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Access to credit for SMEs: theories and evidence

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Introduction

Entrepreneurs who engage in investment activity, are usually risk averse. Under perfect information, complete capital markets provide full insurance against idiosyncratic uncertainty, and financial resources to be allocated to the most productive investment. However, it is a well known fact that market incompleteness resulting from informational asymmetries – due for instance to moral hazard and adverse selection – hinders risk diversification and reduces the availability of external funds for risky ventures. This is especially true in the case of small businesses, i.e. small medium enterprises (SMEs). Entrepreneurs running SMEs will typically have to self-finance part of their investment activity and pledge their wealth to obtain credit, thereby bearing significant risks. This has two important consequences, it distorts the allocation of resources toward low risk – low yield activities and it discourages access to credit, and thereby investments.

The literature on the functioning of credit markets under asymmetric information is extremely vast. In this thesis we focus on firms' access to credit under different source of asymmetric information and the nature of the market incompleteness they generate. This is of key importance in order to: a) understand whether the institutional settings that shape the credit markets are efficient; as well as to: b) design policies capable of ameliorating business access to credit.
Within this broad field of research we focuse on:

i. how the functioning of financial institution and legal system affects access to credit;

ii. how the interaction between lenders and borrowers affects the demand and the supply of credit;

As far as the point (*i.*) in Chapter 1 we analyze how bankruptcy law, such as the institution of debt discharge, affects loan contracts. In particular the work evaluates, under a theoretical and empirical perspective, the effects of debt discharge on access to credit and cost of credit by taking into account its impact on the role of collateral as a signaling device. In the theoretical model we take explicitly into account the fact that borrowers can undo the effects of exemption by posting collateral to secure debt. We use the results from the theoretical analysis, in order to test for the signaling effect of collateral in a sample of small businesses in the US.
For what concerns point (*ii.*) in Chapter 2 and 3 we analyze two different situations. In Chapter 2 we study the emergence of the phenomenon of borrowing discouragement stemming from the combination of uncertainty, asymmetric information and costly loan applications. Discouragement becomes a relevant issue in the credit market especially when credit worthy firms do not apply causing a potential misallocation of financial resources. Regarding this aspect of access to credit, the work aims to give a new theoretical view of borrowing discouragement taking into account other sources of asymmetric information (such as moral hazard) together with uncertainty on collateral requirements and cost of applications. In Chapter 3 we study the importance of using trade credit to reduce the information asymmetries between firms and banks. Under this perspective trade credit work as complementary financing resource. We test the complementarity hypothesis using an empirical methodology that takes into account the relevance of private information in firm-bank relationships.

Chapter 1

Access to credit and cost of credit with bankruptcy exemption

1.1 Introduction

Personal bankruptcy law in the US allows individuals to choose between two different bankruptcy procedures: Chapter 7 and Chapter 13.[1] If an individual files under Chapter 7, her unsecured debt would be mostly discharged. At the same time, the trustee will liquidate individual's non-exempt assets to repay creditors. Crucially, secured creditors can still fully seize the assets pledged as collateral.Types of exempt assets and levels of exemption are decided by individual States. There exists a widely variation across states. Exemptions can be classified on the basis of the type of asset they apply to. Homestead exemption is the exemption on the individual's equity in owner-occupied principal residence. Differently, non-homestead exemption includes individual's equity in cars, cash, and other goods such as furniture, clothing, cooking utensils, farm implements, family bibles, and tools for trade, etc. In most States, the level of homstead exemption is larger that of the non-homestead one. Furthermore, non-homestead exemption is generally low across states. Finally, homestead-exemption is unlimited in some State, and zero in some others.

Unlike Chapter 7, Chapter 13 is more like debt-repayment plan. No debt is

[1] Whenever it might be relevant, please note that we refer to the bankruptcy law in place prior to the reform which took place in 2005, since the data we use in the empirical analysis are from 2002.

discharged. Agents can keep their assets, and they have to use future earnings to repay part or all of their debt.

According to chapter 7, bankrupt individuals could benefit from a fresh start opportunity to the extent that they will keep some assets, while their debt obligation will be partially redeemed. This has a number of potential consequences on the functioning of credit markets.

In this paper we analyze the effect of such asset exemption on the cost of credit and on access to credit in a competitive credit market subject to adverse selection. Unlike previous literature, in our theoretical analysis we take explicitly into account the fact that borrowers can undo the effects of exemption by posting collateral to secure debt. We use the results from the theoretical analysis, in order to test for the signaling effect of collateral in a sample of small businesses in the US based on 2002 SSBF data.

1.2 Exemption and the role of collateral

Consider a standard adverse selection (AS) framework characterized by a competitive credit market populated by (1) Entrepreneurs who are endowed with one asset each, and have to borrow to finance their business; and (2) Competitive lenders who face an opportunity cost equal to zero, and make zero profits in equilibrium. Entrepreneurs are of two types: risky (with a high probability of default) and safe (with a low probability of default). As usual, while each entrepreneur knows her type, lenders only know the distribution of types.

In a pooling equilibrium where all entrepreneurs are financed, safe entrepreneurs would be subsidizing risky ones. Hence, they could benefit from separation by means of a signaling device. Collateral could be such device.

There are two identical credit markets, one located in State 1, and the other located in State 2, where,

1. in State 2's, no assets are exempt from liquidation in the event of bankruptcy;

2. in State 1's, all uncollateralized assets are exempt in the case of default.

Consider first the case of State 1. In the event of bankruptcy, entrepreneurs' assets are liquidated anyway; independently of whether they were posted as collateral or not. Therefore, posting collateral plays no role as a signal. Neither the cost of credit nor access to credit can be affected by the decision to post collateral. Accordingly, in State 1, the prevailing equilibrium should be a pooling equilibrium where, if financial exchange takes place, the same contract applies to all entrepreneurs, independently of whether they post any collateral.

Consider now State 2. In the event of bankruptcy, entrepreneurs' assets will be liquidated if and only if they were posted as collateral. Hence, if going bankrupt, an entrepreneur who has posted collateral suffers a greater loss than an entrepreneur who has not. Posting collateral has now an opportunity cost. Crucially, such opportunity cost is, in expected terms, type-dependent. Risky entrepreneurs have a higher probability to fail than safe entrepreneurs, so that their expected opportunity cost from posting collateral is higher than that of safe entrepreneurs. This provides the sorting condition for a separating equilibrium in which safe entrepreneurs self-select into contracts characterized by higher collateral requirements. In such equilibrium, posting collateral results in a lower interest rate for two reasons:

1. Posting collateral increases the cash flow available to financiers (Direct effect);

2. Posting collateral signals a lower probability of default (Signaling effect).

We provide a model of the credit market to fully analyze the role of collateral on cost of credit and access to credit when AS is the source of asymmetric information. Then, we use the theoretical predictions for the AS case, to identify the signaling role of collateral using data on the Survey of Small Business Finance (SSBF) prior to the 2005 Bankruptcy reform.

1.3 Related literature

Cross-State variability in exemption levels associated with US State bankruptcy laws prior to the 2005 reform, is key to most empirical investigations on the effects of exemption. Various papers have examined the effects of exemption rates on interest rates and credit rationing. Gropp, Scholz and White (1997) found that interest rates on car loans where higher in states with higher exemption levels. Lin and White (2001) found that potential borrowers are more likely to be turned down by banks the higher is the level of exemption. Berkowitz and White (2004) found that small businesses borrow less and pay higher interest rates in states with higher exemption levels. In a similar vein, Berger, Cerqueiro and Penas (2011) find that borrowers have lower access to credit in states with more debtor-friendly levels of exemption. They also find that in such states borrowers are more likely to pledge collateral and have generally tighter loan terms.

Fan and White (2003) investigate the effects of the bankruptcy system on entrepreneurial behavior. States with unlimited homestead exemption are found to have one-third more entrepreneurs than states with low exemptions. Armour and Cummings (2005) find that countries in which the post-bankruptcy period for which filers are obliged to repay from earnings is shorter have more entrepreneurs.

Fay, Hurst and White (2003) tested where pro-debtor bankruptcy laws encourage borrowers' opportunistic behavior. Their evidence is that for every $1000 increase in debtors' potential gain from bankruptcy, the filing rate raises by 7%.

Finally, Grant and Koeniger (2005) investigate the insurance effects. They find that the variance of consumption over time is lower in states with higher exemption levels.

1.4 The Model

We consider a competitive market populated by a large number E of entrepreneurs and a large number L of lenders. The set of entrepreneurs, $\mathcal{E}$, and that of lenders, $\mathcal{L}$, are indexed by $e = 1, ..., E$, and $l = 1, ..., L$, respectively. Both entrepreneurs and lenders are risk-neutral. Lenders are endowed with one unit of financial resources, each, and face an opportunity cost of capital, $r > 0$. Each entrepreneur, e, is endowed with an investment opportunity of fixed size one and an amount of pledgeable wealth, $w_e \in [0, \overline{w}]$. With no loss of generality, we set $L/E > 1$, so that financial resources are abundant. For any given level of wealth, w, we define $\mathcal{E}_w \subseteq \mathcal{E}$ the subset of entrepreneurs endowed with wealth w, and $E(w) = |\mathcal{E}_w|$ the corresponding number of entrepreneurs. Investment lasts one period and delivers an overall $R > 0$ with probability p and 0 otherwise, where p is a function of entrepreneur's type, q:

$$p = \begin{cases} p_H \, if & q = H \\ p_L \, if & q = L \end{cases}, \tag{1.1}$$

with $p_H > p_L$. A fraction λ of the population of entrepreneurs is of type H (safe) and a fraction $1 - \lambda$ is of type L (risky). We assume $p_L R > (1 + r)$, which means that both safe and risky entrepreneurs are worth financing.

Ex ante, entrepreneurs' type is private information and so is information about wealth. In other words, individual wealth is not observable ex ante. However, entrepreneurs can credibly disclose information about its true value at zero cost if they want to. Ex post, in the event of default, wealth is observable and verifiable. Finally, we assume that the value of an amount of entrepreneurial wealth w to the lender is βw, with $\beta < 1$. Hence, liquidating wealth to pay for debt is inefficient.

1.4.1 Contracts, sorting condition and signaling role of collateral

Following Besanko and Thakor (1987), we define a lending contract, $\mathcal{C}$, as a triplet, (R_L, C, π), where R_L is the cost of credit, C is the amount of collateral, and π is the probability to be financed.

Given a contract $\mathcal{C} = (R_L, C, \pi)$, and a level of exemption η, the value of entrepreneurial wealth that the lender is entitled to in the case of default – which we refer to as real guarantees – is given by: [2]

$$G = \min(\max(w - \eta, C), \max(\frac{R_L}{\beta}, C)). \tag{1.2}$$

It is important to note that, other things equal, G is weakly increasing in C, and decreasing in η.

[2] We are assuming that, in the event of default, non-collateralized entrepreneurs' assets are liquidated up to R_L/β – that is up to the value of debt at date 1, R_L.

Sorting condition. The expected payoff for an entrepreneur of type q signing a generic contract, $\mathcal{C}$ is, $p_q(R - R_L) - (1 - p_q)G$. Let $\mathcal{C}_1$ and $\mathcal{C}_2$ two contracts with $\pi_1 = \pi_2 = 1$, $C_1 > C_2$ and $R_{L,1} < R_{L,2}$ such that $G_1 > G_2$. Note that $C_1 > C_2$ implies $G_1 > G_2$, if η is sufficiently high and β is sufficiently low, relative to the other parameters' values. Then, if

$$p_L(R - R_{L,1}) - (1 - p_L)G_1 \geq p_L(R - R_{L,2}) - (1 - p_L)G_2, \tag{1.3}$$

$$p_H(R - R_{L,1}) - (1 - p_H)G_1 > p_H(R - R_{L,2}) - (1 - p_H)G_2, \tag{1.4}$$

holds. This follows directly from $p_H > p_L$. That is whenever entrepreneurs of type L prefer the contract characterized by more real guarantees, entrepreneurs of type H strictly prefer such contract. This implies, in principle, that entrepreneurs of type H could signal their type by self-selecting into a contract characterized by a level of guarantees sufficiently high. In turns, since guarantees are a weakly increasing function of collateral, this means that collateral has a potential role as sorting/signaling device.

Signaling role of collateral as a function of exemption, η. The effectiveness of collateral as a signaling/sorting mechanism depends upon the level of exemption, η. Under no exemption, i.e. if $\eta = 0$, independently of whether they post collateral or not, entrepreneurs' wealth is liquidated in the event of default. Hence, posting collateral does not provide any meaningful signal. In the opposite extreme case of unlimited exemption, i.e. if $\eta \to \infty$, entrepreneurs' wealth is liquidated in the event of default if and only if they post it as collateral. Hence, the opportunity cost of posting collateral increases with exemption. But then, since such cost of capital is type dependent, this implies that the signaling power of collateral is enhanced.

1.4.2 Equilibrium analysis

The sequence of actions is as follows:

Stage 0: Entrepreneurs and lenders meet in the credit market. Lenders simultaneously offer credit contracts; Entrepreneurs decide whether to disclose information about their wealth or not,[3] whether to demand credit or not, and under which contract;

Stage 1: Contracts are signed (if any), and payoffs are realized.

We focus on symmetric Subgame Perfect Nash Equilibria (SPBE) in pure strategies. We define an equilibrium as set of strategies for entrepreneurs and lenders, such that:

1. Lenders and entrepreneurs' strategies constitute best replies at all stages given, other agents' strategies, and the belief function;

2. The belief function is consistent with agents' strategies;

3. Lenders' make zero profits.

We characterize the set of equilibrium contracts in two steps. First, we consider the simple case in which all borrowers have the same level of wealth w. Then we generalize the result to any borrower's wealth distribution.

Borrowers homogeneous with respect to wealth, w

For convenience, let us re-define contracts, in terms of guarantees, G, rather than collateral, C.[4] We will characterize the equilibrium in the general case in which exemption is strictly positive, $\eta > 0$, and then briefly characterize the equilibrium in the special case in which $\eta = 0$. We start our equilibrium analysis with two preliminary results.

1. In any equilibrium, lenders must be making zero profits. Consider an equilibrium in which lenders offer $\mathcal{C}^L \equiv (R_L^L, G^L, \pi_L)$, and $\mathcal{C}^H \equiv (R_L^H, G^H, \pi_H)$ to risky and safe borrowers respectively, such that those lenders who are able to lend make positive profits.[5] Since we assume $E < L$, there will be lenders not able

[3] Another way of saying it is that banks decide whether to ask entrepreneurs to disclose information by offering contracts that require entrepreneurs to do so, or not.

[4] Once we derive the equilibrium contracts in terms of G, we can recover the equilibrium values of C.

[5] Note that in a pooling equilibrium, $\mathcal{C}^L = \mathcal{C}^H$ holds.

to lend, who make zero profits. Then, one of these lenders could deviate and offer a contract $\mathcal{C}^{L'}$, characterized by a cost of credit, $R_L^{L'} = R_L^L - \epsilon$. Clearly, borrowers of type L strictly prefer this contract compared to the equilibrium ones. Moreover, since ϵ can be chosen arbitrarily close to zero, profits of the deviating lender will be strictly positive. Hence, the described deviation is profitable, which destroys the equilibrium. Hence, in any equilibrium, lenders who are offering a contract $\mathcal{C}^L$ must be making zero profits. This also implies that in any separating equilibrium, where $\mathcal{C}^L \neq \mathcal{C}^H$, lenders must be making zero profits on each of the equilibrium contracts.

2. So long as $\eta > 0$, the standard result of models with competitive screening applies according to which, no pooling equilibrium exists. Consider a candidate pooling equilibrium characterized by a contract $\mathcal{C}^P = (R_L^P, G^P, \pi^P)$. The equilibrium contract satisfies lenders' zero profits' condition:

$$\mathcal{C}^p : p_M R_L^P + (1 - p_M)\beta G^P = 0 \tag{1.5}$$

where $p_M \equiv \lambda p_H + (1 - \lambda)p_L$. Suppose first that the level of guarantees equals the level of collateral, $G^P = C^P > 0$. Consider a deviation, $\mathcal{C}' = (R_L^{'}, G', \pi_P)$ where, $R_L^{'} = R_L^P + \Delta R_L$, and $G' = C' = C^P - \Delta C$ where $\Delta R_L = \beta(1 - p_L)/p_L \Delta C + \epsilon$, so that such deviation will be always strictly profitable to lenders so long it attracts borrowers. Borrowers of type L strictly prefer a contract characterized by a higher interest rate and a lower collateral compared to the equilibrium contract $\mathcal{C}^P$ so long as $\Delta R_L \leq (1 - p_L)p_L \Delta C$. It is then immediate to verify that for $\epsilon \to 0^+$, the above deviation will attract at least borrowers of type L, which destroys the candidate equilibrium. Suppose now that $G^P > C^P$. In this case, a deviation characterized by a lower level of collateral has no effect. Consider, instead, a deviation, $\mathcal{C}' = (R_L^{'}, C', \pi_M)$ where, $R_L^{'} = R_L^P - \Delta R_L$, and $C' = \Delta C + G^P$ where $\Delta R_L = -\beta(1 - pH)/p_H \Delta C + \epsilon$, so that such deviation will be always strictly profitable to lenders so long it attracts borrowers of type H. Borrowers of type H strictly prefer a contract characterized by a lower interest rate and higher collateral compared to the equilibrium contract C^P so long as $|\Delta R| > (1 - p_H)p_H \Delta C$. Differently, borrowers of type L will prefer the new contract if $|\Delta R| > (1 - pL)p_L \Delta C$. Given $p_L < p_H$, $(1 - p_L)p_L \Delta C > (1 - p_H)p_H \Delta C$. It then follows that, for $\epsilon \to 0^+$, the above deviation will attract only borrowers of type H, and it would be strictly profitable for both lenders and borrowers of type H, which destroys the equilibrium.

Given points 1-2 above, with no loss of generality, we focus on separating equilibria (SE), which by definition, are equilibria where safe types separate from risky types. We disregard the existence problem and focus on equilibrium characterization.[6] We analyze first the special case in which all borrowers are homogeneous in wealth, w, and information about individual wealth is common knowledge. Then, we deal with the more general case in which borrowers are heterogeneous with respect to wealth, and information about individual wealth is private albeit disclosable at no cost.

Consider a candidate SE equilibrium where lenders offer contracts, $\mathcal{C}_H = (R_L^H, G_H, \pi_H)$ and $\mathcal{C}_L = (R_L^L, G_L, \pi_L)$, such that, rich and safe self-select into contract $\mathcal{C}_H$ and risky select into contract $\mathcal{C}_L$. These contracts should satisfy the following constraints:

1. Borrowers' incentive compatibility constraints

$$(ICC_H) : \pi_H[p_H(R - R_L^H) - (1 - p_H)G_H] \geq \pi_L[p_H(R - R_L^L) - (1 - p_H)G_L], \quad (1.6)$$

$$(ICC_L) : \pi_L[p_L(R - R_L^L) - (1 - p_L)G_L] \geq \pi_H[p_L(R - R_L^H) - (1 - p_L)G_H]; \quad (1.7)$$

2. Feasibility constraints

$$G_i \leq w, \quad (1.8)$$

$$G_i \geq \max(w - \eta, 0), \quad (1.9)$$

$$\pi_i \leq 1 \quad (1.10)$$

$$\pi_i \geq 0 \quad (1.11)$$

with $i = L, H$;

[6] The standard argument applies according to which there is no guarantee that a competitive equilibrium exists. Having said that, there exist parameter configurations such that the equilibrium exist. We characterize the unique equilibrium (outcome) under parameter configurations that guarantee existence.

3. Borrowers' participation constraints:

$$p_H(R - R_L^H) - (1 - p_H)G_H \geq 0, \tag{1.12}$$

$$p_L(R - R_L^L) - (1 - p_L)G_L \geq 0; \tag{1.13}$$

4. Lenders' zero-profits constraints:

$$p_H R_L^H + (1 - p_H)G_H\beta = (1 + r) \Rightarrow R_L^H = \frac{(1 + r)}{p_H} - \frac{(1 - p_H)\beta G_H}{p_H}; \tag{1.14}$$

$$p_L R_L^L + (1 - p_L)\beta G_L = (1 + r) \Rightarrow R_L^L = \frac{1 + r}{p_L} - \frac{(1 - p_L)\beta G_L}{p_L}. \tag{1.15}$$

Our first observation is that –since liquidation of borrowers' asset is an inefficient way of corresponding cash flows to lenders, due to $\beta < 1$ – in any equilibrium, the level of guarantees played by risky types should be minimum. Accordingly, in any SE, $C_L^* \leq \min(w - \eta, R_L/\beta)$ must hold (no distortion at the bottom), so that,

$$G_L^* = \min(w - \eta, \frac{1 + r}{\beta}), \tag{1.16}$$

and R_L^* is determined accordingly by the zero profit constraint, (1.15).[7] In order to prove that $C_L^* \leq \min(w - \eta, R_L/\beta)$ must hold, consider a candidate SE such that the contract designed for L-type entrepreneurs is characterized by $C_L > \max(w - \eta, R_L/\beta)$, so that G_L= C_L. Consider a deviation to a contract such that $G' = C' = C_L - \Delta C$ and $R' = R_L + \Delta R$, where $\Delta R = \beta(1 - p_L)/p_L \Delta C + \epsilon$. It is immediate to verify that such contract will be strictly profitable to lenders if it can attract any borrower. In fact, L-type borrower would strictly prefer this contract if $\Delta R \leq (1 - p_L)p_L \Delta C$. This condition is satisfied for $\epsilon \to 0^+$, so that there exist a strictly profitable deviation, which destroys the equilibrium.

Imposing the $G_L = G_L^*$ and $R_L^L = R_L^{L*}$ and substituting for R_L^H using (1.14), the values of π_H and G_H associated with the optimal contract for safe types, and the value of π_L associated with the optimal contract for risky types solve

[7] If $R_L = (1 + r)/\beta$ the loan is safe as the borrower has enough non-exempt wealth to repay the loan even in the event of default.

$$\max_{\{\pi_L,\pi_H,G_H\}} \lambda\{\pi_H[p_H R-(1+r)-(1-p_H)(1-\beta)G_H\}+(1-\lambda)\{\pi_L p_L(R-R_L^{L*})-(1-p_L)G_L^*\}+w \tag{1.17}$$

subject to the constraints 1-4. The Lagrangean associated with the problem is

$$\begin{aligned}
\mathcal{L} =&\lambda\{\pi_H[p_H R-(1+r)-(1-p_H)(1-\beta)G_H\}+\\
&+(1-\lambda)\{\pi_L[p_L(R-R_L^{L*})-(1-p_L)G_L^*]\}+w\\
&+\tau_H(1-\pi_H)+\tau_L(1-\pi_L)+\gamma_H\pi_H+\gamma_L\pi_L+\theta_H(w-G_H)+\delta_H(G_H-\max(w-\eta,0))\\
&+\mu_H\{\pi_H[p_H R-(1+r)-(1-p_H)(1-\beta)G_H]-\pi_L[p_H(R-R_L^{L*})-(1-p_H)G_L^*]\}\\
&+\mu_L\{\pi_L[p_L(R-R_L^{L*})-(1-p_L)G_L^*]-\pi_H[p_L(R-(1+r)+\frac{p_L}{p_H}(1-p_H)\beta G_H-(1-p_L)G_H]\},
\end{aligned} \tag{1.18}$$

where, τ_i, μ_i, with $i=L,H$, and δ_H, θ_H, are the lagrangean multipliers. The first order conditions are:

$$\frac{\partial\mathcal{L}}{\partial\pi_L} = (1-\lambda)[p_L(R-R_L^{L*})-(1-p_L)G_L^*]+\mu_L[p_L(R-R_L^{L*})-(1-p_L)G_L^*] \tag{1.19}$$

$$-\mu_H[p_H(R-R_L^{L*})-(1-p_H)G_L^*]+\gamma_L-\tau_L=0,$$

$$\frac{\partial\mathcal{L}}{\partial\pi_H} = \lambda\{p_H R-(1+r)-(1-p_H)(1-\beta)G_H\}+\mu_H[p_H R-(1+r)-(1-p_H)(1-\beta)G_H] \tag{1.20}$$

$$\mu_L[p_L(R-(1+r)+\frac{p_L}{p_H}(1-p_H)\beta G_H-(1-p_L)G_H]+\gamma_H-\tau_H=0,$$

$$\frac{\partial\mathcal{L}}{\partial G_H} = -\pi_H(\mu_H+\lambda)(1-p_H)(1-\beta)-\pi_H\mu_L[\frac{p_L}{p_H}(1-p_H)\beta-(1-p_L)]+\theta_H-\delta_H=0. \tag{1.21}$$

We solve for the optimal contracts under two cases: that in which borrowers are rich in the sense that they are endowed with a level of wealth that exceeds the level of guarantees associated with the optimal contract for type-H borrowers; and that in which they are poor in the sense that wealth constraint is binding for those borrowers who self-select into the contract designed for type-H borrowers.

Case a: Sorting rich and safe borrowers from risky one. Consider first the case in which $G_H^* \leq w$ is not binding. We solve the maximization problem under the hypothesis that $G_H^* \in (w, \max(w-\eta, 0))$ and then verify the necessary and sufficient condition for that to hold. Given $G_H^* \in (0, w)$, $\delta_H = \theta_H = 0$. Accordingly, it follows from the FOC relative to G_H that, $\mu_L > 0$,[8] which means that the ICC_L is binding,

$$\pi_L[p_L(R - R_L^{L*}) - (1-p_L)G_L^*] = \pi_H[p_L R - \frac{p_L}{p_H}(1+r) + \frac{p_L}{p_H}(1-p_H)\beta G_H^* - (1-p_L)G_H^*]. \tag{1.22}$$

It is easy to verify that, if the ICC_L is binding, then the ICC_H is slack, so that $\mu_H = 0$ holds. In turns, the FOC relative to the choice of π_L reduces to:

$$(1 - \lambda + \mu_L)[p_L(R - R_L^{L*}) - (1 - p_L)G_L^* + w] + \gamma_L - \tau_L \geq 0. \tag{1.23}$$

It can be immediately verified that the only possibility is $\tau_L = 1$, which means $\pi_L^* = 1$. As for π_H^*, it follows directly from the relevant FOC that the only possibility is $\tau_H = 1$, which means $\pi_H^* = 1$.[9]

The optimal value of G_H is then found imposing, $\pi_L^* = \pi_H^* = 1$, and solving equation (1.22),

$$G_H^* = \frac{(1+r)(\frac{p_H}{p_L} - 1) + (1-p_L)(1-\beta)G_L^*}{(1-p_L)(1 - \frac{p_L}{p_H}\frac{1-p_H}{1-p_L}\beta)}, \tag{1.25}$$

where easy to verify that $G_H^* > G_L^*$ holds, so long as $G_L^* = w - \eta < (1+r)/\beta$, and $G_H^* = G_L^*$ otherwise.[10] Note that $G_H^* > \min(w-\eta, 0)$, directly implies $C_H^* = G_H^* > C_L^*$. Other things equal, there will be always values of w such $G_L^* = w - \eta$, so that

[8] $\pi_H[\frac{p_L}{p_H}(1-p_H)\beta - (1-p_L)]$ is positive and $\pi_H(\mu_H + \lambda)(1-p_H)(1-\beta)$ is strictly negative so that, if $\theta_H = \theta_L = 0$, $\mu_L > 0$ must follow.

[9] This is also confirmed if we substitute for G_H^* using (1.22) in the expression for safe borrowers to obtain,

$$\pi_H(p_H R - (1+r)) - \pi_H(1-p_H)(1-\beta)\frac{(1+r)(\frac{p_H}{p_L} - 1) + (1-p_L)(1-\beta)G_L^*}{(1-p_L)(1 - \frac{p_L}{p_H}\frac{1-p_H}{1-p_L}\beta)} \tag{1.24}$$

which is increasing in π_H whenever safe borrowers are willing to demand credit.

[10] This follows directly from $1 + r > \beta$.

$G_H^* > G_L^*$, and $G_H^* < w$, so that the identified solution is coherent with the starting hypothesis that the constraint $G_H^* \leq w$ were not binding.

Finally let us look at the participation constraints. Type $i = H, L$ will apply for credit if and only if

$$G_i^* \leq \frac{p_i R - (1+r)}{(1-p_i)(1-\beta)} = G_i^{\max} \tag{1.26}$$

There always exists parameter configurations such that the above constraints are satisfied. In particular, other things equal, such constraints are always satisfied for R big enough.

Case b: Sorting poor and safe borrowers from risky ones. Consider now the case in which $G_H^* > w$ so that the constraint $G_H \leq w$ will be binding at the optimal contract. In this case, the optimal values of G_H and G_L, which we call G_H^{**}, and G_L^{**} respectively, satisfy $G_H^{**} = C_H^{**} = w$, and $G_L^{**} = G_L^* = G_L^* = \min(w - \eta, \frac{1+r}{\beta})$ hold, with $C_L^{**} = C_L^* \leq G_L^*$.

We derive the other elements of the optimal contracts under the assumption that that ICC_H is not binding, so that $\mu_H = 0$, and then verify that indeed the ICC_H is not binding. Given $\mu_H = 0$, the FOC relative to the choice of π_L implies $\pi_L^* = 1$ as in the previous case. Then, given $G_H^{**} < G_H^*$, $\pi_H^{**} < 1$, otherwise the ICC_L would be violated. Furthermore, the FOC relative to the choice of π_H implies that the ICC_L must be binding, so that $\mu_L = 1$. Accordingly, we find the value of π_H^{**} by solving the ICC_L,

$$\pi_H^{**} = \frac{p_L R - (1+r) - (1-p_L)G_L^*]}{[p_L R - \frac{p_L}{p_H}(1+r) + \frac{p_L}{p_H}(1-p_H)\beta w - (1-p_L)w]} \tag{1.27}$$

where it is immediate to verify that $\pi_H^{**} < 1$.

Characterization of the equilibrium. We are now able to characterize the equilibrium for the case in which borrowers are homogeneous in wealth. Risky borrowers (independently of whether they are rich or poor) self-select into the contract $\mathcal{C}_L^* = \{R_L^{L*}, C_L^*, 1\}$, with $C_L^* \leq G_L^* = \min(w - \eta, \frac{1+r}{\beta})$, so that they are always able to borrow and are never rationed; safe and rich borrowers self-select into the loan contract $\mathcal{C}_H^* = \{R_L^{H*}, C_H^*, \pi_H^*\}$, where $\pi_H^* = 1$, and $C_H^* > C_L^*$, and, $R_L^{H*} < R_L^{L*}$; and, finally safe borrowers self-select into the loan contract, $\mathcal{C}_H^{**} = \{R_L^{H**}, w, \pi_H^{**}\}$, with $\pi_H^{**} < 1$ if they are poor.

Generalization to any wealth distribution

Let us now extend the above characterization to the case in which borrowers are heterogeneous with respect to pledgeable wealth $w \in [0, \overline{w}]$ they are endowed with, and information about individual wealth is private and disclosable at no cost. The key point here is to show that in any SE both risky and safe borrowers have the incentive to disclose their wealth. This is crucial, because then banks can sort risky and safe borrowers conditional on wealth so that the structure of the optimal contracts derived above will hold in equilibrium, as borrowers with wealth w will have access only to contracts specified for borrowers with that level of wealth.

Let us first analyze the incentives that safe borrowers have to disclose their wealth. In any SE, the ICC of borrowers of type L must be satisfied as strict equality. Otherwise, lenders can make extra profits by offering a new contract to safe borrowers, characterized by slightly lower interest rate or guarantees or both. Hence,

$$\pi_L[p_L(R - R_L^L) - (1 - p_L)G_L] \geq \pi_H[p_L(R - R_L^H) - (1 - p_L)G_H]; \tag{1.28}$$

must hold for any risky borrower. We note that the LHS of the above constraint is decreasing in G_L. As G_L is increasing in w so long as $w - \eta \leq (1 + r)/\beta$, for any borrower of type H, are not disclosing their wealth, the contract offered to them must satisfy,

$$\pi_L[p_L(R-R_L^L)-(1-p_L)\min(\overline{w}-\eta, (1+r)/\beta] \geq \pi_H[p_L(R-R_L^H)-(1-p_L)G_H]; \tag{1.29}$$

Crucially, for a risky borrower with wealth, w_1, such that $G_{L,1} = \min(w_1 - \eta, (1 + r)/\beta) < \min(\overline{w} - \eta, (1 + r)/\beta$ the above constraint is satisfied as a strict inequality. Hence, borrowers of type H with the same level of wealth equal to w_1, have the incentive to disclose their wealth because in that case they can be offered a contract conditional on the wealth level, which needs to satisfy only the ICC_L for risky borrowers endowed with that level of wealth, that is

$$\pi_L[p_L(R - R_L^L) - (1 - p_L)(w_1 - \eta) \geq \pi_H[p_L(R - R_L^H) - (1 - p_L)G_H]; \tag{1.30}$$

which is less strict than the above.

In other words, given a SE in which safe borrowers with wealth w such that $w - \eta < (1 + r)/\beta$ are not disclosing their wealth, lenders have the incentive to propose contracts that require safe borrowers to disclose their wealth, as by doing so they can make extra profits and surely attract borrowers. Let us now turn to the incentives of risky borrowers to disclose their wealth. Note that, the above argument does not hold for safe borrowers endowed with levels of wealth such that $w - \eta \geq (1 + r)/\beta$. However, whether these borrowers disclose their wealth or not does not make a difference in terms of the equilibrium outcome.

Consider now incentives of risky borrowers. Consider a candidate equilibrium characterized by the fact that there is a non-empty subset $\mathcal{E}'$ of entrepreneurs heterogeneous with respect to wealth who are not disclosing their wealth, w, for whom $w - \eta > C$ and $C < R^L/\beta$. $\mu(w|e \in \mathcal{E}')$ will be the equilibrium expected value of wealth for an entrepreneur who is not disclosing her wealth, with, $\mu(w|e \in \mathcal{E}') < \sup(w(\mathcal{E}'))$, where $\sup(w(\mathcal{E}'))$ is the level of wealth of the richest entrepreneur who is not disclosing her wealth. In equilibrium, lenders should breakeven in expected terms, given the information available. Hence, for each borrower e with $e \in \mathcal{E}'$, the equilibrium contract satisfies,

$$p_H R_L^{'} + (1 - p_H)\beta G' = 1 + r \tag{1.31}$$

where, $G' = \min(\mu(w|e \in E') - \eta, \frac{R_L}{\beta})$. It is then immediate to verify that if disclosing her wealth, the richest entrepreneur who is not disclosing it, would be better off by doing so, she will increase the level of expected guarantees she is offering the lenders, thereby reducing the cost of credit, which destroys the candidate equilibrium.[11]

[11]By doing so, she will increase the level of expected guarantees she is offering the lenders to $G'' =$

Define, $\overline{G}_L^* \equiv \min(\overline{w}-\eta, \frac{R_L}{\beta})$ the level of guarantees associated with the equilibrium contract for the risky and wealthiest borrowers who are posting collateral, $\overline{C}_L^* \leq \overline{w}-\eta$. Note that, according to the above discussion, these entrepreneurs are disclosing their wealth. Correspondingly,

$$\overline{G}_H^* \equiv \frac{(1+r)(\frac{p_L}{p_H}-1)+(1-p_L)(1-\beta)\overline{G}_L^*}{(1-p_L)(1-\frac{p_L}{p_H}\frac{1-p_H}{1-p_L}\beta)} \tag{1.32}$$

defines the level of real guarantees that a safe borrower needs to offer in order to self-select into the debt contract characterized by $\pi_H^*=1$. Then, all safe borrowers with wealth $w<\overline{G}_H^*$ cannot self-select into the debt contract characterized by $\overline{G}_H^*$. These borrowers will post collateral $C_H^{**}=w$, thereby offering guarantees $G_H^{**}=w$ (Note that these entrepreneurs might disclose their wealth or not). These borrowers will be rationed with positive probability $1-\pi_H^{**}$. All risky borrowers will self-select into contracts characterized by collateral $C_L^* \leq w-\eta$, and guarantees equal to $G_L^*=\min(w-\eta, R_L/\beta)$, and will never be rationed (note that these borrowers will be disclosing their wealth).

Hence, the fraction of rationed borrowers will be

$$cr = \frac{\sum_{w<\min(\overline{G}_H^*, G_H^{\max})} \pi_H^{**}(w)E(w)}{\lambda \sum_{W:G_H^{**},G_H^* \leq G_L^{\max}} E(w) + (1-\lambda)\sum_{W:G_L^* \leq G_L^{\max}} E(w)} \tag{1.33}$$

1.4.3 Empirical implications

The empirical implication of the adverse selection model are as follows.

i. Exemption, collateral and cost of credit Consider two borrowers, one risky and one safe, homogeneous in wealth, w. Suppose borrowers are rich, in the sense that $w>G_H^*$. For a given level of exemption, η, the difference in the cost of credit faced by risky and safe borrowers, respectively, is as follows:

$$\Delta R_L = \frac{1+r}{p_L} - \frac{(1+r)}{p_H} + \frac{(1-p_H)G_H^*\beta}{p_H} - \frac{(1-p_L)\beta G_L^*}{p_L}, \tag{1.34}$$

$\sup(w(\mathcal{E}'))-\eta$, thereby reducing the cost of credit. Given that, ex post, her true wealth will be observable and verifiable anyway, the advantage of disclosing the information ex ante is clear.

where $G_L^* = \min(w - \eta, R_L^{L*}/\beta)$.

The marginal effect on G_H^* induced by an increase in G_L^* is,

$$\frac{dG_H^*}{dG_L^*} = \frac{(1-\beta)}{1 - \frac{p_L}{p_H}\frac{1-p_H}{1-p_L}\beta} < 1. \tag{1.35}$$

The overall effect on the differential between the cost of credit of rich and safe and risky is

$$\frac{d\Delta R_L}{dG_L^*} = \frac{(1-p_H)\beta}{p_H}\frac{dG_H^*}{dG_L^*} - \frac{(1-p_L)\beta}{p_L} \tag{1.36}$$

Since, $\frac{dG_H^*}{dG_L^*} < 1$ and $p_H > p_L$ hold, this finally implies,

$$\frac{d\Delta R_L}{dG_L^*} < 0 \tag{1.37}$$

We know that $G_L^* = \min(w - \eta, R_L^{L*}/\beta)$ is generally a weakly decreasing function of exemption, that is $dG_L^*/d\eta \leq 0$. Furthermore, G_L^* is strictly decreasing η for sufficiently high levels of η. Therefore, given that marginal effect of G_L^* on ΔR_L is negative, we can conclude that the interest rate differential conditional on posting collateral, goes up (down) as the level of exemption goes up (down). In other words, the effect of collateral on the interest rate goes up with the level of exemption.

Consider now the case of poor borrowers, ie. $w < G_H^*$. In the case such difference is equal to:

$$\Delta R_L|_{G_H^*=w} = \frac{1+r}{p_L} - \frac{(1+r)}{p_H} + \frac{(1-p_H)w\beta}{p_H} - \frac{(1-p_L)\beta G_L}{p_L} \tag{1.38}$$

We note that as the level of exemption decreases (increase), this will eventually results in an increase (reduction) of the level of guarantees offered by risky borrowers, $G_L^* = \min(w-\eta, \frac{R_L}{\beta})$, while the guarantees offered by safe borrowers stay unchanged. This will reduce (increase) the cost of credit faced by risky borrowers compared to safe and poor borrowers. Hence, also for safe and poor borrowers, the effect of posting collateral on the cost of credit they face, compared to risky borrowers, increases with the level of exemption.

ii. Exemption, collateral, and access to credit Notably as the level of exemption decreases the amount of collateral that safe borrowers need to post in order to be not rationed increases. Hence, given a wealth distribution, more safe borrowers fall in the poor category, and will be rationed. Hence, we should observe a negative correlation between exemption level and rationing. Furthermore a reduction of the level of exemption might discourage entrepreneurs from applying for credit. This effect reinforces the conclusion that a reduction in exemption should result in more credit rationing.

Summarizing,

i. Other things equal, for a given level of exemption, the decision to post collateral results in a lower cost of credit

ii. The reduction in the interest rate associated to the decision to post collateral goes up with exemption

iii. The fraction of rationed individuals over total number of individuals demanding credit goes down with exemption (The probability of a safe borrower being rationed goes down with exemption).

1.5 Empirical analysis

We focus on the following three predictions stemming from the model

i. A wealth effect: we should observe a reduction of loan rate and less rationing the richer is the borrower;

ii. a collateral effect: for borrowers posting collateral we should observe a reduction of loan rate and an increase in rationing. Posting collateral, conditional on wealth, is associated with some rationing, as safe and poor borrowers have a probability to receive a loan less than one. Hence, this effect should be smaller for rich borrowers;

iii. exemption effect: a higher level of exemption decreases the amount of collateral that safe and poor borrowers need to post to signal themselves. Hence, with high exemption we should observe a lower fraction of rationed borrowers that post collateral.

1.5.1 Data

The data in this paper come from the Survey of Small Business Finances (SSBF), which has been conducted in 2004-2005 for the Board of Governors of the Federal Reserve System. The public data set provides information for a sample of 4240 firms, selected from the target population of all for-profit, non-financial, non-farm, non-subsidiary business enterprises that had fewer than 500 employees and were in operation as of year-end 2003 and on the date of the interview. The Survey collected information on the availability and use of credit and other financial services along with information on firm demographic characteristics for up to three individual owners, and other information on the number of workers, organizational form, location, credit history, income statement and balance sheet data. The survey asks the respondents to provide information whether the firm applied for credit during the last three years (from 2001 to 2003) and, in that case, whether the recent loan applications were always denied, always approved or sometimes approved. Consistently with our model, in which all firms are credit worth, we consider firms always

or sometimes approved. We exclude the firms always denied because the rejection can be considered as an indicator of non-credit worthiness. The sample size reduces to 1761 credit worth firms, 96% of which have been always financed. For all the firm that in the same period have been always or sometimes financed the survey provides some information on the most recent loan contract. In particular, we have information on the interest rate applied to the loan and whether the firm had to post some collateral to secure the loan. The dataset does not provide information on the amount of collateral posted. From the data we also compute the percentage of rationing. This percentage is the ratio between the number of firms that have been sometimes rationed and the creditworthy firms. According to the model these three measures define the loan contract.
We also include in the dataset the level of bankruptcy homestead and personal property exemptions according to firm geographical location. Exemption levels vary across states, but the public version of the SSBF reports firm location only for nine census divisions (New England; Middle Atlantic; East North Central; West North Central; South Atlantic; East South Central; West South Central; Mountain; Pacific). Thus, we assign to each firm the average level of exemption of its census division. In the states in which the exemption is unlimited we set it to the average dollar value of firms' assets in the sample. We consider two level of exemption: high exemption for firms in a census division in which average exemption is above the median value and low exemption otherwise.
Firm wealth is measured by firm's total asset. We also consider two level of wealth: high asset if asset is above the median value and low asset group otherwise.
Thus, we can identify four groups of firms according to their wealth and level of exemption. The descriptive statistics of the elements of the loan contract are displayed in table 1.1, for the whole sample and the groups.
We observe the following pattern in the data.

1. High asset firms pay a lower cost of capital and are less rationed. The loan rate is 1.5 percentage points lower and the fraction of rationed firms is 3.8% lower for high asset firms compared to those in the low asset group.

2. Posting collateral reduces the cost of capital. In the whole sample, for firms that post collateral loan rate is 0.7% lower, while the fraction of rationed firms is 1.5% higher.

3. The effect of posting collateral on the cost of capital depends on wealth: Low asset firms have a cost of capital 0.9% lower if they post collateral, while for high asset the reduction in the cost of capital for posting collateral is much smaller (0.04%).

4. Posting collateral increases rationing. The fraction of rationed firms increases by 1.5% if firms post collateral.

5. The effect of posting collateral on rationing also depends on wealth. In the group of low asset firms, the fraction of those rationed is 4.4% higher for firm posting collateral, while in the high asset group there is no difference in rationing depending on collateral.

6. Rationing is higher in states with high exemption. The fraction of rationed firms goes from 3.4% to 5% moving from low to high exemption areas. The increase in rationing with exemption is observed for both level of wealth, although for the rich this effect is less evident.

7. However, if firms post collateral the fraction of those rationed reduces by 1.1% moving from low to high exemption levels. This effect is larger (-1.9%) for the low asset firms compared to those with high asset (-0.5%).

When considered independently posting collateral and higher level of exemption are associated with more rationing. On the contrary and consistently with our model, the combination of the two leads to less rationing, and this effect is reinforced the lower is the firm asset.

1.5.2 Multivariate analysis

To further analyze the relationship between collateral and exemption and to spotlight the signaling content of collateral we first estimate a single equation model, one for the bank's decision to finance a firm and another for the loan rate. We put aside for the moment the possible simultaneity among the elements of the contract, i.e. posting collateral, the bank's decision to finance the firm and the cost of credit. We consider this issue later.

Exemption, collateral and wealth effect on rationing

The probability to access credit for firm i is given by the following equation:

$$\pi_i = \alpha_1' Z_i + \alpha_2 \eta_i + \alpha_3 C_i + \alpha_4 C_i \eta_i + \alpha_5 R_{Li} + u_{1,i} \tag{1.39}$$

where π takes on two values: 1 if the firm is always financed, 0 if it is sometimes rationed; Z_i is a set of controls that affect bank's decision to finance; α_1 is a vector of parameters; α_2, α_3, α_4 are parameters; η_i is the level of exemption for firm i; C_i is a dummy equal one if firm i post collateral; R_{Li} is the interest rate on the loan and the error term u_1 is $\sim N(0, \sigma_1)$.

We estimate the probability that $\pi_i = 1$ with standard probit.
As explained before, the dummy for collateral is expected to be negatively correlated with the probability to receive a loan. In the estimation we capture the signaling effect of collateral through the interaction term between exemption level and the dummy for posting collateral. According to the theoretical model an increase in exemption level reduces the value of guarantees necessary for safe borrowers to signal themselves, increasing the number of safe borrowers that can access credit, i.e. increasing the probability to receive a loan. Hence, exemption affects the probability to receive a loan only for safe and poor borrowers able to signal with collateral. We use exemption as identification strategy of the signaling content of collateral, which emerges if we observe that giving collateral in areas with high exemption counterbalances the overall negative correlation between collateral and the probability to receive a loan.

Exemption, collateral and wealth effect on the cost of credit

The cost of credit is determined according to the following equation:

$$R_{Li} = \beta_1^{'} X_{1,i} + \beta_2 \eta_i + \beta_3 C_i + \beta_4 C_i \eta_i + u_{2,i} \quad (1.40)$$

where X_1 is a set of controls, β_1 is a vector of parameters, β_2, β_3, β_4 are parameters, and the error term $u_{2,i}$ is $\sim N(0, \sigma_2)$. We estimate the equation of loan rate by OLS. Posting collateral should have a negative effect on the cost of credit. We identify the signaling value of collateral including the interaction term between exemption and the dummy posting collateral. According to the theoretical model the loan rate increases with exemption only for the risky borrowers. In line with this finding we expect to observe a positive relationship between loan rate and exemption, but a negative sign for β_4 if posting collateral induces an additional reduction of loan rate as exemption increases.

Regressors

We include some controls for firm-bank relationship and various firm, entrepreneur and loan characteristics as control variables in the equation of the financing decision and the equation of the interest rate.

Sorensen and Chang (2006) provide wide evidence of the positive relationship between entrepreneur experience and firm profit. To catch the managing experience effect we include the number of years of the principal owner's managing experience. We expect a negative effect on interest rate as we expect that a greater experience is positively correlated to higher profit and hence generating a higher probability of success for the venture.

Belonging to a minority group has been found to reduce the probability of obtaining a loan (Cavalluzo and Wolken, 2005; Berkowitz and White, 2002), while Cerqueiro and Penas (2011) found evidence that owners belonging to a minority group rely more heavily on their own funds to finance a start up. We include two dummies: the first is equal one if the principal owner is black, the other is equal one if the owner belongs to other minority groups (asian, hispanic, asian pacific, native american). We include also a dummy indicating whether the owner is female, to verify possible discrimination effects on the loan price. Firm's proprietorship characteristic may have some effect on credit availability and loan contract due to different agency costs compared to those of non-family owned firms. Anderson et al (2003) argue that debt holders often establish informed relationships with managers, and the family's presence may foster these relationships to build over successive generations. Niskanen et al (2010) found some evidence of less credit availability in small Finnish firms when family ownership increases and evidence of less collateral requirement associated with managerial ownership. On the contrary no proprietorship effect on the loan interest rate has been found, suggesting the presence of more relevant agency cost for family ownership.

Firm bank relationship can be represented by several variables, such as firm distance from the bank, the duration of in years of the relationship with the lender. Local credit market characteristics may also have a role in explaining the loan pricing decision. To consider possible bank local market power we include a dummy equal one if the Herfindahl–Hirschman bank deposit index of local banking market concentration is greater than 1800 (i.e. highly concentrated). Number of credit applications in the previous three years may represent a proxy of the firm need for financial resources. Given other firm characteristics many or frequent applications may signal the bank the existence of financial distress or greater investment opportunities. Credit score can be used to signal quality to the bank and may have an effect on interest rate. To measure this effect we include a dummy equal one if firm credit score is in the top 25% of the distribution.

We also consider that the characteristics of the loan may have an impact on its price. We take into account that the loan can be a line of credit, a mortgage or with fixed interest rate.

We include the logs of sales to account for dimensional effects and a measure of firm financial structure, the ratio of debt on total asset, to catch for the impact of leverage on the loan contract. Finally, firm wealth is proxied by firm asset.

In the equation of bank's decision to finance the control variables are mainly related to loan characteristics and firm-bank relationships. The amount of loan granted on the total amount applied may positively affect bank profit and hence the bank willingness to finance. Higher loan maturity increases bank's asset rigidity and risk. We expect a negative impact on the decision to finance. A longer firm-bank relationship improves the information flow between lenders and borrowers. We include the numbers of years of the relationship with the lender and we expect a positive effect on the probability to receive a loan. Past delinquencies may represent a bad signal of firm trustworthiness. Thus, we expect a negative sign for the a dummy equal one if the firm has a delinquency record. As in the loan rate equation, we include firm's credit score to proxy its credit quality. We also include a control about firm capital structure. The ratio of debt on total asset is expected to have a negative impact on the bank's willingness to finance, because higher leverage may reduce firm ability to repay. Firm wealth, as proxied by firm asset, is expected to have a positive effect in the financing decision equation. Finally, we include a dummy equal one if the firm has limited liability to catch possible bank's constraints to seize owners' wealth in the event of default.

Results

In table 1.2 the results of the OLS estimation for the cost of credit (R_L) are displayed. The sample of 1761 firms that received a loan during the period of the survey, reduces to 1691 observations, due to missing values. In line with the theoretical model we observe that as exemption increases the cost of credit increases, posting collateral reduces it and the interaction term between posting collateral and exemption is negative. We interpret this latter results as the evidence of the signaling value of collateral. In fact, the reduction in the cost of credit for those posting collateral is amplified increasing exemption. All control variables have the expected sign and are significant at least at 10% level except for the dummy indicating a female owner and the number of applications. In table 1.3 we show the result of the estimation of the probability to get credit. The result confirms the predictions that:

1. posting collateral is associated with a lower probability to get credit;

2. there is a negligible overall effect of exemption on credit rationing;

3. the interaction term between posting collateral and exemption is positive.

We observe that for borrowers posting collateral an increase of exemption reduces rationing. We can interpret this result as the evidence of signaling value of collateral.

1.5.3 Simultaneity

In the model the equilibrium loan contracts are triplet of elements, the cost of credit, the amount of collateral and the probability to be financed, which are simultaneously determined. This simultaneity should be appropriately considered in the estimation.

In addition, the contract stems from a selection process in which firms that need credit can be either denied the loan, discouraged from applying or are financed by the bank. For the moment we put aside the selectivity bias that can arise from this selection process.

We address the simultaneity issue as described below. From the structural equation of the model we know that there is a biunivocal relation between the cost of credit and the amount of guarantees. That is, the cost of credit is affected by the guarantees an entrepreneur is able to post as collateral and the amount of guarantees is affected by the cost of credit. In addition, the cost of credit and the amount of guarantees are exogenous with respect to the probability to access credit. Hence, to obtain consistent and unbiased estimates we need to estimate a system of two equation for the cost of credit as a function of the guarantees and the amount of guarantees as a function of the cost of credit. This estimation is constrained by the available data. The level of collateral is an unobserved continuos variable, while the observed variable is the dichotomous dummy equal one if the firm decides to post and actually posts collateral. Once a type H borrower decides to post collateral, the amount she posts determines the probability to access credit, and this amount is affected by the cost of credit. If she posts a significant amount the borrower is financed with probability one. Thus, in the data we try to capture the relationship between the cost of credit and collateral taking into account that the cost of credit affects the fraction of firms always financed posting collateral. We combine the observations of those posting collateral with those that are always financed to construct our collateral variable which is equal one when the firm posts collateral and is always financed. In this way we are imposing that the ones in the variable correspond to firms of type H that post a significant amount of collateral. In other words, this variable is a proxy of a high level of guarantees for type H borrowers. According to the above argument we have a system of two simultaneous equations, one for the interest rate and the other for the probability of posting collateral for the always financed firms. The estimation procedure and the identification problem that arises in such cases is discussed in Maddala and Lee (1976), and it is referred in the literature as 'two stage probit least square'. To show the nature of the problem we start from the following generic model:

$$R_{L*} = \gamma_1 C^* + \beta_1' X_1 + \varepsilon_1 \tag{1.41}$$

$$C^* = \gamma_2 R_{L*} + \beta_2' X_2 + \varepsilon_2 \tag{1.42}$$

in which R_{L*} and C^* are observed as follows:

$R_L = R_{L*}$

$C = 1\ if\ C^* > 0$

$C = 0$ otherwise

and γ_1 and γ_2 are both different form zero.

The simultaneous equation model arising from above is then:

$$R_{L*i} = \gamma_1 C_i + \beta_1' X_{1,i} + \varepsilon_{1,i} \tag{1.43}$$

$$C_i = \gamma_2 R_{L*i} + \beta_2' X_{2,i} + \varepsilon_{2,i} \tag{1.44}$$

where R_L is a continuos endogenous variable (interest rate),

C is a dichotomous endogenous variable (dummy equal 1 if firm posted collateral and is always financed), which is observed only if $C^* > 0$, i.e. if firm has posted a significant amount of collateral in order to be always financed, and zero otherwise,

X_1 and X_2 are matrices of exogenous variables,

β_1 and β_2 are vectors of parameters of the exogenous variables,

γ_1 and γ_2 are the parameters of the endogenous variables,

ε_1 and ε_2 are the error term and i subscript denotes cross sections.

We estimate the system of the two simultaneous equations in which R_L is the loan rate and C a dummy equal one if the firm posted collateral in order to be always financed, and a set X_1 and X_2 of control variables. The method of estimation for the model and the routine used to implement a two stage probit least square are presented in Keshk (2003).
We expect the following effects:

1. a negative effect of collateral on loan rate;

2. this effect is larger for firms in high exemption areas;

3. a negative effect of loan rate on collateral, i.e. high level of guarantees.

In the second column of table 1.4 and 1.5 we report the estimation results of the simultaneous equation model for the whole sample. We find a negative relationship between $R_L$and C. Other things equal, posting collateral is associated with an average reduction in the cost of credit by 46 base points. Consistently, a higher interest rate is associated to a reduction of the significant amount of collateral, as measured by our proxy. Assuming that collateral is endogenous we do not to include the interaction term between exemption and collateral in the estimation, that would be endogenous by construction. In order to identify the signaling value of collateral, we estimate the model dividing the sample in two subsamples, one including firms located in groups of states with average homestead and personal property exemption level below the mean (low exemption), and the other including firms located in group of states with exemption level above the mean. In the last two columns of table 1.4 we report the results. The negative relationship between collateral and cost of credit is significantly higher (59 base points) in the group of the high exempt firms. This offers further support to the model, and to the role of collateral as signal device.

1.6 Conclusions

Under chapter 7, bankrupt entrepreneurs benefit from a fresh start opportunity to the extent that they keep "uncollateralized" assets exempted from liquidation according to the exemption levels set by the law of the State in which the entrepreneurs operate. This, of course, at the expenses of creditors. However, ex ante, entrepreneurs could undo the effects of exemption by posting enough collateral. We analyze the effects of bankruptcy exemption in a competitive credit market characterized by adverse selection. Differently from the existing literature, we explicitly allow for the fact that borrowers can undo the effects of bankruptcy exemption by posting collateral. We find that: (i) for a given level of exemption, borrowers posting collateral face a lower cost of credit than those who do not post collateral, and; (ii) this effect is stronger the higher is the level of exemption; (iii) exemption has either no effect on credit rationing or reduces it. We test the simultaneous relationship between the decision to post collateral and the cost of credit in a sample of US small businesses using 2003 SSBF data. The empirical analysis support the predictions of the theoretical model.

Table 1.1: Loan rate and fraction of rationed firms by exemption, collateral and assets above and below median

		Any asset			Low asset			High asset		
		WS	LEX	HEX	WS	LEX	HEX	WS	LEX	HEX
C=1	Loan rate	5.49	5.53	5.37	6.06	6.13	5.89	5.08	5.12	4.96
C=0	Loan rate	6.19	6.06	6.57	6.95	6.8	7.42	5.04	5.02	5.12
C=1	Fraction of rationed firms	0.045	0.047	0.038	0.081	0.086	0.067	0.019	0.020	0.015
C=0	Fraction of rationed firms	0.030	0.019	0.065	0.037	0.023	0.077	0.019	0.012	0.044
Any firm	Loan rate	5.81	5.78	5.9	6.55	6.50	6.70	5.06	5.08	5.02
Any firm	Fraction of rationed firms	0.038	0.034	0.050	0.057	0.051	0.072	0.019	0.017	0.025

WS: Whole sample; LEX: Low exemption (below median); HEX: High exemption (above median).

Low asset: asset below median value; High asset: asset above the median value.

Table 1.2: Estimation results : Cost of credit

Variable	Coefficient	(Std. Err.)
Homestead and personal property exemption ($)	0.0000000826*	(0.000000048)
Dummy=1 if firm posted collateral	-0.31451***	(0.06500)
Interaction term between dummy collateral and exemption levels	-0.000000245***	(0.000000065)
Dummy=1 if Fixed interest rate	0.94483***	(0.05912)
Dummy=1 if lending was a new line of credit	-0.16645**	(0.07423)
Dummy=1 if lending was a mortgage	0.16972*	(0.09571)
Banking market concentration: Dummy=1 if Herfindahl index> 1800	0.23343***	(0.05356)
Dummy=1 if firm's Credit score is top 25%	-0.11390**	(0.05567)
Owner managing experience (n. of years)	-0.01521***	(0.00268)
Dummy=1 if Owner is black	0.89743***	(0.22360)
Dummy=1 if Owner belongs to an ethnic minority other than black	0.83107***	(0.10711)
Dummy=1 if Owner is female	-0.03713	(0.07517)
Dummy=1 if firm is family owned	-0.27228***	(0.06694)
Number of credit applications	0.01481	(0.01067)
Years of firm bank relationship	-0.00875***	(0.00258)
Distance of firm from bank (miles)	0.00115***	(0.00039)
Natural log of total sales	-0.32263***	(0.01659)
Debt on total asset	0.02518***	(0.00703)
Total Asset - thousands of $	-0.00001**	(0.0000025)
Intercept	10.73249***	(0.25748)

N	1691
R^2	0.17366
$F_{(19,1671)}$	93.29868

Significance levels : * : 10% ** : 5% *** : 1%

Table 1.3: Probability to access credit

Variable	**Coefficient**	**(Std. Err.)**
Homestead and personal property exemption ($)	-0.0000000097***	(0.0000000019)
Dummy=1 if firm posted collateral	-0.01407***	(0.00296)
Interest rate on loan (%)	-0.00236***	(0.00042)
Interaction term between dummy collateral and exemption levels	0.0000000096***	(0.0000000025)
Loan original maturity (n. of months)	-0.00005***	(0.00002)
Amount granted over total applied	0.03178***	(0.00555)
Years of firm bank relationship	0.00056***	(0.00013)
Dummy=1 if firm's Credit score is top 25%	0.01182***	(0.00257)
Dummy=1 if firm has delinquency records	-0.00721***	(0.00101)
Debts on equity	-0.00019**	(0.00008)
Dummy=1 if firm has limited liability	0.01099***	(0.00363)
Total Asset - thousands of $	0.00000017***	(0.00000031)
N	1654	
$\chi^2_{(12)}$	361.94318	

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Table 1.4: Simultaneous model: dependent variable R_L

	Whole sample	Low exemption	High exemption
Collateral	-0.4686***	-0.3463***	-0.9314***
	(.1124)	(.1267)	(.3478)
Exemption	-0.0000000715***	-	-
	(0.0000000335)	-	-
N. obs	1596	1199	397
R^2	0.16	0.14	0.24
F	81.12	60.02	37.80

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Two stages probit least square estimation (Maddala, Lee, 1976; Keshk, 2003)

List of controls: Dummy Fixed interest rate; Dummy new line of credit; Dummy mortgage; Dummy Credit score top 25%; Number of credit applications; Total sales; Banking market concentration; Owner managing experience (n. of years); Dummy female owner; Dummy black owner; Dummy other minority owner; Years of firm bank relationship; Distance of firm from bank; Debt on total asset; Dummy family owned, Firm Asset.

Table 1.5: Simultaneous model: dependent variable C

	Whole sample	Low exemption	High exemption
Loan Rate	-0.2336***	-0.2409***	-0.1855***
	(.0170)	(.0209)	(.0279)
N. obs	1596	1119	397
LR chi2 (9)	636.02	458.22	195.30

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Two stages probit least square estimation (Maddala, Lee, 1976; Keshk, 2003)

List of controls: Dummy new line of credit; Dummy Credit score top 25%; Loan Maturity; Amount granted over applied; Banking market concentration; Dummy limited liability; Dummy rationing sometimes; Dummy female owner; Years of firm bank relationship; Dummy family owned.

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Chapter 2

Discouraged borrowers and credit rationing with moral hazard

2.1 Introduction

The literature on firm financing argues that in equilibrium credit rationing occurs because of asymmetric information between borrowers and lenders. This information asymmetry may also cause that some potential borrowers do not apply for a loan even if they need credit. For example, in the context of credit constrained households, Jappelli (1990) contemplates this category of potential borrowers and defines them ”discouraged borrowers”. In general, discouragement in the credit market is the phenomenon according which firms/households need credit but do not apply for a loan because they feel they will be rejected. If the application for a loan involves a positive cost to carry on the process, it may be the case that some borrowers with low probability to be financed do not apply because they feel they will be turned down (Jappelli, 1990).

Discouragement becomes a relevant issue in the credit market especially when credit worthy firms do not apply, even though they have a high probability to be financed. In such situation firms discouragement is important because discouraged firms must be included in the accounting of credit rationing. In fact, in many cases the extent of discouragement is larger than that of credit rationing, especially for small firms.

For example using data from the "1987 US National Survey of Small Business Finance" (NSSBF), Levenson and Willard (2000) find that more than twice as many small firms are "discouraged" as are rejected for loans from financial institution in the United States, implying that discouragement is more important than credit restrictions of the Stiglitz-Weiss type. In the most recent wave of the NSSBF (2003) there is evidence of the persistence of discouragement. We found that 14% of the firms that need credit are discouraged from applying for a loan while 7% of the firms that apply are denied. Thus, if we can consider discouraged firms as if they were credit rationed, then the extent of credit rationing is bigger than what we observe considering only rejection of firms that apply.

Our purpose is to identify the nature of discouraged firms and to investigate wether these firms would be credit denied or not if they had applied. In order to empirically assess this issue we need to compare rationed and discouraged firms through their probability of being financed. For discouraged firms this probability is merely theoretical because they never applied. We set a model of access to credit to show that this comparison is feasible. We model a credit market with asymmetric information and different sources of heterogeneity among potential borrowers, assuming that borrowers differ in their application cost, their wealth and the liquidation value of the asset they post as collateral. Given the equilibrium contracts offered by the banks, firms are able to predict their financing possibility and so according to this prediction they decide wether to apply or not. Positive costs of application and uncertainty on the liquid value of the assets are crucial elements in the equilibrium outcome, which identifies three groups of non applicants: self-rationed entrepreneurs with ex ante probability to be financed equal zero; discouraged borrowers with probability to be financed less than one that face sufficiently high cost of application and discouraged borrowers that would be financed with certainty who face a higher cost of application compared to the previous group. We conduct the empirical analysis employing US data, to calculate the ex-ante probability to be financed of discouraged firms in case they had applied and we compare this probability with that of applicants, distinguishing between financed and denied borrowers. We also test the role and the extent of application cost in the decision to apply. We find that denied and discouraged firms are similar in most of the owner and firm characteristics. Moreover, discouraged firms have the same average probability of being financed of the firms that apply and are denied. Results show that discouraged firms with high probability to be financed may have given up the application because of higher cost of application.

The paper is organized as follows. In section 2.2 we review the literature on discouragement. In the following section 2.3 the model is presented. The credit market and the equilibrium analysis are discussed in sections 2.4 and 2.5. Empirical implications are in section 2.6. The empirical analysis is developed in sections 2.7 and 2.8.

2.2 Review of the literature

The literature on discouraged borrower is closely related to that of credit rationing, and in most of the paper discouragement is sought either as an extension of the problem of credit rationing or as integral part of it.

Notion of discouraged borrowers. Jappelli (1990) introduces the notion of discouraged borrower in the analysis of credit rationing in the housing loans market in the U.S. He uses the degree of rejection of applicants for bank loans as a measure of credit rationing. However, the author identifies another group, those who did not apply for loans because they perceived that their application will be rejected by the bank. This group may be considered as credit rationed too since they cannot be treated as having had no demand for loans. The exclusion of this group may lead to biased results, because the self-selection of applicants may induce banks to adapt screening rules that differ from those that would prevail if this group of borrowers were also to apply. Jappelli (1990) classifies this group as "discouraged" borrowers and, together with the rejected group, considers them as "credit constrained" borrowers to distinguish them from the strict definition of credit rationing.

Discouragement in small businesses. According to Levenson and Willard (2000) discouragement depends on the time a firm has to wait to obtain financing.

If the firm receives the credit after waiting a period of length α and if α is very small, then the firm is rationed for only a short period of time and the effects of credit rationing may be negligible. If α is large, then the delay to get access to credit can affect the firm's ability to expand or even survive and finally some firms that anticipate a large α may be discouraged from applying for credit. In this case, firms do not ask for credit at all as they anticipate the refusals of banks for a rather long period: they are self rationed. Adopting the definition of credit rationing by Jappelli (1990), they use "1987 NSSBF" data for investigating the small business sector in the US. They calculate an upper bound for the probability of credit rationing including the sample of discouraged firms among the firms that are credit denied. Given their results and the impossibility to identify between denied firms not credit worthy and firms properly rationed, they conclude that credit rationing is not a pervasive phenomenon in the U.S. economy.

Latent demand for credit. Free et al. (2012) use UK survey data to study the dimensions along which discouraged firms differ from non-discouraged firms (i.e. applicants). They confirm the finding of Levenson and Willard (2000) according to which businesses are around twice as likely to be discouraged from applying as to have been rejected. The authors say that "if the extent of discouragement is indeed large, or significantly larger than rejection, then addressing the fears of discouraged borrowers may be a more appropriate means of intervention than traditional supply-side mechanisms." Their key issue is to analyze how characteristics of the firm, of the entrepreneur and of the strategy influence borrowing decisions. They observe that smaller firms, corporations, serial entrepreneurs, knowledge-intensive service firms, non-family firms, firms without an established banking relationship and firms pursuing cost-focussed strategies were all more likely to record discouragement.

Theory of discouraged borrower. Under the theoretical point of view, Kon and Storey (2003) wonder about the significance of "discouragement". Borrowing the notion of discouragement from the consumer credit literature (e.g. Jappelli, 1990), the authors develop a theory of "discouraged borrowers". A discouraged borrower is a good firm, requiring finance, that chooses not to apply to the bank because it feels its application will be rejected. Their concern is about the extent of discouragement in an economy, which they argue depends on the screening error of banks, the size of application costs and the extent to which banks interest rate differs from that charged by money lenders.

Quality of discouraged borrowers. Taking the notion of a discouraged borrower originally formulated by Kon and Storey (2003), Han et al. (2009) test whether discouragement is an efficient self-rationing mechanism. Using data from the 1998 US NSSBF they find that, after controlling for the characteristics of both the business and the entrepreneur, riskier borrowers are more likely to be discouraged. Moreover, using the length of financial relationship as a proxy for information quality they find that riskier borrowers are more likely to be discouraged. This finding suggests that discouragement is an efficient self-rationing mechanism.

2.3 The model

We examine a credit market with a large number of both entrepreneurs E and and lenders L, where $\frac{L}{E} > 1$. Both entrepreneurs and lenders are risk neutral.
Each entrepreneur has the opportunity to undertake a one-period project which requires a fixed amount of investment of size I. Each entrepreneur has an initial amount of illiquid assets $A \in \mathbb{R}^{+}$ so that he cannot use them to finance the project. In order to undertake the project, the entrepreneur has to apply for credit to a bank and can use his own assets only as collateral to guarantee the loan. If the entrepreneur undertakes the project, it can either succeed yelding $R > 0$ or fail yelding 0. The probability of success p of the project depends on the effort e exerted by the entrepreneur which can be either high (H) or low (L). If the entrepreneur misbehaves, i.e. if he exerts low effort, he gets private benefits $B > 0$ and the probability that the project succeeds is equal to p_L. If he behaves he gets zero private benefits and the probability of success is equal to p_H, with $p_H > p_L$. We assume that the project is feasible only in the absence of moral hazard, that is $p_H R - I(1+r) > 0$ and $p_L R - I(1+r) + B < 0$.
Each lender is endowed with I units of financial resources, meaning that each lender can finance only one entrepreneur. The opportunity cost of the capital is $r > 0$.

Lenders compete competitively in the sense that in equilibrium, the loan they grant gives them zero profit. We also assume that:

i. The application process is costly so that if the entrepreneur decides to apply he knows that he will incur a cost of application $c \in \mathbb{R}^+$. The application cost is the same regardless the bank the entrepreneur applies.

ii. Any amount of entrepreneurial asset A worths for the lender only βA where $\beta < 1$ with $\beta = \{\underline{\beta}, \overline{\beta}\} \sim U$.

The knowledge on β is asymmetric in the sense that lenders know it at the moment the entrepreneur apply for a loan while the entrepreneur is not able to identify ex-ante which β will be applied to his asset. He only knows its distribution function.

Notice that, the assumption that one unit of asset worth β for the lender imply that two or more entrepreneurs with the same value of asset A may be differently evaluated by the lenders. We interpret the difference between the value of an asset posted as collateral and the evaluation of the lender, as the lender's cost of liquidating an asset in the event of default.

The functioning of the market is the following:

Stage 0 : Lenders simultaneously offer credit contracts. Entrepreneurs decide whether to apply or not for credit.

Stage 1 : Lenders and entrepreneurs meet in the credit market. Lenders decide whether to reject or approve each loan application they receive.

Stage 2 : Financed entrepreneurs, if any, privately choose effort.

Stage 3 : Payoff are realized

2.4 Credit Market Analysis

2.4.1 Supply side

The financing contract proposed by the lender to the entrepreneur, if any, is composed by two elements: the cost of credit R_L and the amount of guarantees G to

secure the loan. According to the above assumption the contract is a pair of elements that depend on β, that is $\mathbf{C}(\beta) \equiv \{R_{L,\beta}, G_\beta\}$.
The expected payoff of a lender that finances an entrepreneur is:

$$p_H R_{L,\beta} + (1 - p_H)\beta G_\beta \tag{2.1}$$

The lender is willing to finance an entrepreneur if and only if the following conditions are satisfied:

i. Lender's participation constraint: his expected payoff is greater or equal to the cost of investing I unit of capital at the opportunity cost of capital r

ii. Borrower's incentive compatibility constraint: borrower's expected return exerting high effort is greater or equal to the expected return he will get exerting low effort plus the private benefit.

From the above conditions it follows:

Lemma 1 (Minimum Guarantees)**.** *The minimum amount of guarantees necessary for a lender to finance an entrepreneur is:*

$$G_{min(\beta)} = max(\frac{I(1+r) - p_H(R - \frac{B}{\Delta p})}{p_H + (1 - p_H)\beta}, 0) \tag{2.2}$$

Proof. See appendix.

2.4.2 Demand side

According to the loan contract scheme the expected payoff of a financed entrepreneur is:

$$p_H(R - R_{L,\beta}) - (1 - p_H)G_\beta + A \tag{2.3}$$

Given positive cost of application and uncertainty on evaluation of his asset, the expected payoff of an entrepreneur applying for a loan is:

$$\{\sum_{\beta=\underline{\beta}}^{\overline{\beta}} \pi(\beta) I_{\{A > G_\beta\}} \{p_H(R - R_{L,\beta}) - (1 - p_H)G_\beta\}\} + A - c \tag{2.4}$$

where $\pi(\beta)$ is the cumulative mass function of β.

From above the following emerges:

Lemma 2 (Maximum Guarantees)**.** *The maximum amount of asset that an entrepreneur is willing to post as collateral, and that he is willing to loose in the event of default is:*

$$G_{max(\beta)} = \frac{p_H(R - R_{L,\beta})}{(1 - p_H)} \tag{2.5}$$

Proof. See appendix.

Lemma 3 (Application Decision)**.** *En entrepreneur is willing to apply for a loan if his application cost does not exceed the threshold value:*

$$c(\beta, A) \equiv \sum_{\beta=\underline{\beta}}^{\overline{\beta}} \pi(\beta) I_{\{A>G^{\beta}\}}\{p_H(R - R_{L,\beta}) - (1 - p_H)G_{\beta}\} \tag{2.6}$$

Proof. See appendix

2.5 Equilibrium analysis

The peculiarity of this environment is not only that there exist a moral hazard problem but also that there exist uncertainty on how the lender evaluate the entrepreneur's asset. In such situation where lenders apply different discount factor depending on the type of asset posted to guarantee the loan, lenders' loan contracts portfolio contains as many contract as the number of βs. In this simple framework where β takes only two values, we will have two different contract. However it is important to highlight that despite there are many contracts, the entrepreneur has no chance to choose among them. It is the lender that decides to assign a specific contract to any entrepreneur based on the asset offered as collateral.

In any equilibrium lenders will be offering contracts such that entrepreneurs have the right incentive to exert high effort.

Definition 1 (Equilibrium Contract)**.** *Any equilibrium contract* $\mathbf{C}(\beta)$ *is defined as a pair of elements* $R_{L,\beta}$ *and* G_{β}*, which solve the following problem:*

$$\max_{R_{L,\beta}, G_{\beta}} : p_H(R - R_{L,\beta}) - (1 - p_H)G_{\beta} + A \tag{2.7}$$

subject to:

1. *Lender's participation constraint (LPC):*

$$p_H R_{L,\beta} + (1-p_H)\beta G_\beta \geq I(1+r) \tag{2.8}$$

2. *Borrower's incentive compatibility constraint (BICC):*

$$ICC(\beta): p_H(R-R_{L,\beta})-(1-p_H)G_\beta \geq p_L(R-R_{L,\beta})-(1-p_L)G_\beta + B \tag{2.9}$$

The following result holds:

Proposition 1 (Equilibrium Characterization)**.** *The Equilibrium Contract is characterized as follows:*

$$\mathbf{C}(\beta) = \begin{cases} R_{L,\beta} = \frac{I(1+r)-(1-p_H)\beta G_\beta}{p_H} \\ G^*_\beta = G_{min(\beta)} \end{cases} \tag{2.10}$$

with $\beta = \{\underline{\beta}, \overline{\beta}\}$

Proof. See appendix

2.5.1 Properties of the equilibrium outcome

The interesting cases are the contracts with positive value of guarantees, which imply that en entrepreneur in order to be financed must have sufficient wealth to post as collateral. Such contracts, and so the necessary value of guarantees, are function of β. In this specific case where β takes only two values there are two different equilibrium contracts, $\mathbf{C}(\overline{\beta})$ and $\mathbf{C}(\underline{\beta})$, where $G^*_{\overline{\beta}} < G^*_{\underline{\beta}}$. Under the assumption that entrepreneurs are heterogeneous both on wealth and on the liquidation value of the asset, both equilibrium contracts may coexist in the market. Moreover, conditional on wealth, some entrepreneurs can afford only one of the contracts.

We now analyze the properties of the equilibrium outcome when $p_H R - I(1+r) < p_H \frac{B}{\Delta p}$, that is the equilibrium contracts with positive value of guarantees. According to the model the properties of the equilibrium outcome concern:

a. the clustering of the entrepreneurs according to their wealth;

b. the supply of credit;

c. the demand of credit;

a. Clustering of the entrepreneurs according to their wealth. The presence of two equilibrium contracts each requiring a different value of asset to fulfill the level of guarantees required in each contract, imply that the financing possibility depends on the entrepreneur's wealth. The value of guarantees in the equilibrium contracts determines three different areas where entrepreneurs are clustered according to their wealth:

i. Poor entrepreneurs with asset $A < G^*_{\overline{\beta}}$

ii. Rich entrepreneurs with asset $A \in [G^*_{\overline{\beta}}, G^*_{\underline{\beta}})$

iii. Super rich entrepreneur with asset $A \geq G^*_{\underline{\beta}}$

b. Supply of credit. For each group of entrepreneur as identified above, we can identify which entrepreneurs a bank is willing to finance.

i. Poor entrepreneurs will never be financed. These entrepreneurs are so poor that their wealth does not reach even the minimum guarantees requirement necessary to afford at least one of the contracts.

ii. Rich entrepreneurs, which have an intermediate value of asset, would be financed only if the bank's asset evaluation is high, which corresponds to the contract with $\beta = \overline{\beta}$. These entrepreneurs have sufficient wealth to afford only the contract with the lower level of guarantees. In fact, for a certain asset A, if for the bank its liquidation value is the lowest, then the entrepreneur is not able to fulfill the required level of guarantees given that $A < G^*_{\underline{\beta}}$.

iii. Super rich entrepreneur would be always financed regardless the β. These entrepreneurs have enough wealth to afford the contract with the highest level of guarantees.

c. Demand of credit. From Lemma 3 we know that an entrepreneur decides whether to apply or not for a loan conditional on his application cost. An entrepreneur will apply if such cost does not exceed the threshold value indicated in equation (2.6).

i. Poor entrepreneurs will never apply for a loan regardless their application cost.

ii. Rich and super rich entrepreneurs are not willing to apply for a loan for any application cost $c > c(\beta, A)$.

Notice that the threshold value $c(\beta, A)$ is not the same for rich and super rich entrepreneurs. As explained above, the entrepreneurs know that their financing possibility depends on the wealth they have. This involves a different expected payoff between rich and super rich entrepreneurs, and thus a different threshold value of the application cost.
In particular rich entrepreneurs calculate their expected payoff taking into account that they will be financed only in the case of high bank evaluation of the asset. It is immediate to see that their threshold value is:

$$c(\beta, A|A \in [G^*_{\overline{\beta}}, G^*_{\underline{\beta}})) \equiv \pi(\overline{\beta}) I_{\{A>G^*_{\overline{\beta}}\}} \{p_H(R - R^*_{L,\overline{\beta}}) - (1 - p_H)G^*_{\overline{\beta}}\} \tag{2.11}$$

On the other hand, super rich entrepreneurs, knowing that they can obtain credit under both contracts, calculate their expected payoff considering both contracts. In this case the threshold value of the application cost is:

$$c(\beta, A|A > G^*_{\underline{\beta}}) \equiv \sum_{\beta=\underline{\beta}}^{\overline{\beta}} \pi(\beta) I_{\{A>G^*_{\beta}\}} \{p_H(R - R^*_{L,\beta}) - (1 - p_H)G^*_{\beta}\} \tag{2.12}$$

2.5.2 Market outcomes and implications

Given the clustering of entrepreneurs' according to their wealth, the combination of lenders and borrowers best reply gives the following six market outcomes:

i. **Self-rationed entrepreneurs**: composed by all the poor entrepreneurs.

ii. **Rationed entrepreneurs**: composed by the rich entrepreneurs that apply for a loan but that are not financed because they cannot afford the contract offered.

iii. **Rich-discouraged entrepreneurs**: composed by the rich entrepreneurs that do not apply for a loan.

iv. **Rich-financed entrepreneurs**: composed by the entrepreneurs that apply for a loan and are financed with the contract $\mathbf{C}(\overline{\beta})$.

v. **Super rich-discouraged entrepreneurs**: composed by the super rich entrepreneurs that don not apply for a loan.

vi. **Super rich-financed entrepreneurs**: composed by all the super rich entrepreneur that apply for a loan, which are all financed.

Notice that the equilibrium outcome imply a probability to be financed which can be derived as follow:

$$Pr(F) = \sum_{\beta=\underline{\beta}}^{\overline{\beta}} \pi(\beta) I_{\{A>G^*_\beta\}} \tag{2.13}$$

Specifically, the probability to be financed is zero for poor entrepreneurs, less than one for rich entrepreneurs and one for super-rich entrepreneurs. Hence, it emerges that some discouraged borrowers would have received credit if they had apply. We refers to: rich-discouraged entrepreneurs that would have received a high asset evaluation by the lender and super rich-discouraged entrepreneurs. However there is a difference between these two type of borrowers. For super rich-discouraged borrowers ex-ante and ex-post probability to be financed is the same and it is equal to one. Rich-discouraged borrowers have an ex-ante probability to be financed less than one, while ex-post some would have zero probability to be financed and all the others a probability to be financed equal to one.

2.6 Empirical implications

For wealth greater than $G^*_{\underline{\beta}}$ all firms will be financed with ex-ante probability of 1.

Given positive application cost c we may have:

i. financed firms with $c \leq c(\beta, A|A > G^*_{\underline{\beta}})$

ii. discouraged firms with $c > c(\beta, A|A > G^*_{\underline{\beta}})$

For wealth between $G^*_{\overline{\beta}}$ and $G^*_{\underline{\beta}}$ firm will be financed with ex-ante probability less than 1. Given positive cost of application we may have:

i. applicants firm with $c \leq c(\beta, A|A \in [G^*_{\overline{\beta}}, G^*_{\underline{\beta}}))$

ii. discouraged firms with $c > c(\beta, A|A \in [G^*_{\overline{\beta}}, G^*_{\underline{\beta}}))$

iii. some applicant firms are denied

For wealth less than $G^*_{\overline{\beta}}$ all firm will be credit denied. We may have that all the firms are non applicant regardless the cost of application.

The threshold value of the application cost for entrepreneur with intermediate value of wealth is lower than the threshold value for the rich entrepreneur.

2.7 Empirical analysis

2.7.1 The financing process

The main focus of this empirical analysis is to evaluate if non-applicant firms could be financed in case they applied for a loan. This counterfactual is not observable and can be estimated under some assumptions that will be explained in this section. Preliminary, it is crucial to describe how the financing process works in the data. Using survey data from 2003 US NSSBF we have designed the loan-granting process as a set of sequential decision steps similarly to the multistage model of loan of Chakravarty and Yilmazer (2009). Starting from the initial sample of the firms we may assume that in each stage there is a decision that implies a selection. The process is decomposed as follows:

1. The need of credit of firms: firms declare whether they need credit or not.
2. The application decision: firms decide whether to apply for a bank loan or not.
3. The financing decision: the bank decides whether to grant the loan or not for those firms that applied (approval model).

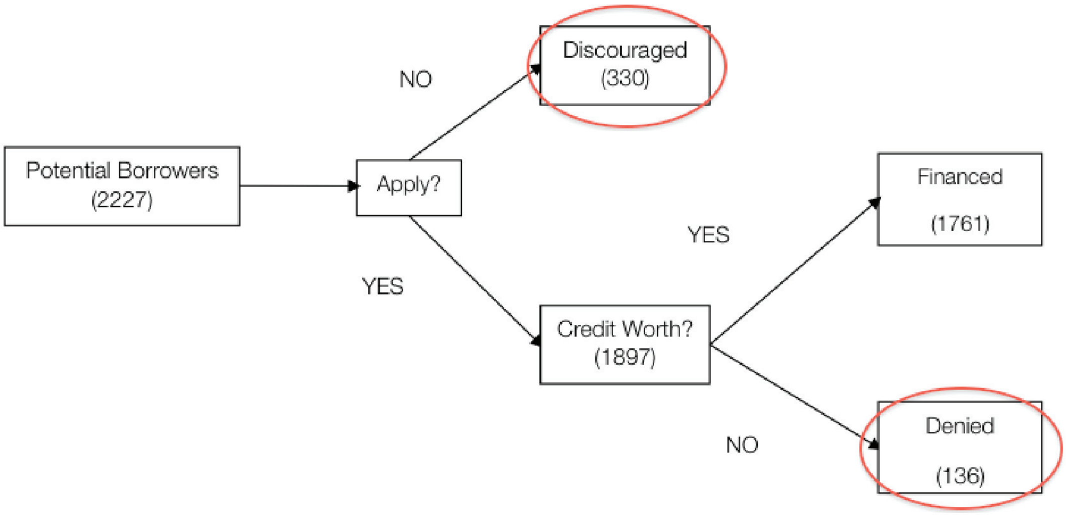

Figure 2.1: The Financing process

As illustrated in figure 1 in the firms' financing process discouragement appears to be more relevant than credit denial. We see that among the firms that needed credit, 14% of them were discouraged to apply for a loan because they feel they will be rejected. The denied firms account only for the 6% of the sample.

The counterfactual for the probability of being financed for discouraged firms is estimated using the predicted probability obtained from the approval model. The use of predicted probability could be questioned considering that the group of non applicants are not considered in the model of approval and so this latter would be different in case all these firms applied. We show that this argument is not relevant in this case.

The model shows that the final outcome that we observe in the loan market represents an equilibrium in which all the participants, i.e. non applicants firms, denied firms financed firms and the bank, do not find profitable to deviate given the best response of the other participants.

In the model we also assume that the approval model of the bank is common knowledge among all the categories of the firms: financed, denied and discouraged.

The approval model used by the bank is based on the pool of applicants and it represents its best response. This means that the policy of the bank does not change

even in the case a non applicant decides to apply for a loan.
Starting from this assumption we want to test what would be the estimated probability for a given non applicant in the hypothetical case she apply.
In other words, we want to test if there is or not a profitable deviation for discouraged firm, i.e. if they would be financed had they applied. Predicted probabilities represent exactly what is the probability of financing in case a single firm is subject to the approval model of the bank. The reasonable hypothesis is that the behavior of just one firm does not affect the approval model used by the bank. The usual concern that the model of financing would be different in case non applicants would have applied does not apply in this case.

2.7.2 Empirical methodology

Starting from the estimation of the approval model used by the bank to decide wether to finance or not a firm, we use the predicted values to estimate the probability of being financed for discouraged and denied firms. The dependent variable is a dichotomous variable that take value of 1 if the firm is financed and 0 otherwise. We can observe it only if the firm decided to apply for a loan. Thus, estimating the probability of being financed, according to the approval model of the bank, the sample selection is accounted as follows:

$$A_i = 1[Z_{A,i}\alpha_A + u_{A,i} > 0] \tag{2.14}$$

$$F_i = 1[Z_{F,i}\alpha_F + u_{F,i} > 0] \tag{2.15}$$

where $A_i > 0$ if a potential borrower decides to apply for a loan ($A_i \leq 0$ otherwise) and $F_i > 0$ if the bank decides to finance the firm ($F_i \leq 0$ otherwise) and is observed only if $A_i = 1[\alpha_A^{'} Z_{A,i} + u_{A,i} > 0]$ holds; $Z_{A,i}$ and $Z_{F,i}$ are vectors of covariates affecting the application decision and the financing decision. $u_{A,i}$ and $u_{F,i}$ are the correlated error terms.

Equation 2.12 is the selection equation, while equation 2.13 is the outcome equation.

In the sample firms fall into one of three categories: 1) they apply for credit and their application is accepted; 2) they apply for credit and their application is rejected; 3) they don't apply for credit.

The probabilities associated with the three types of observations are[1]:

$A = 0 \qquad Pr(A = 0) = \Phi_A(-Z_{A,i}\alpha_A)$

$A = 1, F = 0 \qquad Pr(A = 1, F = 0) = \Phi_A(Z_{A,i}\alpha_A) - \Phi_F(Z_{A,i}\alpha_A, Z_{F,i}\alpha_F; \rho)$

$A = 1, F = 1 \qquad Pr(A = 1, F = 1) = \Phi_F(Z_{A,i}\alpha_A, Z_{F,i}\alpha_F; \rho)$

The log-likelihood function for these three probabilities is:

$$lnL = \sum_{i=1}^{N} A_i F_i ln\Phi_F(Z_{A,i}\alpha_A, \alpha_F Z_{F,i}; \rho) + A_i(1 - F_i)ln[\Phi_A(Z_{A,i}\alpha_A) + \\ -\Phi_F(Z_{A,i}\alpha_A, Z_{F,i}\alpha_F; \rho)] + (1 - A_i)ln\Phi(-Z_{A,i}\alpha_A) \qquad (2.16)$$

We estimate the ML employing the "heckprob" command of STATA.

As in the Heckman's two steps selection model (Heckman, 1979) in order to correctly identify the model we need an exclusion restriction, i.e at least one variable that is correlated with the decision to apply but that does not affect the financing decision of the bank is needed.

2.7.3 Data and descriptive statistics

The data in this paper have been obtained from the National Survey of Small Business Finances (SSBF), which has been conducted in 2004-2005 for the Board of Governors of the Federal Reserve System. The public data set provides informations for a sample of 4240 firms, selected from the target population of all for-profit, non-financial, non-farm, non-subsidiary business enterprises that had fewer than 500 employees and were in operation as of year-end 2003 and on the date of the interview. The Survey collected informations on the availability and use of credit and other financial services along with informations on firm demographic characteristics

[1] See Greene, 2003

for up to three individual owners, and other informations on the number of workers, organizational form, location, credit history, income statement and balance sheet data. The survey asks the respondents to provide informations whether the firm applied for credit during the last three years (from 2001 to 2003) and, in that case, whether the most recent application for credit was denied. Moreover, the survey reports information on whether in the same period the firm, though it needed credit, did not apply for loans fearing rejection.

The sample of firms that need credit, that either applied for a loan or not, fearing rejection, is called potential borrowers and it represents my sample of interest with 2227 observations. The sample of potential borrowers can be split in non applicants or discouraged firms and applicants. Among applicants there are firms that have been financed and firms that have been denied.

The category of discouraged firm has been identified using the following question of the survey: "During the past three years, were there times when the firm needed credit, but did not apply because it thought the application would be turned down?" A discouraged firm is the one who answered "yes" to the question.

The category of financed firm corresponds to those firms which their applications for a loan was always or sometimes approved during the last three years. While those firms that applied for a loan and were always denied represent the category of denied firms.

Table 1 and 2 present summary statistics of several variables on owner's characteristics, firm's characteristics and firm-lender relationships for the different categories of firms. Table 1 reports the summary statistics for potential borrowers, applicants and discouraged borrowers. Table 2 reports the same summary statistics for discouraged, denied and financed firms.

From Table 1 we can see that on average applicant firms and discouraged firms are very different for most of the characteristics analyzed. In fact, except for ownposgrad (1st owner has postgraduate degree), hisp (1st owner is hispanic), owntotpw (owner total personal wealth), capassetontass (capital asset/total asset) which means-differences are not statistically significantly different from zero, for all other variables the means-differences are statistically significantly different from zero. Comparing owner's characteristics between applicants firms and discouraged firms, the latters are significantly younger, less experienced and less educated. They also have worse owner credit quality by all measures: owner bankruptcy, owner delinquencies, owner judgments. They are also likely to be black, asian and female. Concerning firm characteristics and balance sheet indicators discouraged firms are smaller, younger, more likely to be owned by a family, more highly levered, have more cash and less net profit than applicant firms. Discouraged firms are also worse in terms of firm credit quality and they are also more likely to be managed by the first owner of the firm. In terms of firm-lender relationships characteristics discouraged firms deal with a fewer number of financial institutions and have significantly shorter relationships (measured in years) with their primary source of financial services. Discouraged firms have also shorter relationships with all their sources of financial services if we control for the average length of relationships of all these institutions.

In Table 2 the comparison is between discouraged, denied and financed firms. We also run t-test for testing differences in means between discouraged and denied firms and between denied and financed firms. Comparing discouraged firms with denied firms we find that the two categories are very similar in most of the owner and firm characteristics, in particular for those concerning credit quality. The same similarity is significant when we control credit risk through balance sheet indicators. Moreover discouraged and denied firms are similar for the length of the relationships in years with their primary sources of financial services and also for the average length of relationships with all their sources of financial services. However discouraged firms are owned by person less experienced, higher educated, less likely to be black and with an higher percentage of past bankruptcies than denied firms.

From the comparison between denied and financed firms it is immediate to see that the two groups are different for almost all the owner and firm characteristics. Denied firms are younger, smaller, less experienced, less educated and riskier than financed firms. Denied firms have also shorter relationships with their primary financial institution than financed.

2.8 Estimation

2.8.1 Bivariate probit with selection: the approval model and the decision to apply

The equations that I estimate with a bivariate probit with selection are the followings:

$$\begin{aligned} apply_i = owntotpw_i\beta_{11} + firmbkrupt_i\beta_{12} + delinqobl_i\beta_{13} + \\ + creditScore_i\beta_{14} + debtonass_i\beta_{15} + debtOnEq_i\beta_{16} + \\ + profit\_net_i\beta_{17} + family_i\beta_{18} + distfirst_i\beta_{19} \end{aligned} \tag{2.17}$$

$$\begin{aligned} credworth_i = owntotpw_i\beta_{21} + firmbkrupt_i\beta_{22} + deliqobbl_i\beta_{23} + \\ + creditScore_i\beta_{24} + debtonass_i\beta_{25} + debtOnEq_i\beta_{26} + \\ + profit\_net_i\beta_{27} + family_i\beta_{28} \end{aligned} \tag{2.18}$$

The first equation is the selection equation where the dependent variable APPLY is 1 for the firms that apply for a loan and 0 otherwise; the second equation is the outcome equation where the dependent variable CREDWORTH is equal to 1 if the firm is financed by the bank and 0 otherwise. We include the same explanatory variables in both equations because, based on the approval model of the bank, we want to see whether the same variable affect differently the decision of the firms to apply and that of the bank to finance. In order to identify the model we include one more variable in the selection equation that works as exclusion restrictions.
We built the approval model of the bank following the existing literature on the availability of credit according to which a lender is willing to grant a loan to a firm when that firm shares characteristics of other firms that historically have repaid their credits (Cavalluzzo and Cavalluzzo 1998; Cole 1998; Cavalluzzo and Wolken 2005; Chakravarty and Yilmazer 2009). We have included a list of variables that control for firm quality, firm creditworthiness and its risk of credit. OWNTOTPW is the total personal wealth of the firm owner out of her business; we expect owner personal wealth affects positively the probability of being financed because it can

be considered as a source of collateral for the bank. Conversely, the wealth of the owner should be negatively correlated with the decision of the firm to apply. FIRMBKRUPT is a dummy variable with value of 1 if the firm has declared bankruptcy within the past seven years; DELINQOBL is a discrete variable that takes value from 1 to 4 and indicates the number of obligations on which the firm has been 60 or more days delinquent during the previous three years; we expect those two variables, that are proxies of the firm credit risk, to affect negatively both equations. In fact, in presence of previous bankrupts and of delinquent obligations the probability of being financed will decrease as well as the decision of the firm to apply, because it knows that it will be denied with higher probability. CREDITSCORE is the D&B credit score that takes discrete values from 1 to 6. Higher value of the variable corresponds to high credit quality. This further measure of credit quality for the bank should affect positively both the decision of the bank to finance the firm and the decision of the firm to apply. To control for credit risk we also include some firm-specific variables derived from the firm balance sheet. DEBTONASS is the ratio of debt on total asset; DEBTONEQ is the ratio of debt on equity. We expect to find that the decision to apply and the credit availability decrease as those ratios increase. PROFIT_NET is the firm's income after all expenses and taxes have been deducted and is a proxy of creditworthiness of the firm. We expect to find that it affects positively the decision to apply and the financing decision of the bank. FAMILY is a dummy variable with 1 if the firm is owned by a family. DISTFIRST is the exclusion restriction and it measures the distance in miles between the firm and its primary financial institution. We use it as a proxy of the firm costs of application. One might disagree with the use of this variable as exclusion restriction because the distance between the firm and its financial institution could also affect the decision of the bank. Indeed one can use the distance as a proxy of the monitoring cost for the bank. However, using the "1993 NSSBF", Petersen and Rajan (2002) observe an increasing distance between the firm and their lenders. They argue that "increasing capital intensity of lending due to the greater usage of tools such as computers and communication equipment has altered the way loans are made, which, in turn, could account for the growing distance. Their findings suggest that technological change

has eased the ability to lend at a distance and reduced the need for the decisions to be made where the information is collected.” Those findings are enough to justify my hypothesis of the use of the the distance only as a proxy for the application cost of a firm and so as exclusion restriction.
In Table 3 are reported the results of the bivariate probit with selection. The estimated correlation coefficient between the error terms in the two equations is significantly different from zero at 5% level. This confirms the hypothesis of sample selection and also the presence of private information in the decision of the firm to apply. The sign of the estimated coefficients in the two equations are as expected and all the coefficients are statistically significant either at 1% or 5% level.

2.8.2 Predicted probabilities

At this point of the analysis we are able to build the counterfactual: using the results of the outcome equation in model (2.15)-(2.16) I compute the conditional predicted probabilities of being financed for all potential borrowers: discouraged, denied and financed firms.
In Table 4 is reported the average probability of being financed for each category of firms. As expected, the predicted probabilities confirm what we have seen in the summary statistics. Discouraged show an average probability of being financed around 85%, while applicants reach 93% and the financed firms have 94% probability to be financed on average. Interestingly, discouraged firms have the same average probability of being financed of the firms that apply and are denied. These preliminary results suggest a similarity between the group of discouraged and of denied firms. Another check on the validity of the hypothesis of similarity between those two groups is made by plotting the pdf and the cdf of the probability of being financed for the three groups of interest: discouraged, denied and financed. From graph 2 it can be seen that the probability density function for the discouraged is very similar to the one of the denied; while the pdf of the probability of being financed for the financed is different compared to the other two groups. In graph 3 there is the plot of the cdfs. From this graph we see that the probability of being financed of financed firms first-order stochastically dominate the probability of being

financed of the other two groups. While is not clear which order of dominance there is between discouraged and denied distribution functions; but this last issue is not a relevant aspect. A Kolmogrov-Smirnov test of equal distributions confirms that the pdfs of the probability of being financed for the denied and the discouraged are not statistically different, while the hypothesis of equal distributions between denied and financed is rejected at 1% level.

2.8.3 Probability of being financed and distance

So far we have seen that discouraged firms and denied firms share the same owner and firm characteristics. We also know that they have the same average probability of being financed and that the distribution of this probability between the two groups is not statistically significantly different. However, despite discouraged and denied would have the same probability of being financed some apply for a loan and the other do not because they feel to be rejected. How we can explain this difference among firms behavior that appear to be equal in most of their characteristics? It could be that the decision whether to apply or not is driven by some unobservable characteristics that the researcher is not able to identify. Another explanation is that discouraged firms do not apply for a loan because of higher cost of application with respect to denied firms. This explanation is coherent with the initial hypothesis that what we observe in the credit market is an equilibrium outcome. Specifically, for discouraged firms is not profitable to apply for a loan once they predict their probability of being financed. A proxy of the application cost that I use in the estimation is the distance between the firm and its primary source of financial services. Based on this hypothesis we control the average distance between firms and their primary financial institution for high and low probability of being financed of the financed. We compute the median (95.6%) and the mean (93.6%) of the probability of being financed of the financed and we use them as thresholds to discriminate between firms with high and low probability of financing. In Tables 5, 6, 7, 8 the results are shown. Discouraged firms that have a probability to be financed above the median value, show an average distance which is 37% higher than applicants (Tab. 5). Considering the mean as threshold value, the distance for the discour-

aged is more than three times higher than applicants, and this difference in means is statistically significant at 1% level (Tab. 7). If the distance is a proxy of the application cost, discouragement can be explained by differences in the application costs.
Comparing discouraged and denied firms we may observe that differences in the average distance from the bank are smaller. Although this differences in means are not statistically significant, discouraged firms have an average distance which is 29% above that of denied, considering the median of the probability as threshold value, and 31% considering the mean as a threshold value (see Tab. 6 and 8).

2.9 Conclusions

Discouragement is a phenomenon that appears to be rather important in small firms access to credit. Data used in this paper show that 14% of the small business are discouraged in the US, versus a 6% of denied. Under the economic perspective it is important to assess whether or not discouragement can be assimilated to rationing. In this paper we consider this issue in a model with moral hazard in which firms differ by their wealth, the liquidation value of assets they can post as collateral and the cost of application. The combination of these elements gives the following results: all poor entrepreneurs are self-rationed; rich and super rich entrepreneurs can be discouraged depending on the level of application cost; some rich entrepreneurs that apply may be rationed. Moreover, the model predicts a probability to be financed which is zero for poor entrepreneurs, less than one for rich entrepreneurs and one for super-rich entrepreneurs. Hence, it emerges that some discouraged borrowers would have received credit if they had apply.
Empirically we test the prediction of the model in two steps:

1) through an univariate analysis we check if discouraged firms differ substantially from rationed firms;

2) we compare discouraged and denied firms trough their estimated probability of being financed.

The probability of being financed for all the categories of firms, is obtained modeling the process of firm access to credit as a sequence of decisions, which involves self selection. This probability is used as counterfactual for discouraged, i.e. to calculate the likelihood of financing if they had applied. The use of predicted probabilities as counterfactual is justified by the model where we assumed that all three groups of firms (discouraged, denied and financed) know the approval model of the bank and decide whether to apply or not, predicting their probability of being financed. On the other hand we assume that the financing decision rule of the bank does not change if one discouraged firm would deviate, and each agent is playing his best response.

We find that denied and discouraged firms are similar in most of the owner and firm characteristics. We control for the probability to be financed and the cost of application. We find that discouraged firms have the same average probability of being financed of the firms that apply and are denied. Moreover, as predicted by the model, empirical results show that discouraged firms with high probability to be financed may have given up the application because of higher costs of application.

2.10 Appendix

2.10.1 Proof of lemma 1

The lender participation constraint is:

$$p_H R_{L,\beta} + (1 - p_H)\beta G_\beta \geq I(1 + r) \tag{2.10.1}$$

The borrower's incentive compatibility constraint is:

$$p_H(R - R_{L,\beta}) - (1 - p_H)G_\beta \geq p_L(R - R_{L,\beta}) - (1 - p_L)G_\beta + B \tag{2.10.2}$$

After some transformation we can write eq. (2.10.2) as follows:

$$R - R_{L,\beta} \geq \frac{B}{\Delta p} - G_\beta \tag{2.10.3}$$

If we impose lender's participation constraint binding (lenders are making zero profit), the lender is taking the minimum reward necessary to be able to finance en entrepreneurs. From eq. (2.10.1) with equality we can write $R_{L,\beta}$ as function of G:

$$R_{L,\beta} = \frac{I(1 + r) - (1 - p_H)\beta G_\beta}{p_H} \tag{2.10.4}$$

It is easy to see that the gross interest rate is a decreasing function of G_β. As G_β increase the LHS of eq. (**??**), which corresponds to the borrower's remuneration, increases while the RHS of the same equation decreases and the BICC becomes slack. As G_β decrease: $R_{L,\beta}$ increase, the LHS of eq. (**??**) decrease and the RHS increase. Thus G_β can decrease up to BICC binding. It follows that the minimum amount of guarantees a lender requires in order to finance an entrepreneur, which we call $G_{min(\beta)}$ can be found with BICC and LPC binding. It follows that:

$$G_{min(\beta)} = max(\frac{I(1 + r) - p_H(R - \frac{B}{\Delta p})}{p_H + (1 - p_H)\beta}, 0) \tag{2.10.5}$$

That $G_{min(\beta)}$ is positive or equal to zero depends on net present value of the project:

$$G_{min(\beta)} = \begin{cases} 0 & if \quad \mathrm{p}_H R - I(1 + r) \geq p_H \frac{B}{\Delta p} \\ \frac{I(1+r) - p_H(R - \frac{B}{\Delta p})}{p_H + (1-p_H)\beta} & if \quad \mathrm{p}_H R - I(1 + r) < p_H \frac{B}{\Delta p} \end{cases} \tag{2.10.6}$$

2.10.2 Proof of lemma 2

From the participation constraint of the borrower which is $p_H(R - R_{L,\beta}) - (1 - p_H)G_\beta + A \geq A$ we can see that as the value of G_β increases, the expected payoff of a financed entrepreneur decreases. In order for the borrower's participation constraint holding G_β can increase up to the point the above constraint binds. This point corresponds to $G_{max(\beta)}$.

2.10.3 Proof of lemma 3

An entrepreneur will apply for a loan if and only if his expected payoff is greater or equal to the payoff he gets not applying, which is his wealth:

$$U_B \equiv (\{\sum_{\beta=\underline{\beta}}^{\overline{\beta}} \pi(\beta) I_{\{A>G_\beta\}}\{p_H(R - R_{L,\beta}) - (1 - p_H)G_\beta\}\} + A - c) \geq A \qquad (2.10.7)$$

It is easy to see that the above inequality is satisfied for:
$c \leq \{\sum_{\beta=\underline{\beta}}^{\overline{\beta}} \pi(\beta) I_{\{A>G_\beta\}}\{p_H(R - R_{L,\beta}) - (1 - p_H)G_\beta\}\}$.
Thus equation (2.6) represents the maximum cost an entrepreneur is willing to incur during the application process.

2.10.4 Proof of proposition 1

The equilibrium contract is found with both LPC and BICC binding. First of all we prove that BICC is binding assuming that LPC also binds. Second we prove that in equilibrium LPC must be binding.
Suppose that the LPC binds. Then we can substitute equation (**??**) into both the objective function and the BICC so that the maximization problem reduce to:

$$\max_{G_\beta} : p_H R - I(1+r) - (1-p_H)(1-\beta)G_\beta + A$$

$$s.t. :$$

$$ICC_\beta : R - \frac{I(1+r)}{p_H} \geq \frac{B}{\Delta p} - \frac{p_H + (1-p_H)\beta}{p_H} G_\beta$$

The objective function is decreasing in G_β. Thus the utility of a borrower that apply for a loan is maximized with the lowest value of guarantees compatible with the BICC. It is easy to see that the maximum is attained with BICC binding, which corresponds to the value of $G_{min(\beta)}$ as derived in proof of Lemma 1.

Now we prove that in equilibrium the LPC is binding. Suppose not. Then the candidate equilibrium contract is a contract where each lender that finance an entrepreneur makes positive profit. Considering that the number of lender is greater than the number of entrepreneur, there exist at least one lender who are not financing any entrepreneur. This lender is making zero profit. Thus, he will be better off undercutting the competitors by offering a contract that will be strictly preferred by the entrepreneur. Such contract will give him positive profit, which destroys the previous candidate equilibrium. Only under the contract that gives zero profit to lender there is any possibility to undercut the competitor.

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Figure 2.2: Conditional density of the probabilty to be financed

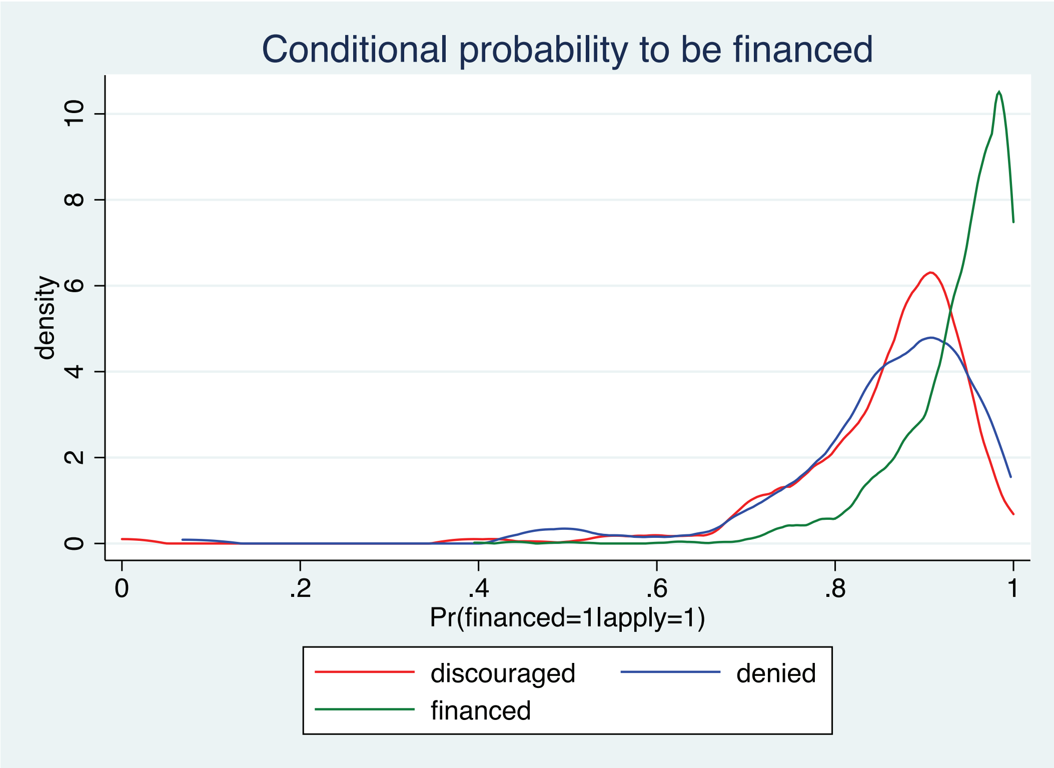

Figure 2.3: Cdf of the probability to be financed

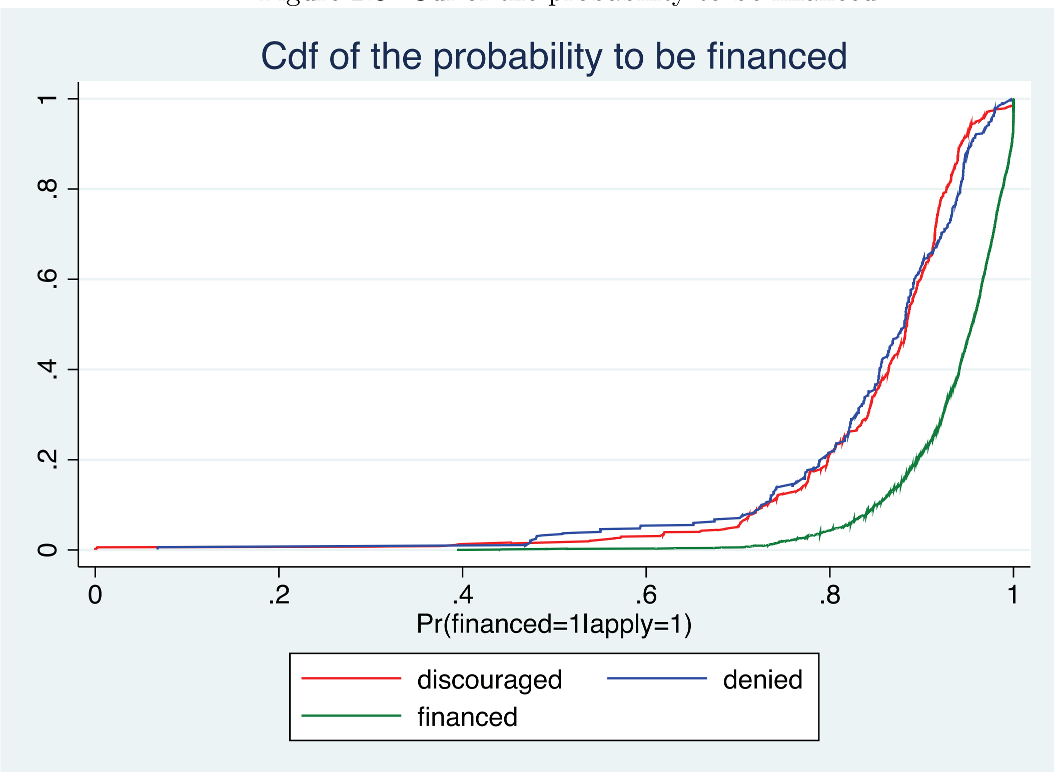

Table 2.1: Descriptive statistics: firms that need credit

	Potential borrowers			Firms that apply (a)			Discouraged firms (b)			(a)-(b)	
	N	Mean	SD	N	Mean	SD	N	Mean	SD		
Owner Characteristics											
Age 1st owner	2169	52.35	11.20	1841	53.15	11.09	328	47.87	10.76	-5.28	***
Experience 1st owner (years)	2169	21.90	11.72	1841	22.96	11.58	328	15.96	10.68	-7.00	***
1st owner is manager (dummy)	2169	0.85	0.36	1841	0.83	0.37	328	0.94	0.24	0.11	***
1st owner has posgrad. degree (dummy)	2227	0.18	0.39	1897	0.19	0.39	330	0.16	0.37	-0.03	
1st owner has graduate degree (dummy)	2227	0.33	0.47	1897	0.34	0.47	330	0.25	0.43	-0.09	***
1st owner is black (dummy)	2169	0.04	0.19	1841	0.03	0.16	328	0.09	0.29	0.07	***
1st owner is asian (dummy)	2169	0.04	0.19	1841	0.03	0.18	328	0.05	0.23	0.02	*
1st owner is hispanic (dummy)	2169	0.04	0.19	1841	0.03	0.18	328	0.05	0.22	0.01	
1st owner is female (dummy)	2169	0.20	0.40	1841	0.17	0.37	328	0.35	0.48	0.18	***
Owner bankruptcy (dummy)	2188	0.02	0.15	1858	0.01	0.10	330	0.10	0.30	0.09	***
Owner delinquencies	2227	0.14	0.35	1897	0.10	0.30	330	0.36	0.48	0.26	***
Owner judgments (dummy)	2188	0.03	0.16	1858	0.02	0.15	330	0.06	0.23	0.04	***
Owner total personal wealth (th $)	2227	3176.77	32707.79	1897	2711.01	19652.76	330	5854.21	70738.68	3143.21	
Firm Characteristics											
ln(number of employees)	2225	2.69	1.64	1895	2.93	1.58	330	1.33	1.25	-1.60	***
ln(total sales)	2206	13.93	2.26	1888	14.33	2.06	318	11.60	1.96	-2.72	***
Firm's Age	2227	16.71	12.81	1897	17.86	13.02	330	10.11	9.04	-7.76	***
Firm family owned (dummy)	2227	0.79	0.41	1897	0.77	0.42	330	0.92	0.28	0.15	***
Growth of sales (dummy)	2227	0.49	0.50	1897	0.50	0.50	330	0.42	0.49	-0.09	***
Firm judgments (dummy)	2227	0.04	0.19	1897	0.03	0.18	330	0.07	0.25	0.03	***
Firm delinquencies	2227	1.59	1.14	1897	1.53	1.10	330	1.94	1.30	0.41	***
Firm bankruptcy (dummy)	2227	0.01	0.10	1897	0.01	0.09	330	0.03	0.17	0.02	***
Firm Balance Sheet											
Profit after taxes (th $)	2227	739,26	4620.18	1897	869.66	4990.29	330	-10.39	501.04	-880.05	***
Debts on equity	2205	3.06	118.58	1887	0.63	22.48	318	17.47	307.42	0.83	**
Liquidity on total assets	2203	0.14	0.44	1885	0.12	0.45	318	0.20	0.33	0.08	***
Financial debts on total liabilities	2071	0.61	0.35	1816	0.62	0.34	255	0.57	0.41	-0.04	**
Debt on total asset	2203	1.33	6.95	1885	1.19	5.35	318	2.18	12.84	0.99	**
Capital asset/tot asset ratio	2203	0.42	0.34	1885	0.42	0.34	318	0.42	0.37	-0.01	
Firm-Financial Inst relationship											
Numb of financ inst firm deals with	2227	3.40	2.05	1897	3.57	2.08	330	2.45	1.60	-1.11	***
Distance firm-financ inst in miles on avg	2217	146.96	234.86	1897	149.62	230.04	320	131.21	261.46	-18.40	
Distance from 1st institution	2214	27.76	175.34	1895	26.55	166.16	319	34.94	222.38	8.39	
Length of relationships with first instit (years)	2216	10.58	10.33	1897	11.21	10.71	319	6.80	6.56	-4.41	***
Length of relationship firm-financ inst (years)	2217	8.34	6.75	1897	8.78	6.92	320	5.73	4.89	-3.05	***
Top 25% credit score (dummy)	2227	0.34	0.47	1897	0.37	0.48	330	0.15	0.36	-0.21	***
D&B credit score	2213	3.77	1.50	1888	3.90	1.48	325	3.03	1.38	-0.86	***

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Table 2.2: Descriptive statistics: discouraged firms vs financed and denied firms

	Discouraged firms (a)			Denied firms (b)			(a)-(b)		Financed firms (c)			(b)-(c)	
	N	Mean	SD	N	Mean	SD			N	Mean	SD		
Owner Characteristics													
Age 1st owner	328	47.87	10.76	133	48.48	11.02	-0.62		1708	53.51	11.01	-5.03	***
Experience 1st owner (years)	328	15.96	10.68	133	18.11	11.07	-2.15	**	1708	23.34	11.54	-5.23	***
1st owner is manager (dummy)	328	0.94	0.24	133	0.93	0.25	0.01		1708	0.83	0.38	0.11	***
1st owner has posgrad. degree (dummy)	330	0.16	0.37	136	0.10	0.30	0.07	*	1761	0.19	0.39	-0.10	***
1st owner has graduate degree (dummy)	330	0.25	0.43	136	0.29	0.46	-0.05		1761	0.34	0.48	-0.05	
1st owner is black (dummy)	328	0.09	0.29	133	0.18	0.39	-0.09	***	1708	0.01	0.12	0.17	***
1st owner is asian (dummy)	328	0.05	0.23	133	0.05	0.21	0.01		1708	0.03	0.18	0.11	
1st owner is hispanic (dummy)	328	0.05	0.22	133	0.06	0.24	-0.01		1708	0.03	0.18	0.03	*
1st owner is female (dummy)	328	0.35	0.48	133	0.29	0.46	0.06		1708	0.16	0.37	0.13	***
Owner bunkruptcy (dummy)	330	0.10	0.30	134	0.04	0.21	0.06	**	1724	0.01	0.09	0.03	***
Owner delinquencies	330	0.36	0.48	136	0.32	0.47	0.04		1761	0.08	0.27	0.24	***
Owner judgments (dummy)	330	0.06	0.23	134	0.07	0.26	-0.02		1724	0.02	0.13	0.06	***
Owner total personal wealth (th $)	330	5854.21	70738.68	136	545.16	924.14	5309.06		1761	2878.27	20386.76	-2333.12	
Firm Characteristics													
ln(number of employees)	330	1.33	1.25	136	2.01	1.35	-0.68	***	1759	3.00	1.58	-0.99	***
ln(total sales)	318	11.60	1.96	136	12.70	1.91	-1.09	***	1752	14.45	2.02	-1.76	***
Firm's Age	330	10.11	9.04	136	12.41	10.78	-2.31	**	1761	18.28	13.09	-5.87	***
Firm family owned (dummy)	330	0.92	0.28	136	0.85	0.36	0.06	**	1761	0.76	0.43	0.09	***
Growth of sales (dummy)	330	0.42	0.49	136	0.53	0.50	-0.11	**	1761	0.50	0.50	0.03	
Firm judgments (dummy)	330	0.07	0.25	136	0.08	0.27	-0.01		1761	0.03	0.17	0.05	***
Firm delinquencies	330	1.94	1.30	136	2.07	1.37	-0.13		1761	1.49	1.06	0.58	***
Firm bankruptcy (dummy)	330	0.03	0.17	136	0.04	0.21	-0.01		1761	0.00	0.07	0.04	***
Firm Balance Sheet													
Profit after taxes (th $)	330	-10.39	501.04	136	131.47	396.87	-141.85	***	1761	926.67	5173.96	-795.20	*
Debts on equity	318	17.47	307.42	135	1.71	20.65	15.76		1752	0.55	22.62	1.16	
Liquidity on total assets	318	0.20	0.33	134	0.14	0.26	0.06	**	1751	0.12	0.46	0.02	
Financial debts on total liabilities	255	0.57	0.41	124	0.65	0.36	-0.08	*	1692	0.62	0.34	0.04	
Debt on total asset	318	2.18	12.84	134	3.18	14.52	-1.00		1751	1.03	3.80	2.15	***
Capital asset/tot asset ratio	318	0.42	0.37	134	0.46	0.38	-0.04		1751	0.42	0.33	0.04	
Firm-Financial Inst relationship													
Numb of financ inst firm deals with	330	2.45	1.60	136	3.41	2.10	-0.96	***	1761	3.58	2.07	0.17	
Distance firm-financ inst in miles on avg	320	131.21	261.46	136	128.01	231.12	3.20		1761	151.28	229.94	-23.27	
Distance from 1st institution	319	34.94	222.38	136	32.56	193.11	2.38		1759	26.09	163.95	6.47	
Length of relationships with first instit (years)	319	6.80	6.56	136	7.66	8.17	-0.86		1761	11.41	10.84	-3.83	***
Length of relationship firm-financ inst (years)	320	5.73	4.89	136	6.01	5.15	-0.28		1761	8.99	6.99	-2.98	***
Top 25% credit score (dummy)	330	0.15	0.36	136	0.17	0.38	-0.01		1761	0.38	0.49	-0.21	***
D&B credit score	325	3.03	1.38	132	2.88	1.45	0.16		1756	3.97	1.45	-1.09	***

Significance levels : * : 10%   ** : 5%   *** : 1%

Table 2.3: Bivariate probit with selection

Variable	**Coefficient**	**(Std. Err.)**
Outcome: probability to be financed		
Owner total personal wealth	0.00019***	(0.00005)
Firm bankruptcy	-0.92867***	(0.14538)
Firm delinquencies	-0.11668***	(0.01679)
Debt on total asset	-0.01719***	(0.00308)
Profit after taxes (th $)	0.00017***	(0.0004)
Debts on equity	-0.00314**	(0.00125)
D&B credit score	0.21683***	(0.01414)
Firm family owned	-0.36618***	(0.11222)
Intercept	0.64264***	(0.13060)
Selection: firms that apply		
Owner total personal wealth	-0.000001***	(0.000001)
Firm bankruptcy	-0.58388***	(0.12112)
Firm delinquencies	-0.10935***	(0.01337)
Debt on total asset	-0.00555***	(0.00192)
Profit after taxes (th $)	0.00024***	(0.00002)
Debts on equity	-0.00064**	(0.00031)
D&B credit score	0.16939***	(0.01134)
Firm family owned	-0.65371***	(0.05062)
Distance from 1st institution	-0.00021**	(0.00010)
Intercept	1.20594***	(0.07157)
rho	0.74244**	(0.26385)

Significance levels : * : 10% ** : 5% *** : 1%

Table 2.4: Summary statistics of predicted probabilities

		Pr(apply)				**Pr(financed=1—apply=1)**			
	Obs	Mean	SD	Min	Max	Mean	SD	Min	Max
Firms that apply	1872	0.87	0.10	0.03	1.00	0.93	0.08	0.07	1.00
Financed firms	1742	0.88	0.10	0.03	1.00	0.94	0.07	0.40	1.00
Discouraged firms	304	0.79	0.12	0.01	0.97	0.85	0.12	0.00	1.00
Denied firms	130	0.80	0.12	0.31	0.97	0.85	0.13	0.07	1.00

Table 2.5: Average distance for high and low probability of being financed with respect to the median

Categories of firms	**All sample**		**<95.6%**		≥ 95.6%	
	Obs	Mean	Obs	Mean	Obs	Mean
Discouraged	319	34.94	286	33.86	33	44.30
Applicants	1985	26.55	990	20.83	905	32.82
Difference				13.03		11.49

Significance levels : * : 10% ** : 5% *** : 1%

Table 2.6: Average distance for high and low probability of being financed with respect to the median

Categories of firms	**All sample**		**<95.6%**		≥ 95.6%	
	Obs	Mean	Obs	Mean	Obs	Mean
Discouraged	319	34.94	286	33.86	33	44.30
Denied	1985	26.55	118	32.27	18	34.44
Difference				1.59		9.86

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Table 2.7: Average distance for high and low probability of being financed with respect to the mean

Categories of firms	**All sample**		**<93.6%**		≥ 93.6%	
	Obs	Mean	Obs	Mean	Obs	Mean
Discouraged	319	34.94	256	18.50	63	101.76
Applicants	1985	26.55	733	17.78	1162	32.08
Difference				0.71		69.68 ***

Significance levels : $*$: 10% $*$: 5% $***$: 1%

Table 2.8: Average distance for high and low probability of being financed with respect to the mean

Categories of firms	**All sample**		**<93.6%**		≥ 93.6%	
	Obs	Mean	Obs	Mean	Obs	Mean
Discouraged	319	34.94	256	18.50	63	101.76
Denied	136	32.56	99	15.68	37	77.73
Difference				2.82		24.03

Significance levels : $*$: 10% $**$: 5% $***$: 1%

Chapter 3

The signaling role of trade credit on loan contract: an endogenous switching approach

3.1 Introduction

Trade credit is widely used as source of financing and many studies report that it is the most important source of short-term external finance. Elliehausen and Wolken (1993) report that in 1987 trade credit accounted for about 15% of the liabilities of non-farm non-financial businesses in the United States, and for small businesses this percentage was about 20% of their liabilities. Rajan and Zingales (1995) report that in 1991 trade credit (estimated using account payables) amounted to 15% of total assets for a large sample of non-financial US firms. In the sample used by Aktas et al. (2012), which contains non-financial, US, listed firms between 1992 and 2007, trade credit represents an average of 8.22% of total assets. Mian and Smith (1992) report that trade credit comprised 26% of the total debts of non financial firms listed on the NASDAQ at the end of 1992. The importance of trade credit as a financing source also applies outside of the US. In France, for example, trade credit represents four times the value of short-term financing by financial institutions (Kremp, 2006). Marotta (2005) shows that trade credit finances on average 38.1% of the input purchases of non-rationed italian firms and 37.5% of rationed ones. This large usage of trade credit is surprising if we compare the cost of trade credit with the other alternative short-term financial resources. In fact, Cuñat (2007) pointed-out the equivalent one-year interest rate of a "two part" contract is about

44%. The reasons of the relative importance of trade credit have been investigated by many scholars. The existing literature can be divided in two main fields: non-financial theories and financial theories. The main discussion among the financial theories is whether trade credit is a substitute or complement of bank credit. Along the same lines as this strand of the literature this paper analyzes the relationship between trade credit and bank credit. While the majority of past researches focused on the substitution role of trade credit, only few theoretical and empirical research have exploited its complementary motif. On the theoretical perspective Biais and Gollier (1997) argue that trade credit is used to reduce the information asymmetry between firms and bank, thus acting as a complementary financing resource. With asymmetric information and without the possibility of financing trough trade credit firms are not able to receive credit. Therefore trade credit acts as channel for good firms to signal their quality to the bank. Burkart and Ellingsen (2004) argue that both complementary and substitution effect are inside the use of trade credit depending on the firms' aggregate debt capacity. Several research attempted to find the empirical evidence of the substitution or complementarity between trade and bank credit. Most of the research focus on the substitution role while a small empirical literature have answered the question about its complementarity. Our purpose is to test the complementarity resulting from the Biais and Gollier (1997) model. According to their model firms decide whether to use trade credit or not depending on the expected outcome in the bank credit market and bank decides whether to extend credit depending on what they observe in the trade credit market. In order to carry on the test we need an estimation methodology that accounts for the simultaneity of the two interdependent decisions. We use a switching regression approach in which the decision to use trade credit depends also on the anticipated outcome in the bank credit market. Our contribution to the existing literature on the complementarity hypothesis is toward the following direction. The paper is the first that test both the assumption and the equilibrium properties of the Biais and Gollier model, accounting for the endogeneity arising from the simultaneous decisions of bank and firms.

3.2 Theoretical and empirical background

The literature on financial theories of trade credit focuses on its relationship with bank loans in presence of credit market imperfections, which cause financial institutions to ration credit to their customers. According to many empirical studies (Petersen and Rajan, 1994, 1997; Danielson and Scott, 2004; Demiroglu et al., 2012) bank credit and trade credit are substitute as there is evidence that firms demand and/or receive more trade credit when they find difficult to obtaining bank loans. These these studies are based on the hypothesis that loan availability affects the demand for trade credit, but clearly it could be also the case that is the amount of trade credit that influence the decision of the bank to deny or extend credit.
The studies by Petersen and Rajan (1994, 1997) represent the most comprehensive analysis on credit availability and trade credit. Their detailed studies analyze both the demand and the supply of trade credit with the aim to empirically assess the different theories of trade credit without focusing on any particular question. Petersen and Rajan (1994) assume exogeneity of bank credit as a result of the pecking order theory according to which given the higher cost of trade credit, this source of financing is used only when bank credit becomes unavailable. For example, trade credit may be used especially during periods of financial distress (Wilner, 2000; Cuñat, 2007). However other studies show that trade credit is not necessarily more expensive than bank credit (Marotta, 2005; Miwa and Ramseyer, 2008), and hence the assumption of exogeneity of bank credit is questionable.
Danielson and Scott (2004) address this issue. They estimate whether credit availability affects firms' trade credit demand through a simultaneous equation system. Their results confirm that the relative importance of trade credit among the other financing sources increases when bank loans are not available. Petersen and Rajan (1997) model trade credit demand as a function of trade credit supply, the firm's total demand for credit, the bank credit availability and the price of bank credit. They employ a simultaneous equation model finding a negative relation between firm-banking relationship and trade credit demand. They also identify that trade credit demand and loan denials are positively, albeit not statistically significant, cor-

related. The interpretation of this result is difficult to reconcile with the hypothesis of substitution between trade credit and bank credit, as it arises when there are weak firm-bank relationship, but not when the firm has been turned down by the bank. If the strength of bank relationship affects the likelihood of loan approval and thereby also inversely the trade credit demand, as point out by Danielson and Scott (2004), there is an underlining collinearity when both banking relationship strength and loan denial variables are included to explain trade credit. This may explain why the above results are such contradictory.

These empirical contributions neglect some important issues. First, there is no direct evaluation of the role of information in the substitutability between the two financing resources. In addition, if there is asymmetric information, it could be the case that the decision of using trade credit conveys some information on the firm quality that affects both the bank decision to extend credit and the contractual terms of the loan. Moreover, in such framework where trade credit is a complement of bank credit, another source of endogeneity may arise. The decision to use trade credit may be driven by firms expectation about loan approval and interest rate charged.

The theoretical foundation for this argument is provided by Biais and Gollier (1997) according to which trade credit can alleviate bank credit rationing due to asymmetric information between banks and firms. When trade credit can be used and if seller have sufficient expected future cash flow to pledge as collateral, there exist an equilibrium where sellers extend trade credit to their customers only if they have received a good signal, and where the positive information contained in the availability of trade credit induces the bank to also lend, if it also has received a good signal. In such situation trade credit plays an important role because it is a credible way for the seller to convey its private information to the bank. If the seller is willing to extend trade credit, and thus to bear the default risk of the buyer, it must be that it has good information about the latter. On observing this, the bank updates positively its beliefs about the buyer, and therefore agrees to lend. Trade credit enable the private information of the seller to be used in the lending relationship, and this additional information can alleviate credit rationing due to adverse selection. On the same wake, Burkart and Ellingsen (2004) set up a theoretical model which implies that bank credit and trade credit can be either substitutes or complements. A salient result of the model is that the availability of trade credit increases the amount that banks are willing to lend. For a given bank loan, additional trade credit permits the borrower higher level of diversion as well as investment. Anticipating that available trade credit boosts investment rather than diversion, banks are willing to increase their lending. Hence, bank credit and trade credit are complements for firms whose aggregate debt capacity constrains investment. By contrast, for firms with sufficient aggregate debt capacity, trade credit is a substitute for bank credit.

This complementarity hypothesis has been studied empirically only by few papers. Cook (1997) tests the signaling role of trade credit in a sample of Russian firms using a probit model to estimate the probability to obtain bank credit, where trade credit enters in the estimation as an exogenous variable. In this estimation the direction of causality runs from trade finance to bank finance, but the possibility that the decision to use trade credit is endogenous is not taken into account. Alphonse et al (2006) address the endogeneity of trade credit using a simultaneous equation model. They propose to link the complementarity effect and the substitutability effect to different classes of small businesses. They argue that firms that benefit from long term banking relationship have no incentives to use trade credit: for these firms only the substitution hypothesis should be relevant. On the contrary, for firms with poor banking relationship, also the complementary hypothesis becomes relevant, because some firms of good quality use trade credit to signal themselves.

In this paper we test the complementarity between trade credit and bank credit employing a different approach with respect to the previous research. Following the theoretical result of Biais and Gollier (1997), we try to disentangle the endogeneity that exists between bank credit availability and trade credit using and endogenous switching regression model. This approach enable us to:

i. evaluate the role of information in the relation between trade credit credit and bank credit;

ii. take into account possible treatment effects arising from the use of trade credit.

3.3 The relationship between trade credit bank credit

Biais and Gollier (1997) argue that trade credit is used to facilitate firms with valuable project to obtain financing and thus reducing credit rationing. Although their definition of credit rationing differs slightly from the original one by Stiglitz and Weiss (1981), their model still sheds light on the relationship between credit market breakdown and asymmetric information. In Biais and Gollier (1997) framework credit rationing occurs if the bank charges an interest rate higher than the cash flow generated by the investment. At this interest rate good firms are not willing to undertake the project even if its NPV is positive. Such situation arises when asymmetric information does not allow the bank to identify between good and bad firms and there is a large fraction of bad firms, or the signal the bank receives is quite imprecise. The model implies that asymmetric information between banks and firms can be reduced if firms are able to finance a fraction of their investment through trade credit. Despite the fact that trade credit is more costly than bank credit, it is used to convey the private information held by the sellers to the banks and thus reducing credit rationing due to adverse selection. Our purpose is to carry on an empirical test of the "Biais and Gollier (1997) model". In the following we describe some of predictions that we want to test.

1. **Decision to use trade credit.**
   Firms which do not suffer from credit rationing do not use trade credit, while firms for which asymmetric information generates credit rationing react by using trade credit.

2. **Bank interest rates and delayed payment price.**
   With asymmetric information, if only bank credit is available the interest rate charged by the bank is so high that good firms are not willing to undertake the project. In such situation delayed payments may be extended by the seller to the buyer, allowing firms to finance part of their investment through trade credit. This arise when the seller and the bank simultaneously receive a good signal about the quality of the firm and thus they both extend trade credit and bank credit respectively to the firm. With trade credit, the bank interest

rate is lower compared to the one without it. At this rate good firms and bad firms with two good signals obtain financing.

Denoting P_{TC} the delayed payment price of the seller, r_{B_TC} the interest rate charged by the bank conditioned on observing trade credit is extended, and r_P the pooling interest rate charged by the bank, when bank is the only source of financing, we have the following relationship between prices:

$$r_P > P_{TC} > r_{B\_TC} \tag{3.3.1}$$

Notice that without asymmetric information the model implies that the interest rate charged on a good firm $r_{B|g}$ is equal to the bank's cost of funds r, and the following relationship holds:

$$r_P > P_{TC} > r_{B\_TC} > r_{B|g} \tag{3.3.2}$$

3. **Amount of trade credit.**

   There exists an interval for the optimal amount of trade credit, where there is not collusion between agents. For amount of trade credit below the lower-bound of such interval, sellers and buyers can collude, while for amounts above the upper-bound banks and buyers can collude. Thus, outside of this interval no signaling role of trade credit takes place. Therefore, in order to alleviate credit rationing not only it is sufficient for firms to signal themselves using trade credit, but such amount must be high enough but not too large.

4. **Probability to obtain financing**

   The model explains that firms that suffer from asymmetric information use costly trade credit to obtain bank credit which otherwise would not be granted; moreover it is necessary a certain amount of trade credit in order to be financed. Therefore, there exist an implicit probability to be financed which, for a firm where asymmetric information is relevant, depends both on the decision to use trade credit and on the amount of trade credit extended. On the other hand, when there is not asymmetric information the probability to obtain financing is 1 for good firms and zero for bad firms. Thus, conditional that a certain amount of trade credit has been extended, for those firms the probability to receive bank credit is 1 while for firms that do not use trade credit this probability is less than 1. The explanation is the following: firms for which the bank observes that trade credit is extended always receive bank financing; these are all the firms able to signal themselves as good, (which include both good firms and bad firms with good signal). On the other hand, firms for which the bank is able to recognize their quality do not use trade credit. The probability to be financed for this group is less than one, because it includes both good and bad firms.

3.4 Empirical setting

The data we use come from the 2003 NSSBF (National Survey of Small Businesses Finances) conducted by the Board of Governors of the Federal Reserve System. Detailed information of this dataset are given in section 2.7.3. In the survey there is also a section regarding the use of trade credit by firms. We use this information together with the information on bank financing to study the relationship between trade credit and bank credit. In particular we use the information whether the firm used trade credit or not during the last year and the information whether the firm has been financed by the bank in the last three years, and if yes, what was the interest rate charged by the bank. As explained in the previous section we want to test whether the use of trade credit has an effect on the contractual terms between bank and firm and on credit rationing. According to the theoretical model of Biais and Gollier (1997) our hypothesis is that firms that use trade credit are those that suffer from relevant information asymmetries and thus they may experience credit rationing. These firms might use trade credit in order to access financing. On the other hand, firms whose characteristics are fully observed do not need to use trade credit to obtain financing. All firms, regardless of whether they use trade credit or not, apply for bank financing and some of them obtain credit at a given interest rate. Our empirical analysis aims to test whether there exists a relationship between the decision to use trade credit, the probability to obtain financing and the interest rate charged by the bank (cost of credit). We argue that the decision on the use of trade credit may affect the other results, i.e. the probability to obtain financing and the cost of credit, in a different way depending on whether the firm uses trade credit or not. At the same time firms decide whether to use trade credit comparing their expected outcomes in terms of cost of credit and probability to obtain credit in the two choices. As already discussed, according to Biais and Gollier (1997), the decision to use trade credit will be undertaken by firms in order to signal themselves as of good quality, to be financed at an affordable interest rate. We define these firms as opaque firms. Indeed, if they do not signal themselves, they will be charged a higher interest rate and thus they will be rationed. On the other hand, we define transparent firms those that decide to not use trade credit because they are better off in terms of expected outcome not choosing it. In the data we observe the interest rate only for firms that obtain credit for both trade credit users and non-users. However, for trade credit users we cannot observe the interest rate they would have paid in case they had not chosen to use trade credit. Viceversa for firms that chose not to use trade credit. Thus, in order to carry on the empirical test of the Biais and Gollier model we need to construct such counterfactual. This analysis allows us to test:

1. whether the self-selection decision affects the interest rate;
2. if this decision is a way to drive private information from the more informed agent (the seller) to the less informed one (the bank).

As we explain in section **??** we use either a switching regression and an endogenous switching regression model.

3.4.1 Empirical assessment of the Biais and Gollier predictions

In this section we describe how we are going to implement and test the prediction of section 3.3:

1. **Decision to use trade credit**

   In our empirical test we model this decision as follow. According to the above definition, we assume that there are two group of firms: opaque firms and transparent firms. The decision to use trade credit depends on the group they belong. Opaque firms are more likely to use trade credit than transparent firms. Thus, when we observe that a firm did not use trade credit we consider it as a firm which characteristics and creditworthiness are fully observed by the bank. On the contrary, we consider a firm that used trade credit as a firm whose characteristics and creditworthiness are not fully observed by the bank.

2. **Bank interest rate and trade credit price**

   In our empirical analysis, assuming that good transparent firms will be financed without using trade credit, we expect to find, for these firms, an interest rate lower than that payed by firms that use trade credit. Moreover, we expect that firms self-select according to their quality and transparency in one of the two "tracks". In particular we expect a negative correlation between the interest rate and the decision not to use trade credit, while we expect a positive correlation between the interest rate and the decision to use trade credit. We expect that firms that choose to use trade credit do so because are better off in terms of lower interest rate than not using it. In fact, as explained above, in case they do not use trade credit they will be charged the pooling interest rate, which is the highest rate in the market. Clearly, we cannot observe the pooling interest rate on the data because at this rate no exchange takes place, but with some non very restrictive assumptions we are able to construct this counterfactual exploiting the features of the switching regression model, as will be explained in the next section **??**.

3. **Probability to obtain financing**

   We estimate the probability to be financed for the two groups of firms conditional on having used or not trade credit. We expect that the probability to be financed for firms that use trade credit is higher than that of the other group. Moreover we also expect an effect of the self selection on this probability. Precisely we expect that the use of trade credit increase the probability to be financed, while the fact of not having used trade credit reduce this probability.

3.4.2 Model set-up

We want to investigate whether trade credit is a complementary source of financing of bank credit. According to the implication of the Biais and Gollier (1997) model firms decide whether to use trade credit or not depending on the expected outcome in the bank credit market. On the other hand, bank decides whether to extend credit taking into account what they observe in the trade credit market. The estimation methodology should take into account the interdependence of the two simultaneous decisions. In order to test whether the decision to use trade credit affects the bank interest rate we cannot use a direct method, because we do not observe the interest rate that would have been charged if firms had chosen not to use trade credit. In this situation the errors in the trade credit equation and those in the interest rate equation are correlated. As suggested by Li and Prabhala (2007) this situation is a problem of self-selection, in which the use of trade credit captures some unobserved heterogeneity in firm quality, and hence creditworthiness, bringing to light information on creditworthiness privately held by the firms. Therefore, the self-selection is not the only reason why it is important to consider the decision on the use of trade credit. If trade credit conveys information of the supplier of trade credit to the bank about the quality of the firm, banks would apply different interest rate, depending on whether they observe selection into trade credit or not.

We model the decision to use trade credit as follow:

$$TC_i^* = Z_i\gamma + v_i \tag{3.4.1}$$

where TC represents the value from using trade credit, Z is a set of trade credit determinants, γ is a vector of parameters and v is the error term. TC^* is a latent variable with the following index function:

$$TC = \begin{cases} 1 \quad if \;\; Z_i\gamma + v_i > 0 \\ 0 \quad if \;\; Z_i\gamma + v_i \leq 0 \end{cases} \tag{3.4.2}$$

We model the cost of bank credit (R) separately for the two cases as a function of a set of loan rate determinants X:

$$R_{TC,i} = X_i\beta_{TC} + u_{TC,i} \tag{3.4.3}$$

$$R_{NTC,i} = X_i\beta_{NTC} + u_{NTC,i} \tag{3.4.4}$$

where β are vectors of parameters, and u are the error terms. We observe R_{TC} when $TC = 1$, but in this case R_{NTC} is not observed, latent or missing. Similarly, we observe R_{NTC} when $TC = 0$, in which case R_{TC} is not observed. We assume that there is interchangeability across states.

This model consisting of equations 3.4.2-3.4.4 cannot be estimated directly because the observed interest rate is a conditional outcome and depends on the chosen alternatives. The empirical estimation requires a switching regression approach. Because of the failure to observe R_{TC} when $TC = 0$ and R_{NTC} when $TC = 1$ we need to write the expected loan rates for a firm using trade credit who self-selects into trade credit. If u and v are bivariate normal we have:

$$\begin{aligned} E(R_{TC,i}|TC = 1) &= E(R_{TC,i}|TC^* > 0) \\ &= E(R_{TC,i}|v_i > -Z_i\gamma) \\ &= X_i\beta_{TC} + E(u_{TC}|v_i < Zi\gamma) \\ &= X_i\beta_{TC} + \sigma_{TC,v}\frac{\phi(Z_i\gamma)}{\Phi(Z_i\gamma)} \end{aligned} \tag{3.4.5}$$

where ϕ is the pdf of the standard normal distribution and Φ is the cumulative density function. The results follows due to the truncation of the distribution of R_{TC} from below. Similarly, the expected cost of credit for those not using trade credit is:

$$\begin{aligned} E(R_{NTC,i}|TC = 0) &= E(R_{NTC,i}|TC^* \leq 0) \\ &= E(R_{NTC,i}|v_i \leq -Z_i\gamma) \\ &= X_i\beta_{NTC} + E(u_{NTC}|v_i \geq Z_i\gamma) \\ &= X_i\beta_{NTC} - \sigma_{NTC,v}\frac{\phi(Z_i\gamma)}{1 - \Phi(Z_i\gamma)} \end{aligned} \tag{3.4.6}$$

which follows from the truncation of R_{NTC} from above. The functions $\lambda_{TC,i} = \frac{\phi(Z_i\gamma)}{\Phi(Z_i\gamma)}$ and $\lambda_{NTC,i} = -\frac{\phi(Z_i\gamma)}{1-\Phi(Z_i\gamma)}$ are the inverse Mills ratio, and they represent the conditional expectation of v given the selection into trade credit or not respectively.

The procedure is to estimate in the first stage the following equation:

$$TC_i = Z_i\gamma + v_i \tag{3.4.7}$$

From equation 3.4.5 we obtain the linear predictions, $Z_i\widehat{\gamma}$ which are used to calculate λ_{TC} and λ_{NTC}.

Employing this switching model we control for self-selection and obtain consistent estimates of β_{TC} and β_{NTC} estimating the equations **??** and **??** by OLS. The strength of this model is that it allows for a clear interpretation of the sign of the inverse Mills ratio, as it tells us the direction of the selection. In addition we are able to verify some of the theoretical predictions of the Biais and Gollier (1997) model:

1. the statistical significance of the coefficient associated to the inverse Mills ratio captures the self-selection effects associated with the choice of using trade credit;

2. the sign of the coefficient of the inverse Mills ratios identifies the benefit in terms of cost of credit for those that use trade credit compared to non-users;

3. the variables λ_{TC} and λ_{NTC} are an estimate of the private information underlying the firm choice, and the test of the significance is a test of whether private information possessed by the firm explains ex-post results (cost of bank credit) (Li and Prabhala, 2007).

If the choice of using trade credit conveys information about the quality of the firm, it is likely that the trade credit decision depends on the expected outcomes in terms of cost of credit. Following this argument we model the decision to use trade credit assuming that it depends on the expected difference in the cost of credit $R_{TC} - R_{NTC}$. This allows for an identification of the treatment effect that trade credit has on interest rate. Following the procedure developed in Lee (1978) we include as a determinant of the trade credit decision in equation 3.4.5 the cost of credit difference for the two groups:

$$TC_i = Z_i\gamma + \delta(R_{TC,i} - R_{NTC,i}) - v_i \tag{3.4.8}$$

The selection into one of the two groups now depends on both exogenous and outcome variables. The estimation procedure suggested by Lee (1978) and described in Maddala (1983) is to substitute equations 3.4.3 and 3.4.4 into equation ??. This gives the following reduced-form:

$$TC_i = Z_i^* \gamma - v_i^* \tag{3.4.9}$$

where the matrix Z^* includes all the variables that determine the trade credit decision as well as the determinants of the cost of credit. From the estimation of equation ?? using a probit model we obtain the inverse Mills ratios:

$$\begin{aligned} \lambda_{TC,i} &= -\frac{\phi(Z_i^* \widehat{\gamma})}{\Phi(Z_i^* \widehat{\gamma})} \\ \lambda_{NTC,i} &= \frac{\phi(Z_i^* \widehat{\gamma})}{1 - \Phi(Z_i^* \widehat{\gamma})} \end{aligned} \tag{3.4.10}$$

Then we estimate by OLS the loan rate equations augmented by the inverse Mills ratio, and we obtain the predicted values for $\widehat{R}_{TC,i}$ $\widehat{R}_{NTC,i}$, that we substitute into equation ??, to get consistent estimates of the parameters γ and δ. The statistical significance of parameter δ captures possible treatment effect associated with the use of trade credit.

3.5 Results

3.5.1 The switching model

We start estimating the standard switching model in equations ??-3.4.5. The set of Z variables includes:

i. Liquidity on total asset;

ii. Firm profit (thousands dollars);

iii. dummy =1 if sales increased in the last three years;

iv. Firm age (years);

v. Inventory of merchandise or production materials on total asset

vi. Loans on total asset

Liquidity on total asset and the growth of sales are measures that account for the transaction use of trade credit. We expect that the higher is the share of liquid asset the less likely the firm uses trade credit. Conversely, when sales are growing we expect that likelihood of observing trade credit also increases. Firm profit may be considered a proxy for firm cash flow only in case profit is not distributed. We expect that trade credit is negatively correlated to profit when a large share of profit is retained, because, for the pecking order argument, firms prefer to rely less on external finance. On the other hand, when profit are largely distributed, then we could expect that the larger is the size of profit the higher is the need for other sources of financing, such as trade credit. Petersen and Rajan (1997) argue that for small firms firm age is a proxy for experience in the business. Some projects may be feasible after and adequate level of experience is achieved. However, for larger firms investment opportunities may decline in firm age (Petersen and Rajan, 1997). Given that, it is difficult to identify the way firm age determines the use of trade credit. Inventories are a proxy of working capital needs that positively influence trade credit. In order to account for firm capital structure we include the ratio of loans on total asset.

To estimate the loan rate equation we use a set of X variables that includes the following regressors. A dummy equal one if firm post collateral, which we expect negatively correlated with the interest rate, as widely agreed in the literature. Loan characteristics affect the cost of credit. Given that it is likely that a fixed interest rate is associated with a higher cost of credit, we include a dummy equal one for fixed interest rate, that we expect to affect positively the cost of credit. We also include the dummy equal one if the loan is a mortgage. To consider possible bank local market power we include a dummy equal one if the Herfindahl-Hirschman bank deposit index of local banking market concentration is greater than 1800 (i.e. highly concentrated). Credit score can be used to signal quality to the bank and may have an effect on interest rate. To measure this effect we include a dummy equal one if firm credit score is in the top 25% of the distribution. The literature provide wide evidence of the positive relationship between entrepreneur experience and firm profit. To catch the managing experience effect we include the number of years of the principal owner's managing experience. We expect a negative effect on interest rate as we expect that a greater experience is positively correlated to higher profit and hence generating a higher probability of success for the firm. The literature reports evidence that entrepreneurs that belong to a minority group rely more heavily on their own funds to finance a start up. We include two dummies: the first is equal one if the principal owner is black, the other is equal one if the owner belongs to other minority groups (asian, hispanic, asian pacific, native american). Firm's proprietorship characteristic may have some effect on credit availability and loan contract due to different agency costs compared to those of non-family owned firms. To control for proprietorship effects we include a dummy equal one if firm is family owned. To account for difference in the monitoring cost we include the distance in miles of the firm from the bank. Finally, to measure the impact of firm financial structure on the loan contract, the ratio of debt on total asset is included. We follow the estimation procedure described above. We first estimate equation 3.4.5 and we obtain the inverse Mills ratio λ_{TC} and λ_{NTC}. Then we estimate the equations for the cost of credit augmented by including the inverse Mills ratios. Results are reported in tables 3.1-3.3. In the standard switching model a positive sign for the coefficient of λ_{TC} means that there is a positive correlation between the unexplained factors that affect cost of credit and those that affect the choice to use trade credit. In both loan rate equations (tables 3.2 and 3.3) the inverse Mills ratios are positive and significant. This result implies that the mean loan rate for those who use trade credit is higher than population average for trade credit users, while the mean loan rate for those that do not use trade credit is lower than their group population average. This is in line with the theoretical predictions: the firms that use trade credit have a cost of credit above average both using and not using trade credit, but are better off using trade credit than not using it. Firms that do not use trade credit would be better off if they use trade credit compared to those firms that actually use trade credit. Estimation also shows that the negative effect of posting collateral on loan rate is higher for firms not using trade credit. This further corroborate the idea that less opaque firms, that do not need to use trade credit, have a lower cost of credit. In addition, we confirm that there is a selection effect in the use of trade credit.

3.5.2 The endogenous switching model

To take into account the endogeneity between the use of trade credit and the cost of credit we estimate the endogenous switching model in which the decision to use trade credit is given by the reduced form in equation **??**, from which we obtain the inverse Mills ratio. The equation of the cost of credit augmented by the inverse Mills ratios are then estimated. Finally we estimate equation **??** substituting back the predicted values for the cost of credit for the two types. As in a simultaneous equation system we need to specify the instruments to identify the model. This means that we need at least one exclusion restriction that determines whether a firm chooses to use trade credit but that does not determine the cost of bank credit. As exclusion restriction we include the percentage of unused line of credit in the Z^* variable set in trade credit equation **??**. We consider this choice appropriate because proximity to the line of credit limits proxies tightness in the use of short term funds and it is likely that this affects the decision to use trade credit. On the contrary, the interest rate charged by the bank on the most recent loan it is likely that it does not depend on the amount of unused line of credit. We report the results of the estimation of equation **??** in table 3.4. The parameter δ is positive and significant showing that expected treatment effect influences the decision to use trade credit.

3.6 Conclusions

In this chapter we aimed to shed light the relationship existing between trade credit and bank loan. The literature links the financial motif of trade credit to the information asymmetries in the credit market. In such framework, in which asymmetric information may induce banks to ration their customers, trade credit is used as a substitute or a complementary source of financing for bank credit. While most of the empirical evidence focused on the substitution hypothesis, little evidence has been found on the complementarity hypothesis. We test this latter hypothesis stemming from the theoretical model of Biais and Gollier (1997) according which trade credit is used to alleviate credit rationing due to asymmetric information. This has implication on the firms' financing probability and also on the interest rate charged by the bank. We use an estimation methodology that takes into account the endogeneity between the use of trade credit and the loan contract offered by the bank in equilibrium. We then test the effect of such decision on the bank interest rate.

Employing a switching regression approach we found that the information disclosure brought conveyed by the use of trade credit is statistically significant in the loan rate equation. In addition we show that firms that use trade credit experience a loan rate which is above average, while those that do not use it have an equilibrium loan rate below average.

Employing an endogenous switching approach we identify the treatment effect of trade credit on interest rate. We found that the decision to use trade credit is significantly linked to difference in the expected interest rate. Our results provide support to the empirical predictions of the Bias and Gollier (1997) model.

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Table 3.1: Probit estimation of the choice of trade credit Dep = Dummy=1 if firms uses trade credit

Variable	Coefficient	(Std. Err.)
Liquidity on total asset	-0.097713**	(0.017514)
Profit (thousands of $)	7.000000*	(3.000000)
Dummy =1 if firms increased sales wrt three years before	0.246238**	(0.021285)
Firm age (years)	0.014766**	(0.000922)
Inventories on total asset	1.065808**	(0.057429)
Loans on capital asset	0.002902**	(0.000879)
Intercept	0.162478**	(0.021377)
N	3418	
Log-likelihood	-9358.068651	
$\chi^2_{(6)}$	916.939936	

Table 3.2: Loan rate for firm using trade credit

Variable	Coefficient	(Std. Err.)
Inverse Mills ratio (λ_{TC})	1.769890**	(0.232175)
Dummy=1 if firm posted collateral	-0.512068**	(0.062099)
Dummy=1 if Fixed interest rate	1.194754**	(0.062035)
Dummy=1 if lending was a mortgage	0.343116**	(0.108555)
Banking market concentration: Dummy=1 if Herfindahl index> 1800	0.316046**	(0.060399)
Dummy=1 if firm's Credit score is top 25%	-0.056805	(0.062064)
Owner managing experience (n. of years)	-0.011544**	(0.003110)
Dummy=1 if Owner is black	0.684874*	(0.322687)
Dummy=1 if Owner belongs to an ethnic minority other than black	0.769304**	(0.126786)
Dummy=1 if firm is family owned	0.050192	(0.071715)
Distance of firm from bank (miles)	0.001109**	(0.000389)
Debt on total asset	0.024389†	(0.013251)
Intercept	4.701048**	(0.166636)
N	1313	
R^2	0.10	
$F_{(12,1300)}$	63.67	

Table 3.3: Loan rate for firm not using trade credit

Variable	Coefficient	(Std. Err.)
Inverse Mills ratio (λ_{NTC})	1.736449**	(0.419005)
Dummy=1 if firm posted collateral	-0.695271**	(0.168521)
Dummy=1 if Fixed interest rate	1.517521**	(0.162350)
Dummy=1 if lending was a mortgage	0.494262*	(0.233305)
Banking market concentration: Dummy=1 if Herfindahl index> 1800	0.134714	(0.156812)
Dummy=1 if firm's Credit score is top 25%	-0.754977**	(0.167238)
Owner managing experience (n. of years)	-0.043942**	(0.007954)
Dummy=1 if Owner is black	1.090756*	(0.459153)
Dummy=1 if Owner belongs to an ethnic minority other than black	1.769291**	(0.297931)
Dummy=1 if firm is family owned	-0.214935	(0.203530)
Distance of firm from bank (miles)	-0.002973	(0.002643)
Debt on total asset	0.047347	(0.043484)
Intercept	8.924585**	(0.516182)
N	242	
R^2	0.21	
$F_{(12,229)}$	27.09	

Table 3.4: Probit estimation of the choice of trade credit with endogenous switching. Dep variable: Dummy=1 if firms uses trade credit

Variable	Coefficient	(Std. Err.)
$R_{TC} - R_{NTC}$	0.255493**	(0.028012)
Liquidity on total asset	-0.541250**	(0.076296)
Profit (thousands of $)	0.000013†	(8.000000)
Dummy =1 if firms increased sales wrt three years before	0.125804**	(0.033824)
Firm age (years)	0.001679	(0.001631)
Inventories on total asset	0.648494**	(0.092031)
Unused line of credit on total asset	-0.024971†	(0.014656)
Intercept	0.886131**	(0.043922)
N	1697	
Log-likelihood	-726.61	
$\chi^2_{(7)}$	95.66	