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"GENDER DIFFERENCES IN BANK LOAN ACCESS"

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Gender differences in bank loan access.

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Abstract:

Traditionally female entrepreneurs report difficulties or higher costs in accessing bank credit. These difficulties can be either the result of supply side discrimination, or the lower profitability of female-owned firms than male-owned ones. This paper aims at analyzing gender differences in bank loan access by means of a large dataset on firms' lines of credit provided by four Italian banks over the period 2005-2008. Estimates show that, after controlling for loan, firm and bank characteristics, female-owned firms: (a) experience a higher probability of having to pledge guarantees than male-owned firms; (b) have a lower probability of access to credit.

Keywords: gender discrimination, bank loan, guarantees.
JEL Classification: E43, G21, D82

1. Introduction

In the last 25 years, both in Italy and the U.S., the number of female entrepreneurs has been significantly growing. The existence of discrimination in labor markets is likely one of the reasons behind women's decision to build their own businesses; notwithstanding this, female entrepreneurs traditionally also report difficulties or higher costs in accessing bank credit. The latter are either the result of supply-side discrimination, or of characteristics related to female-owned firms' creditworthiness and performance.

Most of the empirical studies on credit access by firms owned by minorities find the existence of discriminatory phenomena. For example, Blanchflower *et al.* (2003) find that firms with black owners are charged higher bank loan interest rates than other firms. Diversely, empirical gender studies do not share homogeneous findings on credit market discrimination.

A large number of papers show the existence of gender differences in the composition of financial sources used by male- and female-owned firms (Cesaroni, 2010). The latter are financially more fragile and face higher difficulties in accessing capital, whether in the form of equity or debt, than so called "male firms". For instance, female-owned firms (hereafter "female firms") start their businesses with lower levels of equity than male-owned ones (Carter and Shaw, 2006; Coleman and Robb, 2009), and this gap persists in the subsequent phases of their activity (Calcagnini and Lenti, 2008; Coleman and Robb, 2009). Further, female firms make more intensive use of the entrepreneur's personal funds and a lower utilisation of bank loans (Coleman and Robb, 2009).

However, the same empirical findings do not come out with a clear-cut explanation for gender differences in the use of funds. The are three main and non-mutually-exclusive reasons at the root of such differences: different structural characteristics of male and female firms; demand side effects; and supply side discrimination in credit access.

On one hand, there are studies that find that female firms have greater difficulties than male-owned ones to obtain bank loans (Bellucci *et al.*, 2010; Alesina *et al.*, 2008, Calcagnini and Lenti, 2008). On the other, Riding and Swift (1990), Cavalluzzo and Cavalluzzo (1998), Cavalluzzo *et al.* (2002) analyze small-sized businesses in the U.S.

by taking into consideration credit applications, denial rates and bank-loan interest rates. Their findings show that white men and women expect similar treatment in credit markets, while minorities face more difficulties.

According to Becker (1971) banks mainly discriminate in three ways: (*a*) by applying higher interest rates on loans requested by female entrepreneurs; (*b*) by imposing heavier pre-contractual conditions on female firms than male firms; (*c*) by demanding higher credit worthiness from female entrepreneurs than from their male counterparts before granting them loans.

This paper contributes to the ongoing empirical debate by analyzing gender differences in bank loan access by means of a large dataset on firm loan applications provided by four Italian banks over the period 2005-2008. As we do not have data on interest rates, we focus on types of gender discrimination mentioned (*b*) and (*c*) above.

Specifically, we first test whether female firms are subject to heavier pre-contractual conditions in the form of heavier guarantee requirements (type *b*). To address this issue, we estimate a bivariate probit model to understand if and how firm owners' gender influences the probability of observing secured loans, together with other firm, loan and bank characteristics.

Estimates show that, after controlling for loan, firm and bank characteristics, the request for guarantees does have a gender-biased dimension, as female-owned businesses have a higher probability of having to pledge guarantees than do male-owned ones.

Secondly, we test whether female entrepreneurs are asked for higher credit worthiness than their male counterparts before they are granted loans (type *c*). Specifically, we estimate the probability of obtaining a bank loan using as explanatory variables the firm gender, loan-contract, individual-firm and -bank characteristics, and their interaction. The estimates confirm previous findings, as they show that female firms have, *ceteris paribus*, a lower probability of accessing bank credit. Moreover, smaller sized female firms are even more disadvantaged in credit access than large-sized female firms. The same result occurs for female firms that are not organized as limited liability companies. The two latter results suggest that, in order to improve their access to bank loans, female firms should pursue a strategy oriented towards expanding their

size and increasingly adopting a more structured legal form such as that of limited liability companies.

The paper is organized as follows. Section 2 reviews the theoretical and empirical literature on gender discrimination, while Section 3 describes the dataset used for model estimation. Section 4 presents the empirical model and the estimation strategy, and discusses the main findings. Finally, Section 5 concludes.

2. Review of the literature

A large strand of the empirical literature on gender economics focuses on the causes of credit access discrimination and on differences observed in the financial structure of female firms with respect to male ones. The main findings from this literature, though not conclusive, have helped researchers and policy makers to obtain a better description of the different conditions faced by male- and female-owned businesses in their quest for financing.

One of the first papers on this theme (Hisrich and Brush, 1984) shows that U.S. female firms had more difficulties than male-owned ones during the start-up phase of the business. These difficulties concerned the financial competence of the firm owners, their access to credit, and the firms' capability to pledge guarantees requested by banks. More recent studies have also confirmed these findings for European firms (Eurochambres, 2004). Furthermore the access to finance in the start-up phase is sometimes found to be the main obstacle for female firms (Ceedr, 2004; Orser *et al.*, 2000). Moreover, other authors highlight that financial obstacles significantly contribute to the explanation of why female firms are smaller sized and have lower economic performance (lower profits and lower growth rates) than do male ones (Rosa *et al.*, 1996; Robb, 2002; Fairlie and Robb, 2009).

Potential gender differences in credit access can have three alternative explanations.

First, they could depend on structural differences between male and female firms such as size, date of foundation or owner age, and type of industry.

Specifically, female firms may structurally need fewer financial funds than male firms, as they are more concentrated in the trade and service industries. Traditionally, these industries are made up of businesses with a lower intensity of financial capital

than manufacturing firms (McKechnie *et al.*, 1998). As a consequence, female firms may be credit rationed because lending institutions consider them to be less successful than male-owned businesses. (Pellegrino and Reese, 1982).

Moreover, Carter and Allen (1997) and Carter and Rosa (1998) analyze female entrepreneurs' characteristics. They show that differences in financing patterns between male and female businesses mainly depend on differences in the sector of activity, in their credit history and in owner characteristics other than gender (Robb and Wolken 2002).

Further, Coin (2011) finds that Italian female entrepreneurs are more reliable payers than male entrepreneurs because they typically operate in less risky sectors.

Other authors, therefore, conclude that in many cases discrimination only depends on female entrepreneurs' perceptions (Buttner and Rosen 1992).

Second, gender differences in the access to credit could be due to demand side differences. Watson and Robinson (2003) argue that female entrepreneurs show higher risk aversion than male entrepreneurs. Therefore, the former have a lower propensity to seek indebtedness, or they are less interested in firm growth (Carter and Shaw, 2006). Finally, female entrepreneurs might use less external financing than male ones because they are less willing to lose their control over their firms than male entrepreneurs (Constantinidis and Cornet, 2005; Verheul and Thurik, 2000).

Third, gender differences in credit access might be the result of supply side discrimination. According to Becker (1971), discriminatory behaviour emerges from prejudice or a "taste for discrimination" and it requires that the discriminator pay or forfeit income for the privilege of exercising prejudicial tastes. In this situation, the group receiving the differentially adverse treatment is characterized by credit risks that on average are no higher than those imposed by other groups of borrowers (Ladd, 1998).

Fay and Williams (1993) is one of the first studies that found some evidence of gender-related credit discrimination in seeking start-up funds, although only with respect to clients with poor financial culture. The authors argue that it is not necessarily the banks' fault that women with limited education and experience are considered to be riskier than men. Nevertheless, the authors argue that "the existence of discriminatory behaviour as a consequence of prejudice and stereotyping can be demonstrated only

when all relevant factors up to the point of loan application have been equalised" (Fay and Williams, 1993:365).

Muravyev *et al.* (2008) confirm this result by means of a cross-country analysis (Business Environment and Enterprise Performance Survey – BEEPS). The authors find that female firms do indeed have lower probabilities of obtaining a bank loan, and are charged higher interest rates than male firms. These differences are larger the lower the development of the local financial market is.

Alesina *et al.* (2008) find that female firms are charged with higher interest rates on their credit lines than male-owned ones. Further, this difference becomes larger if female firms pledge personal guarantees and the third party is female, while the interest rate gap between the two types of firms vanishes if a male firm or entrepreneur posts the guarantee for the female firm. Finally, the lending relationship does not affect the interest rate charged to female firms.

Calcagnini and Lenti (2008) analyze loan denial rates and the probability of male and female entrepreneurs obtaining a loan. Their results do not show the presence of gender discrimination, even though they analyze female businesses versus a control group that includes both male firms and other firms for which they were unable to identify the gender of the owner. Potentially, the group "other firms" may contain a relatively large number of female firms and thus those results are not robust.

Fairlie and Robb (2009) consider credit access problems from a different perspective, trying to understand why female businesses are less successful than male ones. The authors compare male and female human capital (measured as their education level attained or their work experience) and find that male business owners often have only a high school education. So differences in education cannot explain differences in credit access problems.

Bellucci *et al.* (2010) study the relevance of the gender of the contracting parties involved in lending. The authors show that female entrepreneurs face tighter credit availability, even though they do not pay higher interest rates. The gender of the loan officer is also important, as they find that female officers are more risk-averse or less self-confident than male officers, as they tend to restrict credit availability to new, un-established borrowers more than their male counterparts.

3. Data description

Data are taken from four Italian banks (San Paolo - Banca Popolare dell'Adriatico (BPDA), Banca di Credito Cooperativo di Fano (BCC di Fano), Banca di Credito Cooperativo di Cesena (BCC di Cesena), Cassa di Risparmio di Teramo (TERCAS)) and refer to new loan applications made by firms during the years 2005-2007. The number of credit lines opened in 2008 is significantly lower than that granted for the previous years and may also imply a smaller coverage ratio of our dataset with respect to the total year loan activity for the most recent period.

Banks are located in the Italian provinces of Pesaro – Urbino, Teramo, and Forlì – Cesena, as bank headquarters and most of their branches are active in those geographical areas. More than 50% of the available information comes from one banking source, i. e. the San Paolo - Banca Popolare dell'Adriatico. [1]

The dataset contains 9,442 observations and each observation represents a loan application of one firm to one of the banks mentioned above.

Information refers to firm characteristics, such as: Type of company (sole proprietorship, partnerships, limited liability, public institutions, professional orders); Industry of activity; Province where the firm operates; Distance (in kilometres) between each firm/loan and the bank providing credit; Gender of the entrepreneur (in the case of sole proprietorship) or of the majority of partners (in the case of partnerships or limited liability companies); Age of the firm/entrepreneur; Firm total sales.

Furthermore, the dataset contains information on the loan application characteristics, such as: whether the application was successful or rejected; the amount requested and the amount deliberated and eventually used; the type of guarantee posted (collateral and/or personal guarantees), if any, and the type of loan (loans backed by accounts receivable, term-loans, revocable-loans). The aggregate includes mortgage loans, current account overdrafts, loans secured by pledge of salaries, credit card advances, discounting of annuities, personal loans, leasing, factoring, other financial investments (e.g. commercial paper, bill portfolio, pledge loans, loans granted from funds

[1] The provincial market share in terms of the four banks' branches is the following: 17% Pesaro Urbino; 5% Forlì Cesena; 53% Teramo.

administered for third parties), bad debts and unpaid and protested own bills (Bank of Italy, 2010).

Finally, the dataset contains information on the length and the number of the lending relationships between the firm and the bank.

3.1 Firm Characteristics

The dataset includes 3,395 firms, of which 1,115 are female firms. The total number of loan applications is 9,442, of which 3,344 are submitted by female businesses (see Table 1).

Table 1 – Dataset composition by gender: absolute values and percentage distribution.

Sex	***Number of firms***	***%***	***Number of loan applications***	***%***
Female firm	1,115	32.84	3,344	35.42
Male firm	2,280	67.16	6,098	64.58
Total	3,395	100.00	9,442	100.00

Source: our calculations on data from the San Paolo Banca Popolare dell'Adriatico, BCC Fano, BCC Cesena, and TERCAS banks.

Table 2 shows the distribution of firms by their legal type. Firms in the dataset are mainly organized in the form of sole proprietorships (86%), followed by partnerships (23%) and limited liability companies (14%). As for female firms, 60% of them are organized as sole proprietorships, followed by partnerships and limited liability companies (28% and 10%, respectively).

The distribution of firms by gender in our dataset is consistent with that for the whole country: in 2008, in Italy, there were 1,429,267 female firms, that is, 23% of the total number of firms. Furthermore, the distribution of female firms by legal type, size and industry is also consistent with countrywide data.[2]

Table 3 shows the distribution of firms by sales, which is consistent with the countrywide data (Istat, 2007). Overall, about 90% of firms are micro-sized, i.e. their sales do not amount to 500,000 euro. Data also show that there are not large differences in firm size according to the gender of the entrepreneur (or firm).

[2] See "*Impresa in genere, secondo rapporto nazionale sull'imprenditoria femminile*", Retecamere (2011).

Table 2 – Distribution of firms by legal type: absolute values and percentage distribution (between parentheses).

Legal Type	*Female firms*	*Male firms*	*Total*	*Female firms: countrywide data (2008)*
Sole proprietorship	666	2,136	2,802	872,969
	(59.73)	(93.68)	(82.53)	(61.1)
Partnership	312	25	337	323,862
	(27.98)	(1.1)	(9.93)	(22.7)
Limited liability	110	28	138	200,638
	(9.87)	(1.23)	(4.06)	(14.0)
Professional orders	23	91	114	
	(2.06)	(3.99)	(3.36)	
Other	4	0	4	31,798
	(0.36)	(0.00)	(0.12)	(2.3)
Total	1,115	2,280	3,395	1,429,267
	(100.00)	(100.00)	(100.00)	(100.00)

Source: our calculations on data from the San Paolo Banca Popolare dell'Adriatico, BCC Fano, BCC Cesena, and TERCAS banks.

Table 3 – Total sales of firms by gender: absolute values and percentage distribution (between parentheses).

Total sales	*Female firms*	*Male firms*	*Total*
0 – 250,000	905	1,939	2,844
	(81.17)	(85.04)	(83.77)
250,000 – 500,000	104	170	274
	(9.33)	(7.46)	(8.07)
500,000 – 1,000,000	66	93	159
	(5.92)	(4.08)	(4.68)
1,000,000 – 2,700,000	21	57	78
	(1.88)	(2.50)	(2.30)
2,700,000 – 7,000,000	13	4	17
	(1.17)	(0.18)	(0.50)
7,000,000 – 15,000,000	3	2	5
	(0.27)	(0.09)	(0.15)
15,000,000 – 40,000,000	3	7	10
	(0.27)	(0.31)	(0.29)
40,000,000 – 75,000,000	0	5	5
	(0.00)	(0.22)	(0.15)
75,000,000 – 150,000,000	0	1	1
	(0.00)	(0.04)	(0.03)
> 150,000,000	0	2	2
	(0.00)	(0.09)	(0.06)
Total	1,115	2,280	3,395
	(100.00)	(100.00)	(100.00)

Source: our calculations on data from the San Paolo Banca Popolare dell'Adriatico, BCC Fano, BCC Cesena, and TERCAS banks.

Looking at the distribution of firms by sector of economic activity, both male and female firms are mainly concentrated in two industries: commerce and manufacturing

(Table 4). However, female firms are also concentrated in the service industry, while male firms are in the construction industry.[3]

Table 4 – Distribution of firms by sector of economic activity, ATECO 2007: absolute values and percentage distribution (between parentheses).

Sector of activity	*Female firms*	*Male firms*	*Total firms*
Agriculture, forestry, fishing and hunting	57	154	211
	(5.11)	(6.75)	(6.22)
Manufacturing	218	382	600
	(19.55)	(16.75)	(17.67)
Electricity, gas, steam and hot water supply	0	8	8
	(0.00)	(0.35)	(0.24)
Collection, purification and distribution of water; waste management	4	10	14
	(0.36)	(0.44)	(0.41)
Construction	34	371	405
	(3.05)	(16.27)	(11.93)
Wholesale and retail trade, repair of motor vehicles	348	512	860
	(31.21)	(22.46)	(25.33)
Transportation and warehousing	17	142	159
	(1.52)	(6.23)	(4.68)
Accommodation and food services	113	109	222
	(10.13)	(4.78)	(6.54)
Finance and insurance	140	398	538
	(12.56)	(17.46)	(15.85)
Real estate activities	9	2	11
	(0.81)	(0.09)	(0.32)
Professional, scientific, and technical services	6	4	10
	(0.54)	(0.18)	(0.29)
Rental, travel agencies, and support services to firms	3	10	13
	(0.27)	(0.44)	(0.38)
Public administration	5	16	21
	(0.45)	(0.70)	(0.62)
Other services (except Public Administration)	137	139	276
	(12.29)	(6.10)	(8.13)
Total	1,115	2,280	3,395
	(100.00)	100	100

Source: our calculations on data from the San Paolo Banca Popolare dell'Adriatico, BCC Fano, BCC Cesena, and TERCAS banks.

3.2 Loan Characteristics

The dataset collects all loan applications made to the four banks in the years 2005, 2006 and 2007 (and some applications in the year 2008). The loan application may have one of the following outcomes:

- Deliberated: the loan has been granted and the application concluded;
- Refused: the application has been rejected;

[3] This distribution is consistent with Italian data, according to which female firms are mainly concentrated in commerce (32%), and agriculture (23%), followed by real estate (10%), manufacturing (10%) and services (9%). Furthermore, female firms operating in the commerce industry are usually the oldest ones (Retecamere, 2011).

- Abandoned: the firm has abandoned the application. The firm could have decided to abandon the application due to discouragement;
- Inquest: this is firm loan demand being examined by a bank, in which the bank has not yet decided. Under this label are all the applications that, as of 31/12/2007, had not yet been decided.

Table 5 shows the gender distribution of granted (i.e. deliberated loan applications) and non-granted (i.e. refused, inquest, or abandoned loan applications) loans. The percentage distribution of female and male outcomes does not highlight any significant gender difference: roughly 95% and 96% of female and male loan applications are accepted, respectively. Up to this point, the descriptive analysis has not found any significant gender difference, as female and male firms have the same (high) percentage of successful applications.

Table 5 – Granted and non-granted loans broken down by gender. (Absolute values and percentage distributions).

Application outcome	*Male*	*Female*	*Total*
Granted loans	5,828	3,171	8,999
	(95.57)	(94.83)	(95.31)
Non-granted loans	270	173	443
	(4.43)	(5.17)	(4.69)
Total	6,098	3,344	9,442
	100	100	100

Source: our calculations on data from the San Paolo Banca Popolare dell'Adriatico, BCC Fano, BCC Cesena, and TERCAS banks.

Table 6 shows the distribution of the amount of loans requested and eventually granted, by gender. It is worth noting that gender differences regard both the total amount initially requested and the amount eventually granted, as both values are substantially lower for female firms at each percentile we consider. These findings seem to indicate that female firms generally ask for smaller loans than male firms in order to obtain a positive outcome for their loan applications.

Other gender differences emerge once we distinguish between secured and unsecured loans. The dataset distinguishes between loans secured by collateral and by personal guarantees (or both). The distinction between collateral and personal guarantees, and their potential different role in bank-borrower relationships, plays an important role in models of bank interest rates. In an asymmetric information context,

guarantees play a role in solving different problems that may arise at loan origination (hidden information-adverse selection problems) or after the loan has been granted (hidden action-moral hazard problems).

Table 6 – Requested and granted amount of loan broken down by gender. Granted Loans.

			Requested		
Percentile	***10%***	***25%***	***50%***	***75%***	***90%***
Female firms	750	9,344	29,956	75,000	188,004
Male firms	10,326	28,225	61,986	140,057	300,000
Total firms	5,000	18,000	50,000	119,508	264,886
			Granted		
Percentile	***10%***	***25%***	***50%***	***75%***	***90%***
Female firms	2,500	8,640	20,000	50,000	120,000
Male firms	5,000	15,000	43,097	115,000	340,000
Total firms	2,600	10,000	20,000	51,646	150,000

Source: our calculations on data from the San Paolo Banca Popolare dell'Adriatico, BCC Fano, BCC Cesena, and TERCAS banks.

Collateral may come from inside or outside of the firm. The former is physical assets owned by the borrower, and is mainly used by creditors to establish priority in the case of borrower default. The latter is assets posted by a third party: in case of default, outside collateral enhances the claim of a single creditor by recurring against additional assets external to the debtor. Therefore, outside collateral is more powerful than inside collateral in solving asymmetric information problems.

Our data do not distinguish between the two types of collateral (inside-outside), but contain information on personal guarantees. The latter are contractual obligations of a third party, and act as external collateral. However, they do not give the lender a specific claim on particular assets, and restrict the actions (s)he could take in the case of borrowers' bankruptcy (Berger and Udell, 2005).

It is worth noting that data on collateral and personal guarantees are not readily available, and few papers distinguish between the two types of guarantees. Furthermore, previous studies (Pozzolo, 2004; Ono and Uesugi (2009); Calcagnini *et al.*, 2012) show that collateral and personal guarantees impact differently on loan interest rates, as they may be diversely correlated with borrower risk. Table 7 considers all applications and shows the percentage distribution of loan type (unsecured, secured by collateral, secured

by personal guarantees, secured by both collateral and personal guarantees) broken down by gender.

Personal guarantees are used more than collateral to assist loans. Distinguishing between female and male firms, data show that male firms have a higher percentage of unsecured loan applications than female firms (36% and 27%, respectively). The most relevant difference concerns the loans granted by both collateral and personal guarantees: while male firms are asked to post *either* collateral (4%) *or* personal guarantees (60%), female firms are asked to post *either* collateral (5%) *or* personal guarantees (55%) *or* both (13%).

Table 7 Loan distribution by type of guarantee and gender. (Absolute values and percentage distributions).

Type of guarantee	*Unsecured*	*Collateral*	*Personal*	*Collateral and Personal*	*Total*
Male firms	2,220	225	3,653	0	6,098
	(36.41)	(3.69)	(59.9)	(0.00)	(100.00)
Female firms	899	154	1,846	445	3,344
	(26.88)	(4.61)	(55.2)	(13.31)	(100.00)
Total	3,119	379	5,499	445	9,442
	(33.03)	(4.01)	(58.24)	(4.71)	(100.00)

Source: our calculations on data from the San Paolo Banca Popolare dell'Adriatico, BCC Fano, BCC Cesena, and TERCAS banks.

Therefore, even if the percentage of successful applications is surprisingly high for firms in the sample, the differences in the relative share of secured and unsecured loans between male and female firms (Table 7), together with the gender difference concerning the amount of loan requested and eventually granted (Table 6), could be driven by gender discrimination, if not justified by any firm structural difference.

The next section describes the model specification and the empirical strategy to consistently verify whether gender differences that have already been found in the descriptive statistics are driven by gender discrimination during credit access.

4. Model specification and empirical strategy

The empirical analysis aims at verifying the presence of gender discrimination in the access to credit by means of two different empirical models.

Model (1) tests the presence of "type b" gender discrimination, i.e. whether banks impose heavier pre-contractual conditions on female firms than on male firms.

Specifically, we estimate a bivariate probit model to understand how the gender variable, together with firm, loan and bank characteristics (and other control variables) influenced the probability of observing secured loans.

Model (2) tests for supply side discrimination in the form of higher credit worthiness required of female entrepreneurs than their male counterparts before granting credit (type c). Here, we estimate a probit model to test if and how the probability of obtaining a successful loan application depends on firm gender and on loan-contract, individual-firm and -bank characteristics, and their interaction with the firm gender.

4.1 The impact of gender on personal guarantees and collateral: Bivariate Probit Model

Theoretical models define guarantees as a mechanism to reduce equilibrium credit rationing and other problems that arise due to asymmetric information between borrowers and lenders. Specifically, under asymmetric information, guarantees play a role in solving problems that may arise at loan origination (hidden information-adverse selection) or after the loan has been granted (hidden action-moral hazard). These models suggest that guarantees may induce borrowers to identify themselves *ex-ante* (to solve adverse selection problem) and/or improve their incentives *ex-post* (to reduce moral hazard), potentially mitigating problems generated by the information gaps existing between borrowers and lenders.[4]

This paper assumes that the conditional probability that the firm will post guarantees, i.e. $Pr(GUAR=1|X)$, given a cumulative distribution function $\Phi(.)$, depends on firm, loan and bank characteristics. Specifically, there are three main groups of variates as explanatory variables.

Firm characteristics and expected signs

Vector F contains the following firm characteristics.

GENDER is a dummy variable that takes a value equal to 1 if the firm is "female"; this variable captures the firm's gender.

[4] In a different perspective, Elul (2008) developed a model of secured borrowing in which a drop in the value of the underlying collateral can generate strategic default, which in turn can serve to stabilize aggregate fluctuations.

AGE is a step variable that ranges from 0 to 8 and higher values are associated with older firms/entrepreneurs; it controls for the firm's age.

FIRM_SIZE is the logarithm of the total sales of the firm. It has been rescaled and divided by 10.

We also control for *FIRM_TYPE* (sole proprietorship, partnership, limited liability), for the number of loan applications submitted each year (*NUM_REL*), and for the length of the lending relationship (*LEND_REL*).

Each variable interacts with the *GENDER* dummy. Further, we control for the sector of activity by means of *SECTOR* dummies and for firm location by means of *REGIONAL* dummies (*NORTH-WEST*, *NORTH EAST*, *CENTRAL* and *SOUTH*).

We expect that the probability of posting guarantees will be inversely related with the *AGE* or the *FIRM_SIZE* variables, when guarantees are used to solve moral hazard problems. Indeed, older firms should be considered less risky as they gained experience and survived under the threat of competition for a longer period (Jimènez *et al.*, 2006). Larger sized firms should have stronger bargaining power and are considered typically less risky than other firms (Berger and Udell, 1998).

It is expected that the number of lending relationships (*NUM_REL*) will increase the probability of pledging guarantees, as multiple applications are a signal of difficulty in accessing credit and therefore of borrower risk (Pozzolo, 2004). Carletti et al. (2007) show that the attractiveness of sharing lending decreases with the amount of banks' equity and firms' prior profitability, while it increases with the cost of monitoring. Less opaque firms, for which the cost of monitoring is lower, borrow more from individual lenders.

The impact of the length of the lending relationship (*LEND_REL*) is not defined *a priori*. On one hand, a long-term banking relationship may benefit the borrowers by helping to build trust between borrowers and lenders, and consequently to reducing moral hazard (Boot and Thakor, 1994). On the other hand, longer lending relationships could be associated with a higher use of collateral if long-term relationships generate more severe hold-up problems (Ogawa *et al.* 2010).[5]

[5] Recent studies empirically show that relationship lending may benefit not only the borrower but also loan officers, and loan officer relationship-building leads to more production of soft information (Uchida et al., 2012). Other studies provide evidence that marginal increases in interbank competition are detrimental to relationship lending in markets where large and out-of-market banks are predominant. By

Firms with a more structured legal form (such as the dummy variables *LIMITED_LIABILITY* or *PARTNERSHIP* are equal to one) should be considered less risky, as they suffer less from informational opaqueness and therefore should have a lower probability of having to pledge guarantees than other firm legal types (Berger and Udell, 1998).

As we are controlling for a full set of firm characteristics that, in the absence of an explicit measure, are proxies for firm risk, if the *GENDER* variable or its interaction with the other firm characteristics positively affects the probability of posting guarantees, then this could be a signal of gender discrimination in the bank loan market.

Loan characteristics and expected signs

Vector L contains the characteristics of each loan contract.

LOAN_SIZE proxies for the loan size and is the ratio between the amount of loan requested by the firm from each bank in the database and the average size of loan requested by firms in the same sector. Larger loans are typically riskier than smaller sized ones. Therefore, the probability of posting guarantees should increase with the loan size (*LOAN_SIZE*). However the expected sign could also be negative, as larger borrowers tend to be safer customers (Berger and Udell, 1990). This variable also interacts with the *GENDER* dummy, and if the estimated coefficient of the interaction variable *LOAN_SIZE*GENDER* is statistically significant, it could be a signal of gender discrimination.

Further, we control for the *LOAN_TYPE*: loans backed by accounts receivable, term-loans, revocable-loans, bad debts and unpaid and protested own bills (Bank of Italy, 2010).

Bank characteristics and expected signs

Vector B contains bank characteristics. We use *BANK* dummies, and their interaction with the *GENDER* variable to test different bank behaviours towards firm gender. Moreover, with the *DISTANCE* variable we control for the impact of the distance between the bank and the firm in kilometres. As the quality of a bank's

contrast, where relational lending technologies are already widely in use in the market by a large group of small mutual banks, an increase in competition may drive banks to further cultivate their extensive ties with customers (Presbitero and Zazzaro, 2011).

proprietary information could be inversely related to the distance between bank and borrower, local lenders can collect "soft" information on firms over time, thereby permitting them to gain an informational advantage over more remote competitors. If this is the case, the probability of posting guarantees should increase with the *DISTANCE* variable. However, as distance erodes the bank's informational advantage, less informed competitors can bid more aggressively (lower guarantee requirements) so that the probability of posting guarantees could eventually decrease with the *DISTANCE* (Agarwal and Hauswald, 2010; Alessandrini *et al.*, 2009).

Furthermore, our model includes time-dummy variables (*Tt*). [6]

Collateral and personal guarantees are jointly determined and likely depend on the same set of variables, and we estimate the following bivariate probit model:

$$\Pr\left(GUAR_{ijt} = 1 \mid X\right) = \Phi\left(X'\beta\right)$$

with

$$X'\beta = \beta'_1 F_{it} + \beta'_2 L_{ijt} + \beta'_3 B_{jit} + \beta'_4 T_t + \varepsilon_{ijt} \qquad (1)$$

Table 8 shows data summary statistics.

Columns (1) and (2) of Table 9 show the estimated coefficients of the bivariate probit model (1), in which the likelihood ratio test rejects the null of zero correlation between the errors of the two probit models (see Table 9, as "rho" labelled LR test).

Overall, the findings are consistent with the prediction that observably riskier borrowers are more likely to pledge collateral to solve moral hazard problems (Berger and Udell, 1990; Boot *et al.*, 1991). Further, estimates also demonstrate that there are gender differences in the use of guarantees that disadvantage female firms.

While *AGE* does not affect the probability of posting collateral or personal guarantees, older female firms (*AGE*GENDER*) have a lower probability of securing their debts with collateral. As expected, large firms (*FIRM_SIZE*) have a lower probability of posting personal guarantees than smaller firms. Furthermore, increasing multiple loan applications (*NUM_REL*) positively affects the probability of posting both collateral and personal guarantees.

Long-term lending relationships (*LEND_REL*) between banks and customers negatively affect the probability of posting collateral (column (1)). However, if the firm

[6] The data Appendix describes the regression variables.

is female, a long-term lending relationship increases the probability of posting collateral as the estimated coefficient of *LEND_REL*GENDER* is positive and statistically significant and more than counterbalances the negative estimated coefficient of *LEND_REL*. This finding suggests that the negative effects of the hold-up problem dominate the benefits of the lending relationship in the case of female firms. Further, the impact of *LEND_REL* on personal guarantees is positive (column (2)).

Table 8 - Summary of regression variable statistics.

VARIABLES	Number	Mean	Median	Standard Deviation	Min	Max
LOAN_SIZE	9442	0.63	0.24	1.54	0.00	38.88
COLLATERAL	9442	0.09	0.00	0.28	0.00	1.00
PERSONAL GUARANTEES	9442	0.63	1.00	0.48	0.00	1.00
LEND_REL	9442	1.57	1.70	0.93	0.00	3.30
SOLE PROPRIETORSHIP	9442	0.76	1.00	0.43	0.00	1.00
PARTNERSHIP	9442	0.11	0.00	0.31	0.00	1.00
LIMITED LIABILITY	9442	0.07	0.00	0.25	0.00	1.00
AGE	9442	0.55	0.60	0.14	0.10	0.80
FIRM_SIZE	9442	1.22	1.17	0.11	0.69	2.00
NUM_REL	9442	0.26	0.20	0.29	0.10	3.70
DISTANCE	9442	1.80	0.00	2.38	0.00	6.67
GDP_PC	9442	19.56	20.03	1.68	13.14	32.42
PROTEST	9442	0.03	0.03	0.00	0.01	0.06
BRANCH	9442	4.67	5.15	0.72	1.90	8.66
REFERENDUM	9442	58.09	60.56	4.27	35.99	71.15

Source: our calculations on data from the San Paolo Banca Popolare dell'Adriatico, BCC Fano, BCC Cesena, and TERCAS banks.

The firm legal type matters. Firms organized as partnerships (*PARTNERSHIP*) or female sole proprietorships (*SOLE_PROPRIETORSHIP*GENDER*) have a higher probability of posting personal guarantees. This finding is consistent with the fact that personal guarantees are only external to the firm and they are typically posted by the proprietors. In the case of these legal types, the owners are, by law, requested to post their personal wealth in case of default.

As expected, the probability of posting guarantees increases with the loan size (*LOAN_SIZE*) but only for collateral, while there seems to be no significant relationship with personal guarantees (column (1) and (2), respectively). Additionally, the effect of

loan size is larger in the case of female firms, as the estimated coefficient of the interaction term *LOAN_SIZE*GENDER* is positive and statistically significant.

Table 9 - The impact of gender on guarantees - Bivariate probit model. Estimated coefficients.

VARIABLES	(1) COLLATERAL	(2)PERSONAL GUARANTEES
GENDER	-0.390	0.083
	(0.451)	(0.323)
SOLE_P	-0.079	-0.013
	(0.084)	(0.053)
SOLE_P GENDER*	-0.025	0.273***
	(0.120)	(0.089)
PARTENERSHIP	-0.131	0.673***
	(0.121)	(0.076)
PARTNERSHIP GENDER*	0.114	0.098
	(0.143)	(0.107)
AGE	0.165	-0.176
	(0.248)	(0.143)
AGE GENDER*	-0.761**	-0.083
	(0.313)	(0.229)
FIRM_SIZE	-0.209	-0.363***
	(0.195)	(0.122)
FIRM_SIZE GENDER*	0.187	-0.149
	(0.290)	(0.216)
LEND_REL	-0.109***	0.228***
	(0.038)	(0.022)
LEND_REL GENDER*	0.205***	0.021
	(0.063)	(0.041)
NUM_REL	0.320*	0.463***
	(0.182)	(0.108)
NUM_REL GENDER*	0.269	0.183
	(0.204)	(0.156)
LOAN_SIZE	0.079***	-0.008
	(0.010)	(0.009)
LOAN_SIZE GENDER*	0.148***	0.006
	(0.028)	(0.023)
BANK2	0.034	-0.223
	(0.336)	(0.201)
BANK1 GENDER*	1.230***	0.842***
	(0.368)	(0.223)
BANK2 GENDER*	0.220	-0.294**
	(0.192)	(0.116)
DISTANCE	-0.050*	-0.027
	(0.029)	(0.020)
NORTH-WEST	1.079***	0.559*
	(0.419)	(0.326)
CENTRAL	-0.084	0.319
	(0.327)	(0.195)
SOUTH	-0.068	0.613***
	(0.353)	(0.208)
2006	-0.140***	-0.092***
	(0.051)	(0.035)
2007	-0.098*	-0.090**
	(0.052)	(0.036)
2008	0.638***	-0.059
	(0.220)	(0.181)
CONSTANT	-1.041***	0.365*
	(0.323)	(0.200)
Sector specific effects	yes	yes
Loan type effects	yes	yes
Observations	10,829	10,829
LR test "rho=0"(p-value)	0.00	0.00

Standard errors between parentheses
*** p<0.01, ** p<0.05, * p<0.1

While firms that applied in 2006 or 2007 have lower probabilities of posting guarantees, there is some evidence that during the crisis the probability of securing loans increased, as the estimated coefficient of 2008 is positive and significant in column (1).

Finally, the estimates show that the probability of posting collateral decreases with the *DISTANCE* between the bank and the firm. Therefore, even if the estimated coefficient of female gender (*GENDER*) alone is not statistically significant, the estimates of the interaction terms show that female firms tend to have higher probabilities of having to secure their loans with collateral (when the loan size or the lending relationship increases) or personal guarantees (in the case of sole proprietorships). Those gender differences (which disfavor female firms) have already been underlined from the descriptive statistics (on loan size and the use of guarantees) are first confirmed here.

4.2 The impact of gender on the probability of granted loans: Probit Model

The previous section showed a preliminary analysis of potential gender discrimination by determining the impact of the gender variable (and its interaction with the other firm, loan and bank characteristics) on collateral and personal guarantees, and the results showed that female firms seem to have a higher probability of having to pledge guarantees than male firms.

This section focuses on the impact of gender on the probability of obtaining a successful loan application. To address this issue, the dependent variable used is a binary variable "*CREDIT*" that takes a value equal to one if the loan has been granted and zero otherwise.

The empirical equation takes the following form:

$$\Pr(CREDIT_{ij,t} = 1 \mid X) = \Phi(X'\beta)$$

with

$$X'\beta = \beta_0 + \beta'_1 F_{it} + \beta'_2 L_{ijt} + \beta'_3 B_{ijt} + \beta'_4 T_t + \beta'_5 C_t + \varepsilon_{ijt} \qquad (2)$$

As in model (1) *F*, *L*, and *B* are vectors of firm, contract and bank characteristics, respectively. Furthermore, model (2) includes time-dummies (*Tt*) and a vector of control variables (*C*). Specifically, to take into account structural differences between Italian regions, vector *C* contains the following variables: per capita gdp (*GDP_PC*), per capita

bank braches (*BRANCH*), per capita protest (*PROTEST*), and the number of people who go to the polls for referendums (*REFERENDUM*). These variables can be considered a set of values that facilitate cooperation between the members of a single community, and, therefore, identify the level of the social capital of each Region (Putnam, 1993). The latter level could especially differ between the North and the South of Italy. Guiso *et al.* (2004) demonstrate that the level of social capital contributes to explaining the variability of financial developments between Italian regions.

Firm characteristics and expected signs

In the case of gender discrimination (which disadvantages female firms) in the bank loan market, the estimated coefficient of the dummy *GENDER* should be negative and statistically significant. However, as the case of model (1) estimates, gender discrimination could exist even if gender alone does not affect the probability of access to credit, but some of the interaction variables do. Indeed, the *GENDER* variable interacts with all the firm, loan and bank characteristics to capture the potential different impact of such variables once we consider male or female firms.

Among other firm characteristics, the age of firms matters in the access to credit, and generally older firms are less finance-constrained because of their reputational advantage (Berger and Udell, 1998). Informational opaqueness problems decrease along firms' life cycles, as older firms have had time to build up a reputation compared to younger firms that, therefore, are considered riskier. Thus, we expect a positive estimated coefficient of the *AGE* variable.

We also expect a positive estimated coefficient of the *FIRM_SIZE* variable: size plays an important role in firms' financial structure (Berger and Udell, 1998). Indeed, asymmetric information and informational opaqueness are generally more severe for small-sized firms than larger ones, and thus the former could turn out to be more financially constrained than the latter.

Furthermore, we expect a negative impact of the number of lending relationships (*NUM_REL,* which may be interpreted as a measure of firm riskiness) on the probability of being financed. Meanwhile, the impact of the length of the lending relationship (*LEND_REL*) is positive if it reduces asymmetric information problems, and negative if it generates hold-up problems.

As for the firm legal type, firms organized in more a structured and solid legal form should be considered safer and therefore should have better access to credit than the others (Berger and Udell, 1998).

Loan characteristics and expected signs

As for loan characteristics, the impact of *LOAN_SIZE* is expected to be negative, because larger loans should be riskier than smaller sized ones (and, consequently, they have a negative impact on the probability of obtaining a loan). However, this variable is the ratio between the amount of loan requested by the firm of each bank in the database and the average size of loan requested by firms in the same sector. Therefore, it also measures the relative firm size, and in this case its impact on the probability of obtaining a loan could be positive.

Moreover, model (2) makes use of additional information on the presence of guarantees to control for customers and loans risk. Specifically, the vector *L* includes three dummy variables, one for collateral (*COLLATERAL*), one for personal guarantees (*PERSONAL*), and a dummy (*DOUBLEG*) to capture the simultaneous presence of both types of guarantee. These dummy variables also interact with the *GENDER* variable to capture potential gender differences. The impact of guarantees on the probability of being financed is not defined *a priori*. Indeed, guarantees may be used as a signal of a high quality debtor, and therefore increase the probability of loans being granted; or riskier borrowers may post guarantees, and the impact on the probability of being financed depends on whether guarantees fully compensate - or do not - for borrower risk.[7] Results for section 4.1 showed that guarantees tend to be associated with riskier borrowers and /or loans.

Bank characteristics and expected signs

The model controls for bank characteristics by means of the dummy variables *BANK* dummies and their interaction with the *GENDER* dummy.

Next, we control for a possible impact of the geographical distance between the bank and firm on the probability of being financed by means of the *DISTANCE*

[7] Among the loan characteristics, model (2) does not consider the *LOAN_TYPE*, to be endogenous to the dependent variable *CREDIT*.

variable. However, descriptive statistics show only marginal differences between application outcomes and distances (Table 10).

Table 10 – Application outcome broken down by distance between banks and firms. (Absolute values and percentage distributions).

Application outcome	*DISTANCE=0*	*%*	*DISTANCE >0*	*%*
Granted loans	5,708	95.26	3,291	95.39
Non-granted loans	284	4.74	159	4.61
Total	5,992	100.00	3,450	100.00

Source: our calculations on data from the San Paolo Banca Popolare dell'Adriatico, BCC Fano, BCC Cesena, and TERCAS banks.

Column (1) of Table 11 reports the estimated coefficients of model (2).

Estimates are consistent with the previous findings of model (1) and show that there are gender differences in the access to credit.

The estimated coefficient of *GENDER* is negative and statistically significant, meaning that gender alone matters in having access to credit, once other firm, bank and loan characteristics have been controlled for. Specifically, calculating the marginal effect of the *GENDER* variable as a discrete change of the dummy variable from 0 to 1, female firms have a -34.77% lower probability of being financed than male firms.

As for the firms' legal type, partnerships are favoured compared to limited liability companies: the former have a larger probability of 6.11% (*PARTNERSHIP* marginal effect) of obtaining credit than the latter. However, the opposite is true for female firms organized as partnerships, as the estimated coefficient of *PARTNERSHIP*GENDER* is negative, and more than counterbalances the positive and significant estimated coefficient of *PARTNERSHIP*.

The empirical model (2) controls for a firm's age by means of the AGE step variable. While *AGE* does not affect the probability of granting a loan, female firms are less disadvantaged in gaining access to credit than male firms if they are older (the estimated coefficient of *AGE*GENDER* is positive and significant, and its marginal effect 4.01%).

As expected, the number of lending relationships (*NUM_REL*) decreases the probability of being financed (-7.08%). However, the impact of multiple lending relationships is less negative for female firms, as the estimated coefficient of *NUM_REL* GENDER* is positive and significant.

The lending relationship (*LEND_REL*) does not affect firms' probability of gaining access to credit, as opposed to its impact on the loan contract characteristics, such as the guarantee requirements we found in model (1).

FIRM_SIZE is not statistically significant, while the probability of gaining access to credit depends positively on *LOAN_SIZE*, as the estimated coefficient is positive and statistically significant. This finding shows that larger sized firms have a higher probability of being financed than smaller firms (marginal effect equal to 1.17%). Further, company size plays an even more important role for female firms, as the estimated coefficient of the interaction term *FIRM_SIZE* GENDER* is positive and statistically significant, i.e. corresponding to a marginal increasing probability effect of 6.73%. Therefore, large-sized female firms are less disadvantaged in their access to credit than smaller sized female firms.[8]

Further, firm regional location matters, as firms located in the *NORTH EAST* (the excluded dummy variable) have a higher probability of being financed with respect to firms located in the other regions.

As stated, guarantees are often used as a mechanism to reduce equilibrium credit rationing, or this is at least true in the case of male firms. Indeed, the presence of collateral (*COLLATERAL*) or personal guarantees (*PERSONAL*) increases males' probability of obtaining a loan, and the marginal effects of those variables are equal to 1.45% and 6.57%, respectively. However, in the case of female firms, the positive marginal effect of guarantees on the probability of being financed is much smaller, as the coefficients of both the interaction variables *COLLATERAL*GENDER* and *PERSONAL*GENDER* are negative and statistically significant (the marginal effects are equal to -6.29% and -3.43%, respectively).

Hence, we run two F tests to verify if collateral and personal guarantees have an overall statistically significant impact on the probability that female firms will be financed, as follows:

[8] The empirical model also considers the impact of the interaction of *FIRM_SIZE* with the sector of activity. Larger firms in the "Electricity, gas, steam and hot water supply" sector have an increasing probability of being financed with respect to the "Other" sector (see Table 4), while firm sector alone does not affect the probability of obtaining a loan, with the exception of the "Collection, purification and distribution of water, waste management" sector. These firms have a higher probability of credit access.

$$H_0 : \hat{\beta}_{PERSONAL} + \hat{\beta}_{PERSONAL*GENDER} = 0 \qquad (3)$$

$$H_0 : \hat{\beta}_{COLLATERAL} + \hat{\beta}_{COLLATERAL*GENDER} = 0 \qquad (4)$$

The null hypotheses of (3) and (4) state that the probability that female firms will be financed is not affected by the provision of personal guarantees and collateral, respectively. While the F test result of (3) rejects the null in favour of a positive impact of personal guarantees on female firms' granted loans (p-value=0.00), the F test result of (4) fails to reject the null (p-value=0.67). In the case of female firms the provision of collateral does not affect their probability of being financed. This finding is consistent with the fact that personal guarantees, acting as outside collateral, are more powerful than collateral, which is typically inside the firm.

The estimates above show that the probability of a firm being financed depends on the bank to which it applies, while no different bank attitudes towards gender exist.

The estimated coefficient of the *DISTANCE* variable is not statistically significant. This finding shows that banks are not influenced by the proximity of the firm requiring financing in the decision of granting the loan or not. This variable, however, impacts on the probability of having to post collateral (Table 9).[9]

While applications made in 2006 or 2007 show a higher probability of being successful with respect to those submitted in 2005, 2008 has a negative estimated coefficient, but is not statistically significant. This is likely because of the small number of observations for this year.[10]

Among other control variables, none of the indicators used to measure the level of social capital has a statistically significant estimated coefficient.

Finally, to verify whether the *GENDER* variable has, on average, an overall statistically significant impact on the probability of firms being financed, the following F test is implemented:

$$\begin{aligned} H_0 : \; & \hat{\beta}_{GENDER} + \hat{\beta}_{COLLATERAL*GENDER} * \overline{COLLATERAL} + \hat{\beta}_{PERSONAL*GENDER} * \overline{PERSONAL} + \\ & + \hat{\beta}_{PARTENRSHIP*GENDER} * \overline{PARTNERSHIP} + \hat{\beta}_{AGE*GENDER} * \overline{AGE} + \hat{\beta}_{FIRM\_SIZE*GENDER} * \overline{FIRM\_SIZE} + \\ & + \hat{\beta}_{NUM\_REL*GENDER} * \overline{NUM\_REL} = 0 \end{aligned} \qquad (5)$$

[9] However, the finding might depend on the definition of the *DISTANCE* variable, which takes a value equal to 0 if the firm is located in the same province as the bank, and positive values according to the distance in kilometres in the other cases (see the Data Appendix).

[10] In the regression sample, only 16 observations referred to the year 2008.

where the upper bars denote the sample mean values of each variable. The F test result of (5) rejects the null in favour of a negative impact of the firm's female gender on the probability of obtaining access to credit (p-value=0.08).

Column (2) of Table 11 reports the estimated coefficients of model (2) in which a *COMPANY* dummy is introduced. The latter takes a value equal to 1 if the firm is organized as a limited liability company or as a partnership and 0 if the firm is a sole proprietorship. Overall the estimates confirm previous findings. Furthermore, sole proprietorships (the excluded dummy) seem to be favoured in credit access than other firm types. However, if the gender of the sole proprietorship is female, the advantage of this type of firm with respect to limited liability firms or partnerships becomes smaller, as the estimated coefficient of the interaction *COMPANY*GENDER* is positive and statistically significant.

Columns (3) and (4) of Table 11 replicate the estimate of columns (1) and (2) by adding the dummy variable *DOUBLEG* and its interaction with the *GENDER* variable. In this case, the simultaneous presence of both types of guarantee reduces the probability of credit access, as the estimated coefficient of *DOUBLEG* is negative and statistically significant, and its marginal effect is equal to -7.21%. The finding is motivated by the fact that in the regression samples of columns (3) and (4), only female firms post both types of guarantees, and, therefore, the estimated coefficient of *DOUBLEG* also captures a gender effect.

Table 11 - The impact of gender on credit access - Probit model. Estimated coefficients.

VARIABLES	(1)	(2)	(3)	(4)
GENDER	-2.799***	-0.991**	-2.775***	-3.978***
	(0.989)	(0.436)	(0.974)	(0.947)
SOLE_P	0.027		0.020	
	(0.118)		(0.118)	
*SOLE_P*GENDER*	0.012		-0.007	
	(0.186)		(0.186)	
PARTENERSHIP	0.655**		0.660**	
	(0.313)		(0.312)	
PARTNERSHIP GENDER*	-0.821**		-0.852**	
	(0.352)		(0.353)	
COMPANY		-0.832***		-0.906***
		(0.270)		(0.284)
COMPANY GENDER*		0.693**		0.685**
		(0.314)		(0.326)
AGE	-0.454	-0.285	-0.455	-0.295
	(0.404)	(0.397)	(0.404)	(0.407)
AGE GENDER*	1.124**	0.969*	1.027*	0.869
	(0.541)	(0.530)	(0.543)	(0.543)
NUM_REL	-2.195***	-2.224***	-2.188***	-2.156***
	(0.247)	(0.247)	(0.246)	(0.246)
NUM_REL GENDER*	1.485***	1.601***	1.514***	1.514***

	(0.267)	(0.263)	(0.266)	(0.263)
LEND_REL	-0.004	-0.009	-0.005	-0.013
	(0.053)	(0.053)	(0.053)	(0.054)
LEND_REL GENDER*	0.088	0.131	0.101	0.105
	(0.092)	(0.090)	(0.093)	(0.092)
FIRM_SIZE	-1.273	-1.670	-1.262	-2.251*
	(1.449)	(1.268)	(1.455)	(1.211)
FIRM_SIZE GENDER*	1.888***		1.891***	2.257***
	(0.687)		(0.670)	(0.647)
LOAN_SIZE	0.327***	0.327***	0.327***	0.358***
	(0.103)	(0.105)	(0.103)	(0.105)
LOAN_SIZE GENDER*	-0.104	-0.079	-0.159	-0.178
	(0.140)	(0.145)	(0.136)	(0.137)
COLLATERAL	0.748***	0.711***	0.750***	0.757***
	(0.216)	(0.217)	(0.216)	(0.216)
COLLATERAL GENDER*	-0.811***	-0.779***	-0.140	-0.159
	(0.260)	(0.260)	(0.338)	(0.333)
PERSONAL	1.148***	1.184***	1.148***	1.183***
	(0.099)	(0.099)	(0.099)	(0.099)
PERSONAL GENDER*	-0.644***	-0.732***	-0.526***	-0.586***
	(0.148)	(0.143)	(0.155)	(0.150)
DOUBLEG			-0.867***	-0.842***
			(0.309)	(0.303)
BANK1	0.956**	0.936**	0.931**	1.049***
	(0.389)	(0.390)	(0.390)	(0.399)
BANK2	1.449***	0.843**	1.484***	0.668
	(0.332)	(0.404)	(0.331)	(0.420)
BANK2 GENDER*	-0.294	0.207	-0.336	0.528
	(0.326)	(0.367)	(0.329)	(0.394)
DISTANCE	-0.042	-0.060	-0.042	-0.058
	(0.054)	(0.051)	(0.054)	(0.054)
NORTH-WEST	-1.087**	-0.984*	-1.134**	-1.151**
	(0.543)	(0.539)	(0.550)	(0.569)
CENTRAL	-1.007***	-0.986***	-1.007***	-1.106***
	(0.326)	(0.328)	(0.326)	(0.333)
SOUTH	-0.968**	-0.876*	-0.984**	-1.006**
	(0.441)	(0.447)	(0.441)	(0.459)
2006	0.377***	0.379***	0.388***	0.379***
	(0.083)	(0.081)	(0.084)	(0.081)
2007	0.554***	0.550***	0.561***	0.557***
	(0.092)	(0.089)	(0.093)	(0.090)
2008	-0.765	-0.827*	-0.754	-0.749
	(0.491)	(0.477)	(0.493)	(0.502)
GDP_PC	0.038	0.051	0.049	0.060
	(0.066)	(0.067)	(0.068)	(0.068)
PROTEST	-1.029	-7.231	-2.570	-4.888
	(15.800)	(15.348)	(16.175)	(16.066)
BRANCH	0.061	-0.026	0.073	0.042
	(0.180)	(0.197)	(0.190)	(0.190)
REFERENDUM	-0.048	-0.045	-0.057	-0.058
	(0.054)	(0.056)	(0.057)	(0.056)
CONSTANT	4.809**	5.963***	5.041**	7.121***
	(2.270)	(2.193)	(2.338)	(2.192)
Sector specific effects	yes	yes	yes	yes
*Sector specific effects*firm size*	yes	yes	yes	yes
Observations	9,442	9,442	9,442	9,442

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

4.3 Robustness checks

In this section we provide some additional empirical evidence of gender discrimination in access to credit.

Firstly, we define firms according to their innovative activity. Indeed, it is often argued that innovative firms have different financial needs and more severe problems in

accessing funds than traditional firms, because the former may be subject to negative cash flows or high return volatility. Therefore, they are riskier than traditional firms. Furthermore, innovative firms typically base their activity on intellectual capital and intangible assets that amplify the problem of financial opaqueness, i.e. investors find it more difficult to evaluate the profitability of their investment projects and, therefore, firms' current and future market value. The consequence of these characteristics is twofold. On one hand, innovative firms usually incur in higher financing costs than traditional firms. On the other hand, innovative firms have a higher probability of being credit rationed than traditional firms (Calcagnini *et al.*, 2011; Bellucci *et al.*, 2012).

Therefore, we control for the innovative nature of firms, according to Pavitt's taxonomy, which classifies firms by evaluating the source and the nature of technological innovations, by considering the intensity of the research and development activities, and the flow of knowledge (Pavitt, 1984). Four categories of industrial firms are defined:

(1) Supplier-Dominated: includes firms from mostly traditional manufacturing such as textiles and agriculture, which rely on sources of innovation external to the firm.

(2) Scale-Intensive: characterized by mainly large firms producing basic materials and consumer durables, e.g. the automotive sector. Sources of innovation may be both internal and external to the firm.

(3) Specialized Suppliers: smaller, more specialized firms producing technology to be sold and installed in other firms, e.g. specialized machinery production and high-tech instruments.

(4) Science-based: high-tech firms, which rely on R&D from both in-house sources and university research, including industries such as pharmaceuticals and electronics.

Table 12 shows the distribution of sample firms according to the Pavitt taxonomy, broken down by gender. Overall, the majority of firms are supplier dominated, but a larger share of female firms is supplier dominated (88%) than male firms (84%).

Columns (1) and (2) of Table 13 show the estimated coefficients of model (2) in which firm sector is defined according to the "Pavitt" taxonomy.

Overall, estimates confirm gender differences in credit access, as female firms result more financially constrained than male ones. Furthermore, the estimates do not

show differences in the probability of obtaining a loan between firms of different Pavitt sectors in column (1), while *scale intensity* or *specialized suppliers* firms have higher probabilities of granted credit than *supplier dominated* firms in column (2).

Table 12 – Firms distribution by Pavitt Taxonomy and gender. Absolute values and percentage distribution).

Pavitt Taxonomy	***Male***	***Female***	***Total***
Supplier-dominated	1,906	977	2,883
	(83.6)	(87.62)	(84.92)
Scale-intensity	152	33	185
	(6.67)	(2.96)	(5.45)
Specialized suppliers	52	9	61
	(2.28)	(0.81)	(1.8)
Science-based	45	11	56
	(1.97)	(0.99)	(1.65)
Other	125	85	210
	(5.48)	(7.62)	(6.19)
Total	2,280	1,115	3,395
	(100.00)	(100.00)	(100.00)

Source: our calculations on data from the San Paolo Banca Popolare dell'Adriatico, BCC Fano, BCC Cesena, and TERCAS banks.

Columns (3) and (4) of Table 13 show the estimated coefficients of model (2) referred only to MICRO firms, defined according to the European Commission classification, i.e. firms whose total sales are under 2,000,000 euro. In this case the impact of gender captured by the estimated coefficient of *GENDER* is larger, and female firms appear to have an even lower probability of obtaining a loan with respect to the previous findings in Table 11.

Column (5) of Table 13 restricts the analysis to LIMITED LIABILITY companies, to test whether the legal organization type influences the gender differences in the access to credit. In this subsample, the estimated coefficient of the *GENDER* dummy variable is not statistically significant, as gender appears only partially to affect the positive outcome of the loan applications of female firms.

Table 13 - The impact of gender on credit access– Robustness Checks - Probit model. Estimated coefficients.

VARIABLES	(1) Pavitt Sectors	(2)Pavitt Sectors	(3) Micro Firms	(4) Micro Firms	(5)Limited Liabilities
GENDER	-2.327**	-3.813***	-4.763***	-5.127***	-2.675
	(1.037)	(1.012)	(1.163)	(1.107)	(2.301)
SOLE_P	-0.036		-0.166		
	(0.115)		(0.136)		
SOLE_P GENDER*	-0.043		0.180		
	(0.188)		(0.200)		
PARTENERSHIP	0.535*		1.490***		
	(0.314)		(0.475)		
PARTNERSHIP GENDER*	-0.878**		-1.720***		
	(0.352)		(0.507)		
COMPANY		-0.995***		-0.215	
		(0.315)		(0.361)	
COMPANY GENDER*		0.748**		-0.032	
		(0.352)		(0.397)	
AGE	-0.312	-0.143	-0.221	-0.086	0.825
	(0.403)	(0.402)	(0.475)	(0.475)	(1.200)
AGE GENDER*	0.994*	0.849	0.848	0.714	-0.135
	(0.540)	(0.539)	(0.595)	(0.592)	(1.453)
NUM_REL	-2.145***	-2.165***	-2.234***	-2.178***	-5.355***
	(0.247)	(0.239)	(0.275)	(0.274)	(1.891)
NUM_REL GENDER*	1.480***	1.540***	1.457***	1.447***	4.396**
	(0.275)	(0.263)	(0.300)	(0.294)	(1.852)
LEND_REL	0.019	-0.007	-0.022	-0.005	-0.351
	(0.054)	(0.054)	(0.056)	(0.055)	(0.256)
LEND_REL GENDER*	0.110	0.115	0.114	0.096	0.390
	(0.091)	(0.090)	(0.096)	(0.095)	(0.492)
FIRM_SIZE	-1.368	-1.333	-6.945***	-7.141***	113.470***
	(0.847)	(0.837)	(2.302)	(2.451)	(5.787)
FIRM_SIZE GENDER*	1.167*	1.698***	3.890***	3.835***	2.193
	(0.628)	(0.600)	(0.840)	(0.857)	(1.511)
LOAN_SIZE	0.309***	0.346***	0.909***	0.849***	-0.038
	(0.106)	(0.108)	(0.243)	(0.241)	(0.074)
LOAN_SIZE GENDER*	-0.153	-0.178	-0.644**	-0.577**	0.448***
	(0.138)	(0.136)	(0.265)	(0.262)	(0.170)
COLLATERAL	0.702***	0.725***	0.865***	0.891***	0.955
	(0.218)	(0.215)	(0.269)	(0.271)	(0.848)
COLLATERAL GENDER*	-0.697***	-0.712***	-0.821***	-0.831***	-1.957**
	(0.264)	(0.261)	(0.302)	(0.303)	(0.931)
PERSONAL	1.091***	1.140***	1.113***	1.139***	1.042**
	(0.098)	(0.099)	(0.102)	(0.102)	(0.437)
PERSONAL GENDER*	-0.613***	-0.708***	-0.577***	-0.625***	-0.815
	(0.148)	(0.143)	(0.157)	(0.152)	(0.536)
BANK1		1.192***	1.356***	1.358***	1.324
		(0.410)	(0.467)	(0.472)	(0.856)
BANK2	1.399***	0.542	2.212***	1.458***	
	(0.352)	(0.454)	(0.429)	(0.456)	
BANK2 GENDER*	-0.171	0.715*	-0.606	0.087	
	(0.339)	(0.417)	(0.386)	(0.395)	
BANK1 GENDER*	1.103***				
	(0.402)				
DISTANCE	-0.054	-0.079	-0.088	-0.111*	-0.013
	(0.055)	(0.054)	(0.058)	(0.059)	(0.172)
NORTH-WEST	-0.771	-0.680	-1.580***	-1.417**	0.238
	(0.596)	(0.605)	(0.588)	(0.609)	(1.024)
CENTRAL	-0.874***	-0.972***	-1.169**	-1.267***	-1.926***
	(0.321)	(0.325)	(0.457)	(0.433)	(0.587)
SOUTH	-0.765*	-0.769*	-0.941*	-0.962**	-0.510
	(0.417)	(0.428)	(0.498)	(0.476)	(1.667)
2006	0.396***	0.384***	0.424***	0.392***	-0.849**
	(0.082)	(0.079)	(0.090)	(0.086)	(0.335)
2007	0.601***	0.593***	0.639***	0.605***	0.022
	(0.091)	(0.089)	(0.099)	(0.098)	(0.360)
2008	-0.731*	-0.741*	-0.897	-1.054*	-0.579
	(0.417)	(0.410)	(0.612)	(0.565)	(0.692)
GDP_PC	0.054	0.060	0.139	0.129	-0.169
	(0.069)	(0.068)	(0.092)	(0.088)	(0.122)

PROTEST	-7.957	-9.999	-47.976**	-45.011**	45.632
	(18.531)	(17.438)	(20.089)	(20.298)	(30.358)
BRANCH	0.125	0.084	0.045	-0.018	0.091
	(0.185)	(0.181)	(0.284)	(0.290)	(0.402)
REFERENDUM	-0.066	-0.066	-0.123	-0.110	0.056
	(0.057)	(0.055)	(0.083)	(0.082)	(0.095)
CONSTANT	5.526**	1.325	14.748***	15.256***	-169.145***
	(2.254)	(2.374)	(3.969)	(4.069)	(8.745)
PAVITT Scale-intensity	-1.907	3.596**	no	no	no
	(1.337)	(1.449)			
PAVITT Specialized suppliers	1.044	6.206***	no	no	no
	(1.606)	(1.725)			
PAVITT Science-based	-0.261		no	no	no
	(1.170)				
PAVITT Other	-6.255***		no	no	no
	(1.692)				
*PAVITT_D*GENDER*	yes	yes	no	no	no
*PAVITT*FIRM_SIZE*	yes	yes	no	no	no
Sector specific effects	no	no	yes	yes	yes
*Sector specific effects*firm size*	no	no	yes	yes	yes
Observations	9,489	9,489	9,044	9,044	645

Robust standard errors between parentheses
**** p<0.01, ** p<0.05, * p<0.1*

5. Conclusions

This paper contributes to the research on gender discrimination in credit markets by analyzing gender differences in credit access by means of a large dataset on firms' lines of credit with four Italian banks over the period 2005-2008. Estimates show that, after controlling for loan, firm and bank characteristics, female firms: (a) have a higher probability of having to pledge guarantees than male firms; (b) have a lower probability of gaining access to credit. Further, smaller sized female firms are even more disadvantaged in credit access than large-sized female firms. The same result occurs for female firms that are not organized as limited liability companies. The two latter results suggest that, in order to improve their access to bank loans, female firms should pursue a strategy oriented to expanding their size and to increasingly adopting the legal form of limited liability companies.

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Data Appendix

The empirical analysis uses information on new lines of credit to a large sample of Italian nonfinancial firms. The variables used are defined as follows.

GENDER is binary dummy variable that takes a value of 1 if the gender of the firm owner is "female" and 0 if the gender is "male". The following table describes how to identify a female-owned firm:

Table A.1 – Definition of female-owned firm

Presence of women	LIMITED LIABILITY	PARTNERSHIPS	SOLE PROPRIETORSHIPS	OTHER JURIDICAL TYPE
Majority	If in the list of partners women hold more than 50% of social capital and women are more than 50% of total "administrators" If the list of partners is not available at the registry of firms: women are more than 50% of total "administrators"	>50% "partners"		>50% "administrators"
Strong (see the 215/92 Italian Law)	If in the list of partners women hold more than 2/3 of social capital and women are more than 2/3 of total "administrators" If the list of partners is not available at the registry of firms: women are more than 2/3 of total "administrators"	>60% "partners"		>60% "administrators"
Exclusive	If in the list of partners women hold more than 100% of social capital and women are more than 100% of total "administrators" If the list of partners is not available at the registry of firms: women are more than 100% of total "administrators"	100% "partners"	Owner	100% "administrator"

Source: *Osservatorio dell'imprenditoria femminile* 2004.

SOLE PROPRIETORSHIP is a binary dummy variable that takes a value equal to 1 if the firm is a sole proprietorship and 0 otherwise.

PARTNERSHIP is a binary dummy variable that takes a value equal to 1 if the firm is a partnership and 0 otherwise.

LIMITED LIABILITY is a binary dummy variable that takes a value equal to 1 if the firm is a limited liability company and 0 otherwise.

COMPANY is a binary dummy variable that takes a value equal to 1 if the firm is a partnership or a limited liability company and 0 otherwise.

AGE is a step variable that ranges from 0 to 8 and higher values are associated to older firms/entrepreneurs. It has been rescaled and divided by 10.

FIRM_SIZE is the logarithm of the total sales of the firm. It has been rescaled and divided by 10.

LEND_REL is equal to the number of years in the sample that the firm-bank relationship lasts. It has been rescaled and divided by 10.

NUM_REL is the number of loan application submitted by each firm in each year. It has been rescaled and divided by 10.

LOAN_SIZE is the ratio between the amount of loan requested by the firm of each bank in the database and the average size of loan requested by firms of the same sector. It represents a proxy for loan/firm size.

COLLATERAL is a binary dummy variable that takes a value of 1 when collateral are posted and 0 otherwise. This variable is a proxy for inside collateral.

PERSONAL is a binary dummy variable that takes a value of 1 when personal guarantees are posted and 0 otherwise. Personal guarantees are granted by third parties in favour of borrowers. This variable acts as outside collateral.

DOUBLEG is a binary dummy variable that takes a value of 1 when both personal and collateral are posted and 0 otherwise.

NORTH-EAST is a binary geographical dummy variable that has a value of 1 for firms with headquarter in North-East of Italy and 0 otherwise. The provinces are: Bologna, Bolzano, Forlì-Cesena, Ferrara, Modena, Padova, Parma, Ravenna, Rimini, Rovigo, Trento, Verona.

NORTH-WEST is a binary geographical dummy variable that has a value of 1 for firms with headquarter in North-West of Italy and 0 otherwise. The provinces are: Bergamo, Como, Milano e Torino.

CENTRAL is a binary geographical dummy variable that has a value of 1 for firms with headquarter in Central Italy and 0 otherwise. The provinces are: Ancona, Ascoli Piceno, Arezzo, Firenze, Frosinone, Grosseto, Latina, Macerata, Perugia, Pisa, Pesaro-Urbino, Roma.

SOUTH is a binary geographical dummy variable that has a value of 1 for firms with headquarter in Southern Italy and 0 otherwise. The provinces are: L'Aquila, Avellino, Bari, Benevento, Brindisi, Campobasso, Caserta, Catania, Chieti, Cosenza, Catanzaro, Enna, Foggia, Isernia, Messina, Napoli, Nuoro, Pescara, Potenza, Reggio Calabria, Salerno, Sassari, Taranto, Teramo, Trapani.

DISTANCE is the ln (1+ distance in kilometers between the province in which the bank is located and the province in which the firm is located). If the bank and the firm are located in the same province this variable is, therefore, equal to 0.

2005 is a binary dummy variable that takes a value equal to 1 if the application is made in the year 2005 and 0 otherwise.

2006 is a binary dummy variable that takes a value equal to 1 if the application is made in the year 2006 and 0 otherwise.

2007 is a binary dummy variable that takes a value equal to 1 if the application is made 2007 and 0 otherwise

2008 is a binary dummy variable that takes a value equal to 1 if the application is made in the year 2008 and 0 otherwise.

BANK1 is a binary dummy variable that takes a value of 1 if the bank is "BCC Fano" and 0 otherwise.

BANK2 is a binary dummy variable that takes a value of 1 if the bank is "San Paolo Banca Popolare dell'Adriatico" and 0 otherwise.

BANK3 is a binary dummy variable that takes a value of 1 if the bank is "BCC Cesena" and 0 otherwise.

BANK4 is a binary dummy variable that takes a value of 1 if the bank is "TERCAS" and 0 otherwise.

GDP_PC is per capita gdp.

BRANCH is per capita bank braches.

PROTEST per capita bill protest.

REFERENDUM is the percentage of people who go to the polls for referendums.