impact of multiple banking and debt concentration on the probability of requiring more credit. The effect of the duration of the relationship with the main bank is not statistically significant at an aggregate level, while for large companies we find a negative and significant marginal effect. Conversely, the number of banking relationships positively affects the probability that both small and large businesses require more credit. As regards debt concentration, applying for additional external financing is more likely when both small and large firms hold a large debt share at their main bank.

On average, recurring to multiple banking, debt concentration and relationship duration significantly reduce credit constraints probability. However, when we disaggregate the analysis by firm size, several differences emerge, especially between small and large firms. Small enterprises are less likely to be rationed as the number of relationships increases, while the probability of credit rejection tends to increase with the number of banks for large companies. As regards debt concentration, we find again a contrasting result for small and large enterprises. Debt concentration at the main bank is advantageous for small firms, but it significantly increases the probability of rationing for large companies. Similarly, a long relationship with the main bank reduces small and medium businesses' financing constraints, while the opposite impact is found for large enterprises.

In order to deepen the analysis of role of banking relationships on firm access to finance and properly assess its heterogeneity across firm size groups, in the next sub-sections we analyse the patterns of predicted credit demand and rationing probabilities for each of the three dimensions of firm-bank relationships considered.

5.4.1 Number of banks

Figure 2 shows the patterns of the predicted probabilities of demanding more credit and being rationed for small, medium and large firms at different levels of number of banks (ranging from 1 to 20, the 1st and 99th percentiles of the observed distribution, respectively), together with the profiles of the corresponding differences across size groups.

The probability of requiring more credit is increasing in the number of banks for all the three size classes (Figure 2a). Overall, the differences in the probabilities disaggregated by firms' size are not statistically significant (Figure 2b).

As regards the probability of credit rationing (Figure 2c and 2d), our results are only partially in line with Cenni et al. (2015). We find an opposite evidence splitting up SMEs into small and medium firms: on the one hand, large and medium firms are more likely to be denied credit when the number of banks increases; on the other hand, small firms show a contrary trend, the probability of being denied credit is decreasing in the number of banks. At the mean level of the variable (5

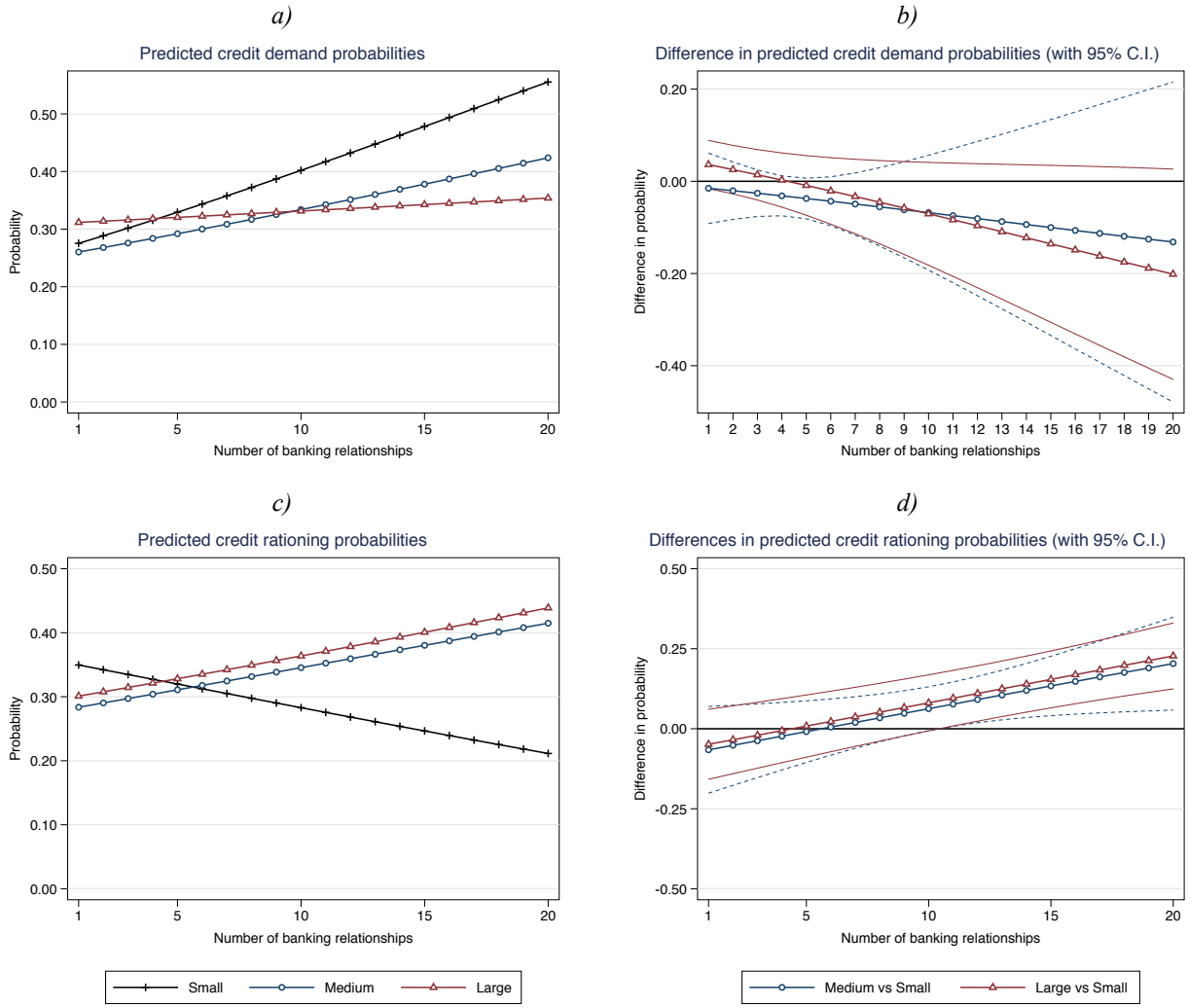

Figure 2 – Number of banks relationships and credit demand and rationing probabilities.

banking relationships), the probability of credit rationing is almost the same for medium and small firms, around 32%, and slightly higher for large firms, almost 34%. The differences between medium and small firms, as well as differences between large and small, are significantly different from 0 only when the number of banks is higher than 10.

Our findings show that medium and large firms don not benefit from extending their number of banking relationships. This result is consistent with previous empirical literature: Petersen and Rajan (1994), Berger and Udell (1995), Dewatripont and Maskin (1995), Cole (1998), Haroff and Körting (1998), Degryse and van Cayseele (2000) highlight that multiple banking leads to weak relationships between lenders and borrowers with consequent credit constraints. Conversely, we find an opposite result for small firms, for which rationing probability is decreasing in the number of banks. This evidence is discordant with the literature asserting that small and opaque firms have advantages from a limited number of relationships based on a deep knowledge of the counterpart. Sharpe (1990) suggests that a strong relationship with the main bank leads to information rents and reduces credit rationing probability. By contrast, Detragiache et al. (2000) show that firms can

decrease liquidity problems by recurring to several micro-loans from different banks. Loans diversification allows firms to maintain relationships with a number of banks and to rely on a large range of lenders to satisfy their credit needing.

5.4.2 Main bank's debt share

The effect on the probability of requiring more credit is not monotonic for all the three size classes when debt concentration varies from 0 (the 1st percentile of the observed distribution) to 100% (the 99th percentile) (Figure 3a). The difference between medium and small firms is negative and statistically significant for levels of concentration higher than 85%, while the difference between large and small enterprises is negative and statistically significant for levels of concentration up to 10% and higher than 80%, while it becomes positive and significant when debt share is between 30% and 55% (Figure 3b).

We observe that firm size significantly affects the pattern of the effect of main bank's debt share on credit rationing probability (Figure 3c). The difference medium versus small is statistically significant beyond a level of consolidation around 70%, while the difference large versus small is statistically significant for levels of main bank's debt share up to 25% and beyond 55% (Figure 3d). For large firms, credit rationing probability is increasing in main bank's debt share up to a level around 65%, then the trend is slightly decreasing. For main bank's debts beyond the 45% threshold, large firms' exposure to credit rationing is higher than that of small and medium firms. The relationships between banks and large firms do not depend necessarily on strong ties, due to less opacity than small and medium enterprises in the process to assess their creditworthiness. Our results show that a higher debt concentration at the main bank is not beneficial for large companies. Indeed, large firms need high amounts of capital for their investments, which might require too many resources for a single institution and, beyond a certain level, the main bank may be unwilling or not able to finance the firm especially in a period of high financial distress. On the contrary, the probability of credit rationing for medium and small enterprises is basically decreasing in main bank's debt share.[5] This result is consistent with the evidence pointed out by Bongini et al. (2009), who highlight that even small levels of consolidation, just higher than 15%, are sufficient to improve the screening and controlling of opaque firms. Medium enterprises are more likely to be rationed than small firms for levels of concentration up to 50%; then, the opposite is true. As Petersen (2004) explains, economies of scale and information monopoly lead the

[5] Unfortunately, EFIGE data do not provide information on the size of the loan requested by firms and thus we cannot directly assess the role of loan amount on credit rationing probability. However, data from the EC/ECB Survey on the Access to Finance of Enterprises (SAFE) confirm that in Italy large firms apply for loans of significantly larger amount than small and medium enterprises. Specifically, about the 80% of the loans requested by large firms have a dimension over 1 million of euro. Conversely, the 60% of loans requested by small and micro enterprises considered together does not exceed 100,000 euro and only the 3% of them have an amount larger of 1 million. This descriptive evidence can contribute to explain the heterogeneity in credit rejection probability according to firms' size pointed out by our empirical findings.

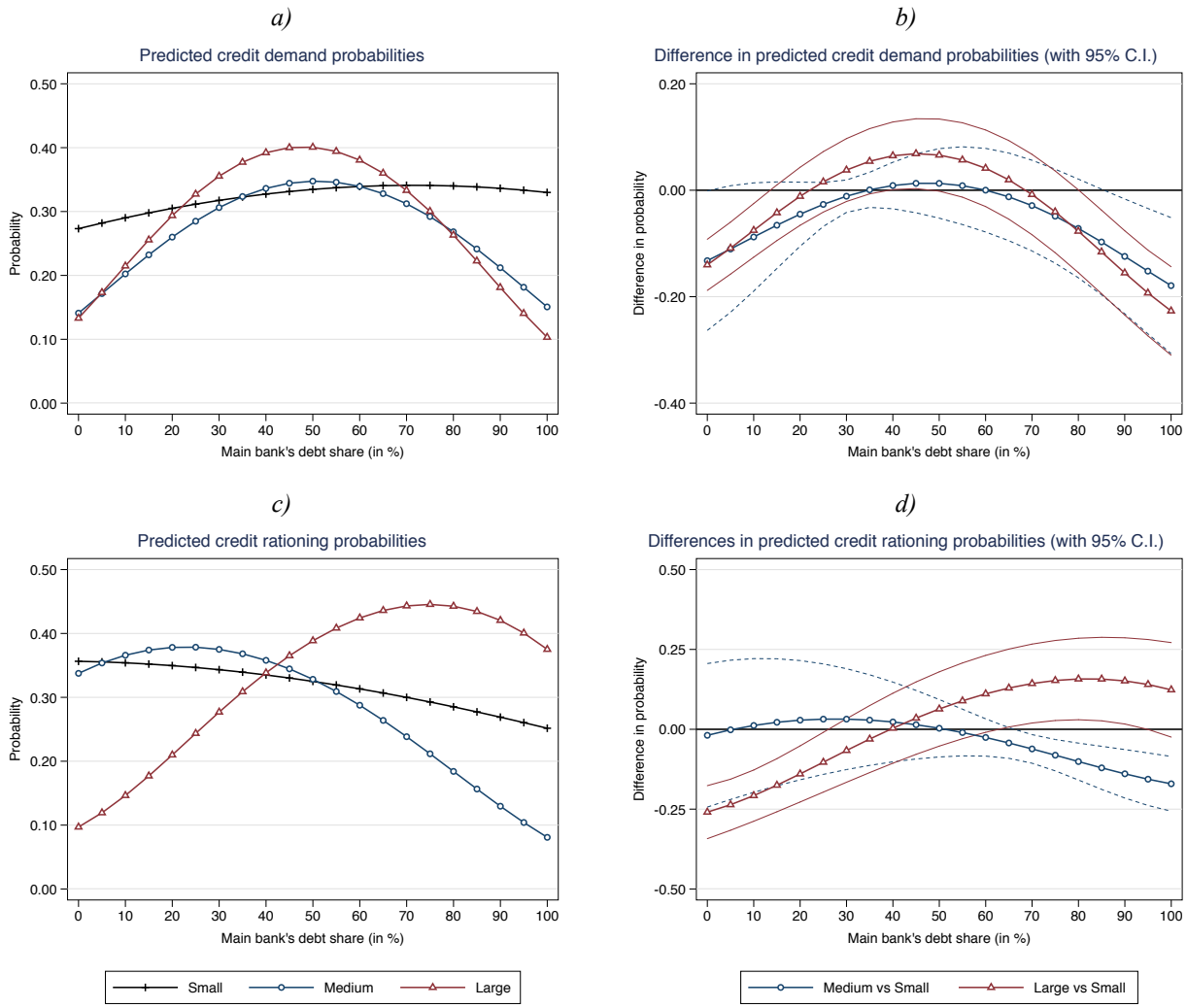

Figure 3 – Main Bank's debt share and credit demand and rationing probabilities.

main bank to a favoured condition with respect to competing lenders. Debt consolidation thus has a positive effect on bank-firm relationships, as it creates the conditions for an intensive transmission of information between the borrower and lender, hardly obtainable from external institutions.

5.4.3 Duration of firm-bank relationship

Analysing the profiles of the predicted credit demand probabilities as relationship length varies between 1 (the 1st percentile) and 60 years (the 99th percentile) (Figure 4a), we note a non-monotonic impact for large firms. Conversely, the probability of requiring more credit is decreasing with relationship duration for small enterprises, whereas, the effect is not pronounced and the slope is nearly flat for medium enterprises. The difference between medium and small firms is statistically significant for relationship durations up to 10 years, while the difference large versus small is statistically significant up to 5 years and beyond 50 (Figure 4b).

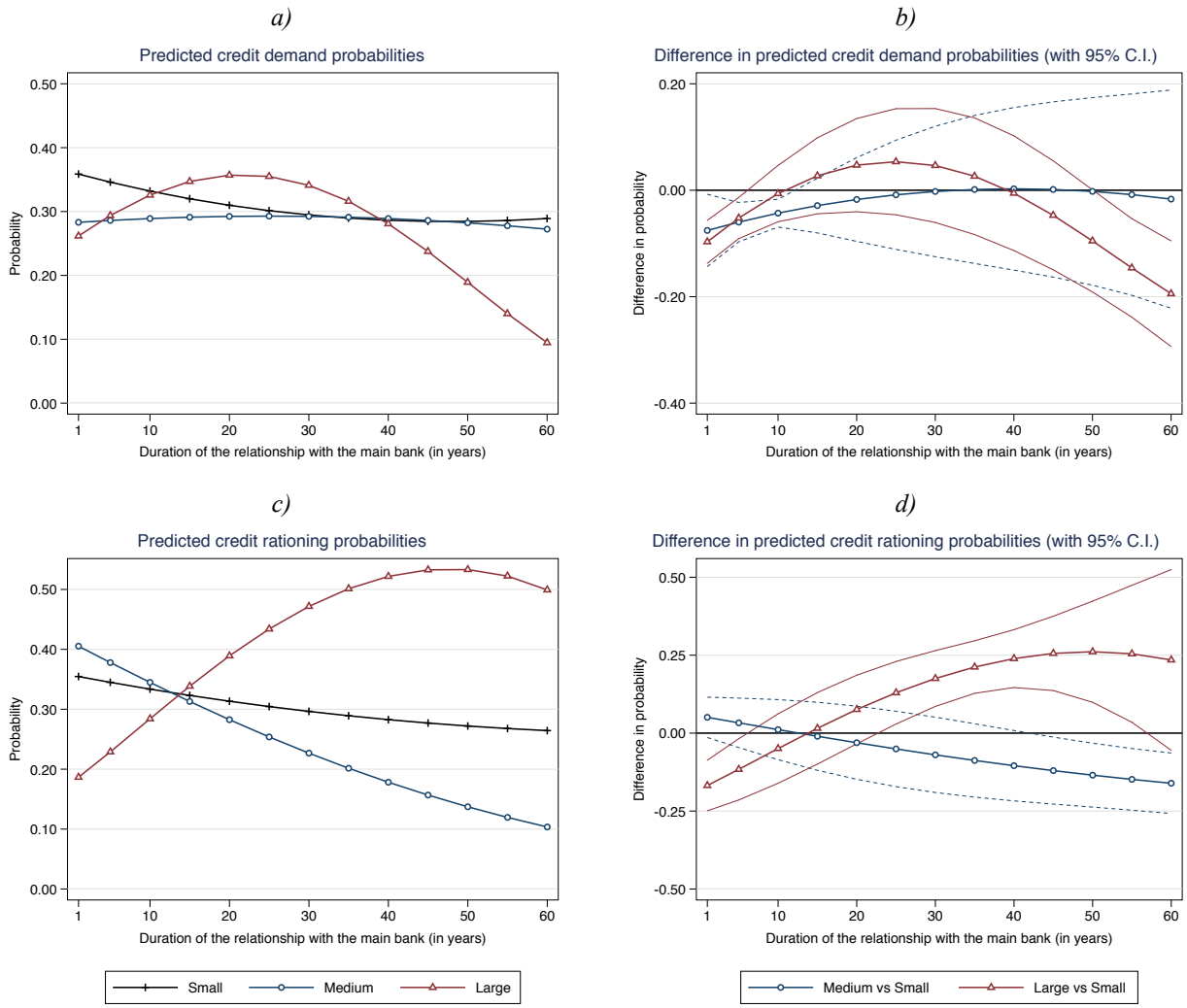

Figure 4 – Relationship duration and credit demand and rationing probabilities.

As regards credit rationing, we find that small and medium firms are less likely to be denied credit when the relationship duration increases, while the opposite is true for large firms (Figure 4c). The difference between medium and small enterprises is negative and statistically significant when the relationship duration is higher than 40 years. Conversely, the difference between large and small firms is negative and statistically significant when bank relationship duration is up to 5 years, while it becomes positive and significant when relationship duration is beyond 25 years (Figure 4d). Boot and Thakor (1994), Petersen and Rajan (1994) and Von Thadden (1995) find that as a firm-bank relationship consolidates, the bank gathers more information and manages to assess the future perspectives of its customers more efficiently. Our results are in line with this literature: long-lasting firm-bank relationships, reducing the opacity of small and medium enterprises, decrease the probability of being denied credit. By contrast, the information accumulation by banks is easier for large firms and the relationship duration becomes less important in the process of credit worthiness assessment. Contrary to Cenni et al. (2015), we find that the probability of being denied credit for a

large firm is increasing in the relationship duration. This latter evidence supports our previous results about consolidation of main bank's debts that is often associated to long firm-bank relationships: over time, large firms increase their needs of capital for their investments and, beyond a certain level, the main bank may be unwilling or not able to provide the same firm for additional credit. Moreover, a long-lasting relationship with a bank increases the likelihood to collect different type of financial connections that can increase the bank's bargaining power and can limit firm's capacity to build a similar relationship with a new bank, at least in the short time. As pointed out by Ongena and Smith (1997) an established relationship increases the array of contracting possibilities, but also increases the possibility that the bank can use the private information it obtains to "lock-in" the customer to the bank (Greenbaum, Kanatas and Venezia, 1989; Sharpe, 1990; Boot and Thakor, 1994). This situation allows the bank to manage credit according to your needs, so even rationing credit, while it does not allow the firm to replace the bank with other intermediaries, at least not in the short term, because of the broad range of activities and financial services held with the main bank.

6. Conclusions

In this paper, we use detailed data on Italian manufacturing firms from EFIGE dataset to investigate the effect of firm-bank relationship on credit rationing with a particular focus on firms' dimension. Specifically, we analyse how banking variables affect both the credit demand and rationing probabilities, focusing on the number of banking relationships, main bank's debt share, relationship duration and lending technologies. Further, we show that firm size matters and has an indirect impact on credit availability through the depth and strength of firm-bank relationships.

Results highlight the beneficial effect of close lending relationships on firms' access to credit. Evidences on multiple banking are mixed: we find that businesses are more likely to apply for more credit when the number of banks increases. Only the differences in predicted probabilities between large and small firms are statistically significant. This positive trend is evident independently of firm size, but it is much more accentuated for small enterprises as the number of banks increases, highlighting a higher dependence of these firms on bank credit. Large companies instead may have access more easily to other forms of financing such as intra-group funds, bonds and equity. As regards the effects on firms' access to credit, large and medium firms are more exposed to credit constraints when the number of banks increases, while small firms show an opposite trend. Differences in the probabilities between small and large firms are statistically significant also when the number of banks is low, whereas differences between medium and small businesses become significant when the number of banks is high. As regards debt concentration, we find an inverted U-

shaped effect on credit demand for medium and large companies, suggesting that debt concentration exerts its highest effects at intermediate values. For small firms, instead, the inverted U-shaped profile is less evident, suggesting instead an increasing trend. Differences in the predicted probabilities between medium and small firms are significant only for high levels of consolidation, whereas differences between large and small businesses are significant also for a low concentration. Further, we find that high levels of lending held at the main bank reduce rationing probability for small and medium firms, while the opposite is true for large companies. Contrasts for medium versus small firms are statistically significant for high levels of debt concentration, while differences between large and small are statistically significant also for low debt shares. We can draw similar conclusions for relationship duration. In fact, credit constraints are less likely when small and medium firms have a long relationship, while an opposite evidence appears for large firms. Contrasts are statistically significant for medium to long-lasting relationships. On the one hand, long relationship duration and high debt concentration allow a large information exchange and reduce small and medium firms' information opacity. On the other hand, an opposite evidence emerges for large companies that should avoid excessive debt concentration and long-lasting relationships with a single institution in order to mitigate credit constraints. Finally, we find that the effects of relationship duration on credit demand follow a decreasing trend for small and large companies, whereas the slope for medium businesses is almost flat. Differences are statistically significant up to intermediate durations. Our findings thus highlight that credit demand decreases over time: businesses require more financial funds in order to set up and grow, then their financial needs stabilize. Further, when a company is enough large, it can choose alternative ways of external financing other than bank. Credit demand for large companies is in fact lower and decreases more rapidly with relationship duration.

Evidence on the role of lending technologies shows that enterprises which are usually asked to provide collateral guarantees are more likely to apply for more credit and be credit denied. In fact, banks' request of personal or asset-based guarantees may be interpreted as an indication of the lower creditworthiness and higher insolvency risk associated with the borrower. As regards relationship lending, we highlight the beneficial effects of soft information exchange: firms are more likely to require more credit and are characterized by a lower probability of being rationed. This is true both for small and large companies, but close firm-bank relationships, going beyond a mere asset-based assessment, are more beneficial for large firms. Moreover, we confirm the advantage for medium and large companies from transactional lending technologies with respect to small businesses.

To summarise, our analysis emphasizes two relevant issues: in periods of high financial distress credit rationing issues are particularly relevant not only for small firms, but also for large companies and firm-bank relationships are crucial in influencing firms' access to credit in Italy. Moreover,

external financing needs of large companies are not comparable to those of small firms: financing large businesses exposes the banking institution to financial risks that are much higher than those related to investment projects of small firms. In these cases, banks may be unwilling to grant credit in a logic of loan portfolio diversification or they can to be unable to provide the entire amount requested when firms' external financing needs are too large. In this respect, it emerges the relevance of relationship lending not only in reducing the opacity related to small firms, but also in mitigating the uncertainty and risk associated to large investments. In fact, large credit exposures could be extremely burdensome for a single bank and, especially in a system where smaller and local banks are predominant, credit availability is significantly influenced by the strength of the relationship between lender and borrower.

Our empirical findings offer useful indications for future research aimed at better understanding the main factors shaping both credit demand and financial constraints, which are crucial for the functioning and stability of bank-oriented financial systems.

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Appendix A

Table A1 – Definitions of variables

Dependent variables	
External finance use	Equal to 1 if the firm recurred to external financing in the period 2008-2009, 0 otherwise
Credit demand	Equal to 1 if the firm has applied for additional credit during the last year, 0 otherwise
Credit rationing	Equal to 1 if the firm applied for more credit, but its application was not successful, 0 otherwise
Firm's characteristics	
Age	Age of the firm in years
Medium	Equal to 1 if the firm has 50 employees or more and less than 250, 0 otherwise
Large	Equal to 1 if the firm has 250 employees or more, 0 otherwise
Individual first shareholder	Equal to 1 if the main shareholder is an individual or a group of individuals, 0 otherwise
Domestic first shareholder	Equal to 1 if the main shareholder is domestic, 0 otherwise
Group	Equal to 1 if the firm belongs to a group, 0 otherwise
Ownership concentration	Herfindahl-Hirschman index of ownership concentration: share of firm's equity owned by the largest shareholder
Family managed	Equal to 1 if the CEO is the individual who owns or controls the firm or a member of the family that owns or controls it, 0 otherwise
Decentralized management	Equal to 1 if managers can take autonomous decisions in some business areas, 0 otherwise
Export before 2008	Equal to 1 if the firm has exported any of its products before 2008, 0 otherwise
RD investment share	Percentage of the total turnover the firm has invested in R&D on average in the years 2007-2009
Young CEO	Equal to 1 if the CEO is less than 34 years old, 0 otherwise
Female CEO	Equal to 1 if the CEO is female, 0 otherwise
Public incentives	Equal to 1 if the firm has received public incentives in the years 2007-2009, 0 otherwise
Quality certification	Equal to 1 if the firm has gone through any form of quality certification
Product concentration	Percentage of the 2008 turnover core product represents
EU competitors	Equal to 1 if the main competitors are located in EU countries, 0 otherwise
Lending technologies and firm-bank relationships	
Collateral lending	Equal to 1 if the bank normally uses collaterals to assess firm's credit worthiness
Transactional lending	Equal to 1 if the firm has indicated balance sheet information and/or historical records of payments and debt service as relevant lending factors by the main bank, 0 otherwise
Relational lending	Equal to 1 if the firm has indicated interviews with management on firm's policy and prospects and/or brand recognition as relevant lending factors by the main bank, 0 otherwise
Number of banks	Number of banking relationships
Main bank's debt share	Firm's debt share at its main bank
Relationship duration	Length of relationship with firm's main bank
Regional and local credit market characteristics:	
Branch density	Average of regional branch density in years 2006-2008, calculated as the number of branches over total population in each region
Functional distance	Regional average distance between bank branches and their headquarters
HHI of bank loans	Regional Herfindahl-Hirschman concentration index of bank loans in year 2007 (Source: Bank of Italy)
Identification variables	
Sector financial dependence	Variable which ranges from 1 to 5: the higher it's the more firm's sector depends on external financing
Growth obstacles perceived	Equal to 1 if the firm has indicated labour market regulations or legislative or bureaucratic restrictions as main factors preventing the growth, 0 otherwise
Total lending	Ratio between the amount of loans granted by banks to non-financial corporations and total population in each region (in thousands of Euros) in year 2007 (Source: Bank of Italy)

Table A2 – Descriptive statistics

	All firms (*N = 3021*)		Firm recurring to external finance (*N = 1860*)		Firms having applied for more credit (*N = 592*)		Firms being denied credit (*N = 229*)	
Variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Firm's characteristics								
Age	29.40	20.69	29.20	20.77	27.48	20.85	27.58	20.62
Medium	0.14		0.16		0.14		0.16	
Large	0.05		0.05		0.05		0.06	
Individual first shareholder	0.80		0.81		0.80		0.74	
Domestic first shareholder	0.95		0.96		0.97		0.95	
Group	0.17		0.17		0.19		0.22	
Ownership concentration	0.41	0.34	0.39	0.34	0.41	0.33	0.43	0.34
Family managed	0.38		0.36		0.36		0.35	
Decentralized management	0.15		0.16		0.17		0.17	
Export before 2008	0.72		0.73		0.72		0.71	
RD investment share	3.99	7.52	4.31	7.98	5.10	9.51	5.16	10.70
Young CEO	0.03		0.03		0.03		0.04	
Female CEO	0.10		0.10		0.10		0.09	
Public incentives	0.27		0.32		0.32		0.29	
Quality certification	0.57		0.60		0.60		0.62	
Product concentration	91.06	18.07	90.90	18.10	89.80	19.30	92.10	16.70
EU competitors	0.34		0.33		0.33		0.38	
Lending technologies and firm-bank relationships								
Collateral lending	0.28		0.45		0.59		0.72	
Transactional lending	0.97		0.95		0.95		0.93	
Relationship lending	0.60		0.35		0.36		0.34	
Number of banks	4.19	2.81	4.71	2.98	5.02	3.29	5.17	3.41
Main bank’s debt share	45.60	26.14	45.60	26.10	45.90	24.20	44.90	23.50
Relationship duration	9.96	12.54	16.20	12.40	15.00	11.60	14.40	11.10
Regional and local credit market characteristics:								
Branch density	0.22	0.09	0.22	0.10	0.22	0.10	0.21	0.09
HHI of bank loans	560.96	121.10	560.00	121.75	561.00	119.00	566.00	134.00
Functional distance	3.70	0.41	3.70	0.42	3.71	0.42	3.71	0.41

Notes: the Table reports means (and standard deviations for continuous variables only) computed on the full sample and on the subsamples of firms using external financing (i.e., external finance use = 1), having demanded additional credit (i.e., credit request = 1) and credit rationed firms (i.e., credit denied = 1). Descriptive statistics are computed using sample weights.

Table A3 – Credit request and External financing

	Credit demand		External financing use	
Variables	Coefficient	Standard Error	Coefficient	Standard Error
Age	-0.0090***	0.0032	-0.0057**	0.0025
Age^2	0.0001**	0.0000	0.0000**	0.0000
Medium	-0.3861	0.5963	0.0411	0.1535
Large	-0.2858	0.3430	0.1465	0.1580
Individual first shareholder	0.0582	0.1177	-0.0045	0.1236
Domestic first shareholder	0.4744*	0.2578	0.2472*	0.1375
Group	0.1097	0.1560	-0.2053*	0.1096
Ownership concentration	0.2125	0.1980	-0.2351*	0.1294
Family managed	-0.0520	0.1009	-0.1050*	0.0553
Decentralized management	0.0422	0.0292	0.0998	0.1032
Export before 2008	-0.0262	0.0925	0.0108	0.0567
RD investment share	0.0157***	0.0036	0.0079***	0.0021
Young CEO	-0.1334	0.0953	0.0501	0.0957
Female CEO	-0.0052	0.0795	-0.0174	0.0731
Public incentives	0.0206	0.1691	0.3875***	0.0197
Quality certification	0.0512	0.1093	0.0940**	0.0422
Product concentration	-0.0032	0.0021	0.0004	0.0013
EU competitors	0.0116	0.1138	-0.2479***	0.0503
Branch density	-0.3055	0.2299	-0.6386***	0.1773
Bank loans concentration	0.0000	0.0004	-0.0002	0.0003
Functional distance	0.0399	0.0442	0.0483	0.1109
Collateral lending	0.4214***	0.0696		
Collateral lending × Medium	0.0835	0.3195		
Collateral lending × Large	-0.0031	0.0675		
Transactional lending	0.1667**	0.0778		
Transactional lending × Medium	-0.2396	0.3791		
Transactional lending × Large	-0.5268***	0.0489		
Relationship lending	-0.0583	0.0600		
Relationship lending × Medium	0.1225	0.1944		
Relationship lending × Large	0.3347***	0.1209		
Number of banks	0.0513	0.0481	0.0957***	0.0230
Number of banks × Medium	-0.0164	0.0394	-0.0025	0.0274
Number of banks × Large	-0.0368	0.0336	-0.0595**	0.0238
Main bank's debt share	0.0081***	0.0021		
Main bank's debt share × Medium	0.0226	0.0202		
Main bank's debt share × Large	0.0298***	0.0093		
Main bank's $debt\ share^2$	-0.0001***	0.0000		
Main bank's $debt\ share^2$ × Medium	-0.0002	0.0002		
Main bank's $debt\ share^2$ × Large	-0.0003***	0.0001		
Relationship duration	-0.0096*	0.0054		
Relationship duration × Medium	0.0108	0.0187		
Relationship duration × Large	0.0441***	0.0098		
$Relationship\ duration^2$	0.0001	0.0001		
$Relationship\ duration^2$ × Medium	-0.0001	0.0002		
$Relationship\ duration^2$ × Large	-0.0009***	0.0001		
Sector financing dependence	0.3041	0.2664	0.6184***	0.0137
Growth obstacles perceived	0.1598***	0.0344	0.0030	0.0477
Total lending			0.0139***	0.0042
Intercept	-2.7316*	1.4390	-1.7232***	0.3841
ρ	0.2356	1.3556		
Sector fixed-effects	Yes [0.0000]		Yes [0.0000]	
Number of observations	3020			
Log-likelihood	-2504.84			

Notes: robust standard errors, clustered at the sectoral level, are reported next to parameter estimates. P-values for the joint significance of sector fixed effects are reported in square brackets.
***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Supplementary Appendix B

Table B1 – Number of banking relationships and credit demand probability

	Credit demand probability			Differences in credit demand probability	
Number of banks	Small	Medium	Large	Medium vs Small	Large vs Small
1	0.274	0.261	0.315	-0.0131	0.0412
2	0.287	0.269	0.318	-0.018	0.0311
3	0.300	0.277	0.321	-0.023	0.0207
4	0.314	0.286	0.324	-0.0281	0.01
5	0.328	0.295	0.327	-0.0335 *	-0.0009
6	0.342	0.303	0.330	-0.0389	-0.012
7	0.357	0.312	0.333	-0.0444	-0.0234
8	0.371	0.321	0.336	-0.0501	-0.035
9	0.386	0.330	0.339	-0.0558	-0.0467
10	0.401	0.339	0.342	-0.0616	-0.0587
11	0.416	0.349	0.345	-0.0675	-0.0707
12	0.431	0.358	0.349	-0.0734	-0.0829
13	0.447	0.367	0.352	-0.0793	-0.0951
14	0.462	0.377	0.355	-0.0852	-0.1075
15	0.478	0.387	0.358	-0.0911	-0.1199
16	0.493	0.396	0.361	-0.097	-0.1323
17	0.509	0.406	0.364	-0.1028	-0.1447
18	0.524	0.416	0.367	-0.1086	-0.1571
19	0.540	0.426	0.370	-0.1143	-0.1695
20	0.555	0.435	0.374	-0.1198	-0.1818

Notes: the table reports the predicted probability of requiring more credit for small, medium and large firms at selected levels of the variable Number of banks, ranging from 1 to 25 (the 1st and the 99th percentile of the observed distribution, respectively). "Medium vs Small" and "Large vs Small" are the differences in the predicted probabilities between medium/large and small firms.
***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Table B2 – Number of banking relationships and credit rationing probability

	Credit rationing probability			Differences in credit rationing probability			
Number of banks	Small	Medium	Large	Medium vs Small		Large vs Small	
1	0.3477	0.2807	0.3185	-0.067		-0.0293	
2	0.3396	0.2881	0.3237	-0.0515		-0.0159	
3	0.3315	0.2954	0.3291	-0.036		-0.0024	
4	0.3234	0.3028	0.3344	-0.0205		0.0111	
5	0.3153	0.3103	0.3398	-0.005		0.0246	
6	0.3072	0.3178	0.3453	0.0106		0.0381	
7	0.2992	0.3253	0.3508	0.0261		0.0516	
8	0.2912	0.3329	0.3563	0.0417		0.0651	
9	0.2832	0.3404	0.3618	0.0572		0.0786	
10	0.2753	0.3480	0.3674	0.0727	**	0.0921	*
11	0.2674	0.3556	0.3730	0.0882	**	0.1056	**
12	0.2596	0.3632	0.3786	0.1036	***	0.119	**
13	0.2518	0.3708	0.3843	0.119	***	0.1325	**
14	0.2441	0.3784	0.3899	0.1343	***	0.1459	***
15	0.2364	0.3859	0.3956	0.1495	***	0.1592	***
16	0.2289	0.3935	0.4014	0.1646	***	0.1725	***
17	0.2214	0.4010	0.4071	0.1797	***	0.1858	***
18	0.2139	0.4085	0.4129	0.1946	***	0.199	***
19	0.2066	0.4160	0.4187	0.2095	***	0.2121	***
20	0.1993	0.4235	0.4245	0.2242	***	0.2251	***

Notes: the table reports the predicted conditional probability of credit rationing for small, medium and large firms at selected levels of the variable Number of banks, ranging from 1 to 25 (the 1st and the 99th percentile of the observed distribution, respectively). "Medium vs Small" and "Large vs Small" are the differences in the predicted probabilities between medium/large and small firms. ***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Table B3 – Main bank's debt share and credit demand probability

	Credit demand probability			Differences in credit demand probability	
Main bank's debt share	Small	Medium	Large	Medium vs Small	Large vs Small
0	0.266	0.149	0.157	-0.117 *	-0.109 ***
5	0.276	0.179	0.196	-0.0972	-0.0798 ***
10	0.285	0.208	0.236	-0.077	-0.0498 **
15	0.294	0.237	0.274	-0.0572	-0.0208
20	0.303	0.264	0.308	-0.0387	0.0057
25	0.310	0.288	0.338	-0.0224	0.0284
30	0.317	0.308	0.363	-0.0088	0.0465 *
35	0.323	0.324	0.382	0.0017	0.0595 **
40	0.328	0.337	0.395	0.0087	0.0669 **
45	0.332	0.344	0.401	0.0121	0.0687 **
50	0.336	0.348	0.400	0.0118	0.0647 **
55	0.338	0.346	0.393	0.0076	0.055 *
60	0.340	0.340	0.380	-0.0003	0.0397
65	0.341	0.329	0.360	-0.0118	0.019
70	0.341	0.314	0.334	-0.0268	-0.0068
75	0.340	0.295	0.303	-0.045	-0.0369
80	0.339	0.273	0.268	-0.066	-0.0705 *
85	0.336	0.247	0.230	-0.0892 *	-0.1062 ***
90	0.333	0.219	0.190	-0.1139 **	-0.1425 ***
95	0.329	0.189	0.151	-0.1393 **	-0.1775 ***
100	0.323	0.159	0.114	-0.1643 **	-0.2093 ***

Notes: the table reports the predicted probability of requiring more credit for small, medium and large firms at selected levels of the variable Main Bank's Share, ranging from 0 to 10 (the 1st and the 99th percentile of the observed distribution, respectively). "Medium vs Small" and "Large vs Small" are the differences in the predicted probabilities between medium/large and small firms.
***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Table B4 – Main bank's debt share and credit rationing probability

	Credit rationing probability			Differences in credit rationing probability	
Main bank's debt share	Small	Medium	Large	Medium vs Small	Large vs Small
0	0.349	0.330	0.099	-0.0191	-0.2502 ***
5	0.349	0.346	0.122	-0.0032	-0.2277 ***
10	0.349	0.359	0.149	0.0096	-0.2 ***
15	0.348	0.367	0.180	0.0192	-0.1679 ***
20	0.346	0.372	0.213	0.0256	-0.1328 ***
25	0.343	0.373	0.247	0.029	-0.0961 **
30	0.340	0.370	0.282	0.0296	-0.0588
35	0.337	0.364	0.315	0.0273	-0.0221
40	0.332	0.355	0.346	0.0224	0.0131
45	0.328	0.343	0.374	0.0151	0.0464
50	0.322	0.328	0.399	0.0054	0.0771
55	0.316	0.310	0.421	-0.0064	0.1049 *
60	0.310	0.290	0.439	-0.0201	0.1295 **
65	0.303	0.267	0.454	-0.0355	0.1506 **
70	0.296	0.243	0.464	-0.0523 ***	0.1679 **
75	0.288	0.218	0.469	-0.07 ***	0.1811 ***
80	0.279	0.191	0.469	-0.0882 ***	0.1898 ***
85	0.271	0.164	0.464	-0.1063 ***	0.1938 ***
90	0.261	0.138	0.454	-0.1236 ***	0.1926 **
95	0.252	0.112	0.438	-0.1395 ***	0.186 **
100	0.242	0.089	0.416	-0.1531 ***	0.174 **

Notes: the table reports the predicted probability of rationing for small, medium and large firms at selected levels of the variable Main Bank's Share, ranging from 0 to 10 (the 1st and the 99th percentile of the observed distribution, respectively). "Medium vs Small" and "Large vs Small" are the differences in the predicted probabilities between medium/large and small firms.
***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Table B5 – Duration of the relationship with the main bank and credit demand probability

	Credit demand probability			Differences in credit demand probability	
Relationship duration	Small	Medium	Large	Medium vs Small	Large vs Small
1	0.352	0.289	0.259	-0.0626	-0.0927 ***
5	0.342	0.290	0.295	-0.0522 **	-0.0473 **
10	0.331	0.290	0.331	-0.0402 ***	0
15	0.320	0.291	0.355	-0.0294	0.0349
20	0.311	0.292	0.368	-0.0196	0.0564
25	0.303	0.293	0.368	-0.0108	0.0641
30	0.297	0.294	0.355	-0.0031	0.058
35	0.291	0.295	0.330	0.0036	0.0386
40	0.286	0.296	0.293	0.0093	0.007
45	0.283	0.297	0.248	0.0142	-0.0346
50	0.280	0.298	0.197	0.0181	-0.0829 *
55	0.279	0.300	0.145	0.0211	-0.1334 ***
60	0.278	0.301	0.097	0.0232	-0.1809 ***

Notes: the table reports the predicted probability of requiring more credit for small, medium and large firms at selected levels of the variable Relationship Duration, ranging from 1 to 60 (the 1st and the 99th percentile of the observed distribution, respectively). "Medium vs Small" and "Large vs Small" are the differences in the predicted probabilities between medium/large and small firms. ***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Table B6 – Duration of the relationship with the main bank and credit rationing probability

	Credit demand probability			Differences in credit demand probability	
Relationship duration	Small	Medium	Large	Medium vs Small	Large vs Small
1	0.352	0.289	0.259	0.0512 *	-0.1595 ***
5	0.342	0.290	0.295	0.0341	-0.1072 **
10	0.331	0.290	0.331	0.0129	-0.0405
15	0.320	0.291	0.355	-0.008	0.0242
20	0.311	0.292	0.368	-0.0283	0.0839
25	0.303	0.293	0.368	-0.0479	0.1367 ***
30	0.297	0.294	0.355	-0.0668	0.1812 ***
35	0.291	0.295	0.330	-0.0847	0.2166 ***
40	0.286	0.296	0.293	-0.1016 *	0.2423 ***
45	0.283	0.297	0.248	-0.1175 **	0.2575 ***
50	0.280	0.298	0.197	-0.1324 ***	0.2614 ***
55	0.279	0.300	0.145	-0.1462 ***	0.253 **
60	0.278	0.301	0.097	-0.1591 ***	0.2316

Notes: the table reports the predicted probability of rationing for small, medium and large firms at selected levels of the variable Relationship Duration, ranging from 1 to 60 (the 1st and the 99th percentile of the observed distribution, respectively). "Medium vs Small" and "Large vs Small" are the differences in the predicted probabilities between medium/large and small firms.
***, ** and * denote significance at the 1, 5 and 10% levels, respectively.