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Abstract

Microcredit has been proposed as a tool for poverty reduction. However, little is known about the way banks determine loans terms and if the credit supplied is enough to satisfy demand. This paper, firstly, proposes a theoretical model to analyse microcredit interest rates and amounts. Secondly, the model predictions regarding loans' size are tested using a disequilibrium model and data from a developed country with a growing market. It is found that banks actively adjust loan amount to client and macroeconomic risks, and that credit rationing was high, even though declining as the market developed. Finally, policy implications are derived.

Keywords: loans terms, default risk, asymmetric information, microcredit, business starts

JEL: G21, O16.

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1. INTRODUCTION

Microcredit refers to the credit granted by financial institutions to poor or social excluded persons, who do not have access to the formal banking system. This credit is normally given in small amounts (25,000 euro or less - Mark and Tilleben, 2007), borrowers present a reduced or null collateral and is used to start a small business. Sometimes, the collateral is replaced by a system of group lending, where the group is responsible for the credit of all members (Stiglitz, 1990). Microcredit is seen as a way of empowering poor people to get out of the poverty trap without using government social policy. On the policy side, the European Commission acknowledges microcredit as a important tool for promoting employment and social inclusion.

Despite microcredit has started in less developed countries, it also exists in transition and developed economies. In these countries the goal of microcredit continues to be helping the poor to improve their social and economic conditions. In Europe, microcredit started in the 1990s, and therefore microlenders have few years of experience. The exceptions are the UK and France were microcredit institutions exist since the 1980s. In Eastern Europe microcredit has also been growing since the 1990s, and there has proved to be a flexible financing instrument to explore new business opportunities (de Aghion and Morduch, 2000).

In developed countries, one of the main ways of offering microcredit is through collaboration between banks and non-for-profit organizations (Jayo et al., 2009). In the country studied in this paper, Portugal, this is precisely the case, with commercial banks cooperating with the Portuguese microcredit association (*Associação Nacional de Acesso ao Crédito* - ANDC) to offer microcredit loans. This association is not profit-oriented and its main aim is to facilitate the access of individuals to credit. ANDC does not directly grants credit, but it technically assists individuals to obtain credit from banks with which it has formal agreements. More recently, in Portugal banks are also offering microcredit autonomously but at higher interest rates than the ones charged through ANDC. The microcredit market operating through ANDC, which we be the focus in this paper, can then be labelled a social microcredit market, with lower interest rates and directed more to social excluded individuals without access to the formal banking system.

In the context of the overall credit market, the microcredit segment is not important in quantitative terms, but it has a role in promoting social and economic inclusion of less favoured individuals. The banks offering microcredit are the major players in the overall banking market and, as they argue, are present in the microcredit niche mainly for social reasons.

In this paper, our goal is to study how banks determine the loan amount in microcredit using a database of ANDC for the period 1999-2009. Even though this topic has not been very studied in the literature, it is rather important. Indeed, it is relevant to know banks' motivations

when fixing the loan amount, if there is credit rationing, the effect of competition, and the way banks react to macroeconomic environment. Micro borrowers are very concerned with loans' availability (Porteous, 2006) and, in general, liquidity constraints in the first year of trading are very important for firm's survival (Saridakis et al., 2013).

Given this, we start by developing a model with asymmetric information to understand how banks determine the conditions of microcredit loans. After and given the possibility of credit rationing, we make use of a disequilibrium model to estimate both credit demand and credit supply. In the literature there are some works estimating credit scoring models for microcredit loans, but to our knowledge this is one of the first papers doing an econometric modelisation of microcredit loan's size using data on individual clients.

This paper is organized as follows. Section 1 develops a theoretical model for the determinants of the interest rate and amount of microcredit loans. Section 2 proceeds to test empirically the predictions of the model. Finally, Section 3 concludes.

2. THE MODEL

In this section, we develop a model with asymmetric information in order to understand the determinants of micro-loans interest rate and amount. As in Chemmanur and Fulghieri (1999), there is a risk-neutral entrepreneur who needs financing in order to undergo a new project. Given the project's small dimension, the entrepreneur's only option is bank financing. The model to be considered has two periods. At time *t=0*, the firm is financed, and at time *t=1*, the investment pays back. If the project is not carried out, it is lost forever.

2.1 Private information and investment technology

The quality of a firm is one of two possible types: either good ($q=G$) or bad ($q=B$). The two types of firms have different default rates: the default rate of the good firm (d_G) is smaller than the default rate of the bad firm (d_B). There is asymmetry of information because the firm's type is known by the entrepreneur but not by the bank.

The cash flow generated by the project is proportional to the investment done. Let ι denote the amount invested in the new project at *t=0*. We assume that there is a critical value I for the amount invested above which no additional value is created. The time *t=1* cash flow is thus given by the following investment technology that is known by the entrepreneur and the bank:

$$v(\iota) = k\iota, for\ \iota < I;\ v(\iota) = kI, for\ \iota \geq I,$$

Thus, it turns out that no entrepreneur will invest an amount larger than I.

2.2 The outsiders' evaluation technology

An essential assumption is that the bank does not know the type of the firm that asks for financing, but it can make an evaluation of the firm's quality at some cost, *c*.

The result of the evaluation process is denoted by e and it may be either good ($e=g$) or bad ($e=b$). The evaluation technology is the same for all banks and the accuracy of an evaluation is not complete. One may evaluate a firm, and still not be sure which is the firm's type. We model the precision of such technology as:

$$\Pr(e = g|q = G) = 1. \Pr(e = g|g = B) = y. 0 < y < 1.$$

While it is assumed that a good firm gets always a good evaluation, a bad firm may get either a bad or a good evaluation. When investors produce information about a bad type firm, a fraction *y* of them obtains good evaluations, and a fraction (*1-y*) obtains bad evaluations. Naturally, the precision of the evaluation technology increases as y decreases.

The outsiders' evaluation cost depends on two factors. First, it is determined by the amount of information available to the bank about the entrepreneur and his project. Hence, the evaluation cost decreases as more information is accessible to the bank about its client. Second, firms belonging to industries intrinsically more difficult to evaluate have a larger evaluation cost. The first factor is related to information availability, whereas the second factor is related to the difficulty in processing information.

2.3 The bank

We assume that there is a risk-neutral bank that can finance in full the project. The bank offers two contracts to the entrepreneur. One contract where the bank evaluates the project and sets an interest rate depending on the evaluation obtained, and another without information production. In reply, the entrepreneur can choose among one of the contracts or abandon the project.

Between banks there is Bertrand competition, implying that a bank expected profit is zero:

$$E(\pi) = \left(1 + r^l\right)\rho I - (1 + r^m)I - cI = 0$$

, where r^l is the lending rate, ρ the entrepreneur's probability of surviving, r^m is the opportunity cost of bank's funds given by the interbank market rate, and *c* is the evaluation cost proportional to the size of the loan. Therefore, the lending rate defined by the bank is:

$$r^l = \frac{1 + r^m + c}{\rho} - 1$$

Notice that the entrepreneur's probability of surviving has a negative effect on the loans rate. In Section 2.5 we will explain how this probability is obtained attending to the evaluation process.

2.4 Characterization of the equilibrium

The decision to finance the new project may be seen as a game where players are the entrepreneur and the bank. The Perfect Bayesian Equilibrium (PBE) of this game consists of (i) a choice by the bank of the financing contracts to offer to the entrepreneur (with the interest rate, amount financed, and with or without information production); and a (ii) decision by the entrepreneur accepting any contract offered by the bank or deciding not to undergo the project.

In order to characterize a PBE, each of the above choices must fulfil the following conditions: (i) the choices of each agent maximize its objective function, given the equilibrium beliefs and choices of others (sequential rationality); (ii) the beliefs of all players are consistent with the equilibrium choices of the others and these beliefs are formed, along the equilibrium path, using Bayes' rule (beliefs consistency) [2]; (iii) deviations from equilibrium strategies by any agent are suboptimal.

2.5 Contract with information

If the entrepreneur decides to accept a contract with information production, the bank makes the evaluation. After observing the outcome of that process, the financial institution defines the interest rate to offer.

Let φ denote the proportion of good type entrepreneurs in the market. Under no additional information, φ reflects the initial belief about the probability that an individual is type good. If the bank conducts the evaluation of the firm, its initial belief will be updated using the Bayes' rule:

$$\Pr(q = G|e = g) = \frac{\Pr(q = G \cap e = g)}{\Pr(e = g)} = \frac{\phi}{\phi + y(1-\phi)} > \phi$$

$$\Pr(q = G|e = b) = 0$$

The probability that a firm is type good and, simultaneously, is evaluated as good, $\Pr(q = G \cap e = g)$, is equal to the prior probability assessment of the firm being of type good (G), ϕ. The probability that the evaluation is good, $\Pr(e = g)$, is equal to the probability of a right evaluation, ϕ - that occurs when the firm is good - plus the probability of a wrong evaluation,

2 Out-of-equilibrium beliefs are determined by Bayes' rule and the investors' equilibrium strategies.

$y(1-\phi)$- that may occur when the firm is bad. If the evaluation is bad, there is no possibility of the firm being type good, because we assumed that a good firm has always a good evaluation. The bank will use this new information to update its belief regarding the default probability of the firm. If the evaluation has a bad outcome, then the bank knows for sure that the firm is bad and the probability of default (*def*) assigned to the firm is d_B. The probability of surviving is simply $\rho_{eb}=1-d_B$. In this case, the bank offers to the firm the interest rate:

$$r_{eb}^{l} = \frac{1+r^{m}+c}{\rho_{eb}} - 1$$

The entrepreneur's profit is $kI - r_{eb}^{l} I$. It is assumed that the project rate of return, k, is sufficiently high to ensure that the entrepreneur has at least zero profit: $k \geq r_{eb}^{l}$.

If the evaluation is good, there is still some uncertainty about the firm's type:

$$\Pr(def|e=g) = \frac{\Pr(def \cap e=g)}{\Pr(e=g)}$$

$$= \frac{d_G\phi + d_B(1-\phi)}{\phi + y(1-\phi)} = d_G \frac{\phi}{\phi + y(1-\phi)} + d_B \frac{d_B(1-\phi)}{\phi + y(1-\phi)}$$

The first element in the numerator comes from the fact that all good firms receive a good evaluation and their default rate is d_G. The second element in the numerator can be justified because a fraction *y* of bad firms receives a good evaluation and their default rate is d_B.

Given that the firm has a good evaluation, the probability that the bank assigns to its surviving is simply: $\rho_{eg} = \Pr(def|e=g)$. Is this situation the bank offers the firm the interest rate:

$$r_{eg}^{l} = \frac{1+r^{m}+c}{\rho_{eg}} - 1 \quad (1)$$

Since the probability of default if the evaluation is good is between d_G and d_B[3], the probability of surviving of a firm that gets a good evaluation is larger than the one of a firm that gets a bad evaluation. Therefore, the bank offers a lower interest rate to the former than to the latter: $r_{eg}^{l} < r_{eb}^{l}$. This implies that the good entrepreneur has a positive profit.

3 The probability of default is a linear convex combination of d_G and d_B.

2.6 Unconditional price contract

When the bank does not conduct an evaluation of the firm, the interest rate is determined using the prior probability ϕ. The bank's expectation about the firm's probability of default is: $\phi d_G + (1-\phi)d_B$. In this case, the expected probability of default is larger than if the firm receives a good evaluation (since $\phi < [\phi + y(1-\phi)]$, but is smaller than if the firm receives a bad evaluation. The interest rate offered by the bank will not include the evaluation cost and is given by:

$$r_u^l = \frac{1+r^m}{\rho_u} - 1$$

In this case, the interest rate is more favourable for the entrepreneur than in the case of a bad evaluation. This means that both types of entrepreneurs will have a positive profit with the unconditional price contract.

2.7 Contract choice by the entrepreneur

The bank always finances the full amount *I*, because the loan remunerates its capital at an adequate rate. Therefore, the entrepreneur's choice depends only on the interest rate and not on the amount financed in each contract. The good entrepreneur chooses the contract with information when $r_{eg}^l < r_u^l$. This last condition will be fulfilled if the cost of information is not too high (Proposition 1).

In turn, a bad firm can choose between pooling and separating from good firms. The pooling situation enables the bad type firm to obtain a lower interest rate. If a bad firm chooses to separate, the best deviating contract is the one where it offers an unconditional price contract while the good type firm offers a contract with information. In this case the entrepreneur will not conduct an evaluation of the bad firm, which reduces the interest rate charged to this firm.

Suppose now that the bad entrepreneur chooses to pool with the good firm choosing a contract with information. By trying to mask as a type good firm, the type bad firm aims to get better financing conditions. The bad firm will have a good evaluation with probability *y*, and a bad evaluation with probability (*1-y*). Thus, the interest rate that the firm expects to pay is:

$$yr_{eg}^l + (1-y)r_{eb}^l$$

The bad entrepreneur will pool with good firms only if it pays a lower interest rate than in the separating equilibrium, which occurs if:

$$r_u^l > yr_{eg}^l + (1-y)r_{eb}^l.$$

For the pooling equilibrium to exist it is necessary that the evaluation costs are not too high. The consistency of the pooling equilibrium is guaranteed by the following out-of-equilibrium beliefs: if any entrepreneur offers the bank a contract with other parameters than those specified in the equilibrium contract, the bank infers with certainty that the firm's type is bad.

Proposition 1 (Market Equilibrium)

If the evaluation cost is sufficiently low, $c < c_v$, and the project return is sufficiently high, $k \geq r_{eb}^{l}$, then there is a pooling equilibrium where (i) both good and bad firms accept the contract with information production offered by the bank, the financing amount is *I* and interest rates are $\{r_{eg}^{l}, r_{eb}^{l}\}$and (ii) the bank is willing to finance firms.

The content of this proposition is quite intuitive. The bank offers the entrepreneur two contracts: one with and another without information production. The bank finances the project in full and adjusts the interest rate of each contract according to the information it obtains.

Good entrepreneurs have advantage in choosing contracts with information because they will always be identified as good. When good entrepreneurs choose the contract with information, bad entrepreneurs mimic them choosing the same contract. This may induce the bank in mistake and allow the bad firm to enjoy a low interest rate. Since bad entrepreneurs may be identified as such, their financing conditions are worse on average than those of good entrepreneurs. The fact that a project is sufficiently productive ($k \geq r_{eb}^{l}$), ensures that even if an entrepreneur gets a bad evaluation, he will have at least a zero profit. Finally, entrepreneurs choose the contract with information production since information is not too expensive ($c < c_v$).

In what follows we characterize how, in equilibrium, the interest rate charged by the bank in compensation for financing the firm depends on model's parameters.

Proposition 2

In equilibrium, the interest rate offered by the bank increases with (a) the cost of evaluating the project, *c*; (b) the bank's cost of financing, r^m; and (c) the probability of default of the entrepreneur ($d_B$or d_G). A decrease in the precision of the evaluation technology (an increase in *y*), increases the interest rate in the case of a good evaluation, but does not affect the interest rate to be offered in the case of a bad evaluation.

Let us provide the intuition for such results. Regarding (a), if *c* increases, the bank has to support larger evaluation costs, and a thus a larger interest rate will be required to finance the firm. This result allows an interesting conclusion about the role of ANDC. In a first stage, this

association, with its deep knowledge of the microcredit sector, helps the entrepreneur to prepare the project for bank evaluation, gathering information on its viability and also on the entrepreneur. This information is then passed to the bank when ANDC requests the financing of the project. This action reduces the cost of information for banks, contributing to reduce the interest rate charged to entrepreneurs.

Result (b) follows from the fact that if the bank has a higher financing cost, it has to charge a higher interest rate to maintain its profit level.

An increase in the probability of default reduces the expected profit of the bank. To protect its profitability, the bank is forced to increase loan's interest rate.

A change in information precision also affects the interest rate. When a firm gets a good evaluation, a decrease in the precision of information (an increase in *y*) increases the expected default rate assigned by the bank to the firm. This leads the bank to increase the interest rate charged to these firms. However, when the firm gets a bad evaluation, the bank knows for sure that the firm is type bad. In this case, the information's precision does not have any impact on the bank's expected default rate and on the interest rate.

2.8 Assuming projects with small productivity

An important assumption that was made above was that projects are sufficiently productive to pay the interest rate in the case of a bad evaluation ($k \geq r_{eb}^{l}$). That may not occur in microcredit projects, because some of them typically have a small rate of return. Sometimes the main concern of projects is not economic return, but the social integration of the entrepreneur. If the bank has to reduce the interest rate up to the point where the project has zero profit ($r_{eb}^{l} = k$), the bank would have a negative profit. [4] If that is the case, the pooling equilibrium may not exist.

In general, the microcredit entrepreneur has few managerial skills and an increase in investment's size and complexity, implies an increase in the probability of default. Such relation was validated empirically by Schreiner (2004). If the default rate depends positively on the amount of investment, the bank may still be interested in financing the project in an amount smaller than *I*. For concreteness, we assume that $d_G = \overline{d_G} + aI$ and $d_B = \overline{d_B} + aI$, with $a > 0$ and $I < (1 - \overline{d_B})/a$ to ensure d_B and d_G smaller than one. [5]

We have then for the firm with a bad evaluation:

$$\rho_{eb} = \bar{\rho}_{eb} - aI,$$

with $\bar{\rho}_{eb} = 1 - \overline{d_B}$. For the firm with a good evaluation, we have instead:

4 Notice that banks are operating at a zero economic profit.
5 If the project is not undertaken (I=0), then naturally $d_G = 0$ and $d_B = 0$.

$$\rho_{eg} = \bar{\rho}_{eg} - aI,$$

with $\bar{\rho}_{eg} = \overline{d_G}\frac{\phi}{\phi+y(1-\phi)} + \overline{d_B}\frac{y(1-\phi)}{\phi+y(1-\phi)}$.

If the firm gets a bad evaluation, the bank's expected profit is

$$E(\pi) = \left(1 + r_{eb}^{l}\right)(\bar{\rho}_{eb} - aI) - (1 + r^{m})I - cI. \quad (2)$$

If the bank lends *I* and sets the interest rate in order to have a zero expected return, the entrepreneur has a negative profit. Therefore, the maximum interest rate that the bank can set is $r_{eb}^{l} = k$, which insures a zero profit for the entrepreneur. However, at that interest rate banks' profit is negative. [6]

The only alternative for the bank is to reduce the amount granted up to the point where it has a zero expected return at the interest rate $r_{eb}^{l} = k$, which from equation (2) implies:

$$I = I_v = \frac{\bar{\rho}_{eb}}{a} - \frac{1 + r^{m} + c}{(1 + k)a}$$

By reducing the amount granted, there is a decrease in the expected default rate that improves bank's profit. Regarding the projects with a good evaluation, we continue to assume that they are able to pay the interest rate that ensures a zero expected profit for the bank that lends I, ie, $k > r_{eg}^{l}$. This implies that they are financed in the full amount *I*.

Proposition 3

If r_{eb}^{l} from eq. (1) is larger than *k* and $k > r_{u}^{l}$, the evaluation technology is not precise enough ($y > y_1$), and the evaluation cost is sufficiently low, ($c < c_1$), then there is a pooling equilibrium where (i) the bank finances firms, offering to a firm with a good evaluation a contract $\{I, r_{eg}^{l}\}$ and to a firm with a bad evaluation a contract with $\{I_v$<I, $r_{eb}^{l} = k\}$ (ii) both good and bad firms accept the contract offered.

The latter proposition shows that, when bad firms are not sufficiently productive, the bank has to ration credit to firms that get a bad evaluation in order to guarantee that the financing is profitable for the bank and the firm. The evaluation technology cannot be too precise ($y > y_1$), otherwise type bad firms would prefer the separating equilibrium, where they can get financed in the full amount *I*.

6 With the interest rate r_{eb}^{l} from eq. (1) the bank has a zero profit. If it reduces the rate to $r_{eb}^{l} = k$ its profit becomes negative.

3. EMPIRICAL TEST

3.1 The context of analysis

In the empirical part of this paper, we analyse the credit granted by Portuguese banks in collaboration with the main Portuguese microcredit association (ANDC), in the period 1999-2009. [7] This period covers the birth and development of the microcredit market in Portugal. From 1999 to 2005, only one bank granted loans, and from 2006 two more banks entered the market, leading to an increase in competition.

ANDC is a non-for-profit association that aims to fight poverty by promoting business initiative with microcredit. This association receives the original project from small entrepreneurs without access to the formal banking system, and helps them do prepare the business plan. Then, the plan is delivered to a bank, which decides or not to finance the project. If the project is financed, ANDC also advises the client during the implementation and management of the project. This is used as a replacement of the usual group monitoring present in microcredit (de Aghion and Gollier, 2000). Loans granted are small, with a maximum of 10,500 euro. Even though collateral is not mandatory, it is demanded a guarantor for a minimum of 20% of the capital. This works as a collateral substitute, which is common in microcredit programs (Morduch, 1999). In articulation with ANDC, all banks charge the same interest rate to each client, which is the Euribor 6 months plus a spread (Alves, 2010). [8] This explains why our focus is on the determination of the loan amount. [9]

3.2 Credit rationing and the determinants of loan amount in the literature

If all borrowers are treated equally in terms of interest rate, the same does not occur in terms of the loan amount. The model developed in Section 2 (Proposition 3) shows that in microcredit high risk (*i.e.* type bad) borrowers may be credit rationed, receiving a loan smaller than they desire. The literature on credit rationing and credit risk focus mainly in developing countries. The study of Schäfer et al. (2010) for Kazakhstan shows that wealthier and less risky clients tend to receive larger loans. Schreiner (2004) shows that characteristics of the borrower, such as sex or experience as a borrower are important determinants of the default rate. Namely, in the microcredit literature there is evidence that women have historically a smaller rate of default in developing countries, which leads banks to favour them (Schreiner, 2004; Marrez and Schmit,

7 Our period of analysis stops in 2009 because we do not have data on industry defaults and sales from that year onwards.

8 In other markets this practice is also common, as is the case of the Belgium market (Cayrol et al., 2010)

9 Proposition 3 may be adapted to accommodate the situation were both the type good and type bad entrepreneurs are charged the same interest rate. In this case, the type bad entrepreneur would have a smaller loan than when his interest rate is k.

2009). Nevertheless, Brana (2011) found discrimination against women in France. Dutta and Magableh (2006) find credit rationing in the microfinance market of Jordania. Andersson et al. (2011) also found that shrimp farmers in Bangladesh using formal microcredit lenders are more credit-constrained than the ones using informal lenders, due to the informational disadvantage of formal lenders. Given that this literature focus mostly in developing countries, its conclusions may not be directly applied to a developed country as Portugal, and in what follow we will assess empirically whether they are valid in this market.

3.3 Empirical methodology and variables

In order to admit the possibility of credit rationing, it is considered the following disequilibrium model of the credit market (Atanasova and Wilson, 2004; Kremp and Sevestre, 2011):

$$c_i^d = \beta_1 \boldsymbol{x}_{1i} + \varepsilon_{1i}$$
$$c_i^s = \beta_2 \boldsymbol{x}_{2i} + \varepsilon_{2i}$$
$$c_i = \min(c_i^d, c_i^s)$$

, where c_i^d is credit demand, c_i^s credit supply, and c_i credit traded. Credit demand and supply are not observed, while credit transactions are observed. Vectors $\boldsymbol{x}_{1i}$ and $\boldsymbol{x}_{2i}$ are the explanatory variables of credit demand and credit supply respectively, and ε_{1i} and ε_{2i} are zero mean normal error terms with variances σ_1 and σ_2 and correlation ρ.

Now consider the normal density and distribution functions of loans, which if demand is observed are $f_d(c_i) = \phi(c_i - \beta_1 \boldsymbol{x}_{1i})$ and $F_d(c_i) = \Phi(z_{1i})$, with

$$z_{1i} = \frac{1}{(1-\rho^2)^{\frac{1}{2}}}(w_{2i} - \rho w_{1i}),$$

$w_{1i} = (c_i - \beta_1 \boldsymbol{x}_{1i})/\sigma_1$ and $w_{2i} = (c_i - \beta_2 \boldsymbol{x}_{2i})/\sigma_2$. If supply is observed, we have $f_s(c_i) = \phi(c_i - \beta_2 \boldsymbol{x}_{2i}$, $F_s(c_i) = \Phi(z_{2i})$, with

$$z_{2i} = \frac{1}{(1-\rho^2)^{\frac{1}{2}}}(w_{1i} - \rho w_{2i}).$$

Madala and Nelson (1974) and Madala (1983) show that the likelihood distribution for c_i is:

$$l(c_i) = \frac{1}{\sigma_1} f_d(c_i)\big(1 - F_s(c_i)\big) + \frac{1}{\sigma_2} f_s(c_i)(1 - F_d(c_i))$$

The model can be estimated by full-information maximum likelihood.

Another interesting issue is whether an entrepreneur suffers credit rationing. Following Gersovitz (1980) and using unconditional probability, it is necessary to assess the probability that $\Pr(c_i^d > c_i^s) = \Pr(\beta_1 \boldsymbol{x}_{1i} + \varepsilon_{1i} > \beta_2 \boldsymbol{x}_{2i} + \varepsilon_{2i})$, where the error terms have normal distributions. A firm is considered credit rationed when $\Pr(c_i^d > c_i^s) > 0.5$.

A better alternative is to use the probability of credit rationing conditional on the observed amount of credit, which assumes the form of

$$\Pr(c_i^d > c_i^s | c_i\ ) = \frac{f\prime_d(c_i)(1-F_s(c_i))}{f\prime_d(c_i)(1-F_s(c_i))+f\prime_s(c_i)(1-F_d(c_i))} \qquad (3)$$

where $f'_d(c_i) = \frac{1}{\sigma_1} f_d(c_i)$ and $f'_s(c_i) = \frac{1}{\sigma_2} f_s(c_i)$. A firm is credit rationed when that probability is larger than 0.5.

We use a sample of loans that were actually granted to micro-entrepreneurs, for which we have information on the amount of credit, the interest rate and other characteristics at the moment the credit was granted. This means that we are ignoring the entrepreneurs that were fully rationed and which were not able to get any credit.

The variables used to explain credit demand (vector $\boldsymbol{x}_{1i}$) were unemployment rate, GDP, growth in industry sales, interest rate and characteristics of the entrepreneur and project (descriptive statistics are in Table 2). Regarding the two latter elements, we considered schooling, labour market experience, sex, dummy for immigrant, dummy for entrepreneurs sponsored by a non-for-profit institution, and dummies for each industry. The projects were grouped in 11 activities using industry codes (*CAE*) and with the concern of creating representative and meaningful groups of activities (Table 1 below).

Unemployment rate and real GDP are introduced to capture the effect of aggregate macroeconomic conditions on the demand for credit. In an expansionary phase of the business cycle it is expected an increase in the demand for loans. The growth in industry sales is considered to capture the effect of industry conditions on credit demand. Loans interest rate is an usual variable in explaining credit demand. The entrepreneur and project characteristics may also affect demand. For instance, entrepreneurs with more years of school or labour market experience may create more complex projects, which demand larger loans. Dummies for each industry are considered to control for differences in credit demand across industries.

In turn, to explain credit supply we used some of the variables also present in credit demand: real GDP, and characteristics of the entrepreneur and project. Additionally, we introduced the following variables: industry default rates, and the accumulated number of

clients of the bank granting the loan. Next, we explain the reason behind the choice of the variables.

Section 2's model shows that in some circumstances bad firms receive less credit than good firms, because microcredit projects are not sufficiently profitable for banks to charge high interest rates to bad firms. In other words, in microcredit banks may choose to adjust the amount of credit to the risk level of the project instead of adjusting the interest rate (in the theoretical model the risk is captured by the type of the firm). Consequently, all the variables that affect credit risk may affect the amount of credit granted to a specific customer, namely the GDP, industry default rate, and characteristics of the borrower.

GDP is used as explanatory variable to translate macroeconomic conditions that affect the odds of business success. Outside the microcredit literature Bonfim (2009) and Bhattacharjee et al. (2009), for example, study the impact of macroeconomic conditions on firms' credit risk and survival, respectively. It is expected that in a scenario of macroeconomic deterioration, banks decrease the amount lent.

In turn, industry default rate translates the risk associated with the industry. The specific risk of the project is captured by the characteristics of the project and entrepreneur, namely by schooling, labour market experience, and dummy for immigrants. In the microcredit market, where projects are normally start-ups with no historical financial information, it is difficult to assess credit risk in a quantitative and formal way. Banks have to rely instead on the life history of the borrower and in a qualitative assessment of the "soft" skills and attitude of the entrepreneur (Mark and Tilleben, 2007). It is expected that banks see more educated individuals as having better management ability and better capacity to understand market evolution, and therefore being associated with a smaller rate of default. It has been found that financial education during secondary education promotes sound financial management in adulthood (Bernheim et al., 1997) and that education is related with entrepreneurial activity (Thompson et al., 2010).

Additionally, more labour market experience may be associated with better capacity to manage a business, implying a lower risk of default. This is especially true because many entrepreneurs start a business in a field where they have worked previously. Experience was measured using a proxy given by Minserian experience: age minus years of schooling minus six. [10] As seen above the sex of the borrower can also be important for default risk. The fact that the

10 This measure overstates the true labour market experience since an individual may have been unemployed.

borrower is an immigrant may also increase credit risk, because they tend to have less knowledge of the local economy and culture.

The accumulated number of microcredit clients since 1999 of the bank granting credit translates the experience of the bank in the new microcredit market. When they enter the market for the first time, banks may be fearful of granting large loans, since microcredit is normally seen as high risk segment. As banks increase their experience in this market and improve the perception of the real risk involved, they will adjust the amount of loans granted.

GDP and unemployment were obtained from the National Statistical Office (INE). Industry default rate and the growth of industry sales were calculated for all the industry based on *Quadros de Pessoal* (*Ministério da Solidariedade e da Segurança Social*) using five-digit industry codes (*CAE* in the Portuguese statistical classification). *Quadros de Pessoal* is a Linked Employee Employer Database that includes all private firms, offering information on the number of workers, sales and surviving of firms. The industry default rate is the proportion of firms that closed in a given industry. The growth of sales translates the industry annual percentage growth of sales. These variables were not available for 2003 and 2007 due to a change of industry codes in those years.

3.4 Empirical results

In this section we analyse the empirical results obtained by estimating the disequilibrium model for the microcredit market. The correlations between variables are low, and the estimation results are in Table 1. In terms of credit demand, we observe as expected that GDP has a positive effect, with a 400 million euro increase (around 1% of the average quarterly GDP in the sample) having an effect of 148 euro (2.8% of the average loan in the sample). Unemployment rate also has a positive effect on demand: 1 percentage point (p.p.) increase in that rate increases credit demand by 331 euro (6.2% of the average loan). On the one hand, taking into account that in a period of increasing unemployment, business survival will be less likely, the latter effect is surprising. But, on the other hand, as unemployment increases, employment alternatives for entrepreneurs in the labour market decrease, leading them to invest more in their own micro-businesses.

Table 1 – Demand and supply of credit

	Demand				Supply		
Variables	Coef.	Std.Err.	p-val.	Variables	Coef.	Std.Err.	p-val.
GDP	0.3786	0.0837	0.0000	GDP	0.4484	0.1079	0.0000
Unemployment	331.6738	123.9656	0.0075	Industry default rate	2180.936	1863.778	0.2419
Change in Industry sales	-69.2886	293.8352	0.8136	Intitut. sponsor	517.7315	499.6289	0.3001
Interest rate	-6430.602	2927.842	0.0281	Experience	3.9313	9.0507	0.6640
Intitut. sponsor	566.1975	687.4325	0.4101	Women	-596.202	193.5640	0.0021
Experience	1.9433	7.2374	0.7883	Schooling	124.0293	30.4636	0.0000
Women	210.9288	295.1738	0.4749	Immigrant	-174.600	273.2949	0.5229
Schooling	-25.8245	55.1908	0.6398	Bank' clients	-0.4327	0.3209	0.1775
Immigrant	-266.3806	196.3961	0.1750	Constant	-12993.8	4254.491	0.0023
Tech. activities	-520.8741	309.3582	0.0922				
Constant	-11115.02	3275.080	0.0007				
(…)							
Obs.: 1031		Log likelihood: -8946.525					
Demand variance: 952.462***(65.891)		Supply variance: 2078.618*** (134.125)			Correlation between demand and supply: 0.399 (1.0346)		

Note: In the demand equation we included more 10 industry dummies that come out non-significant: Agriculture, Wholesale trade, Retail trade, Communications, Construction, Cultural activities, Education, Clothing industry, Support services, and Other. The base category is Restaurants

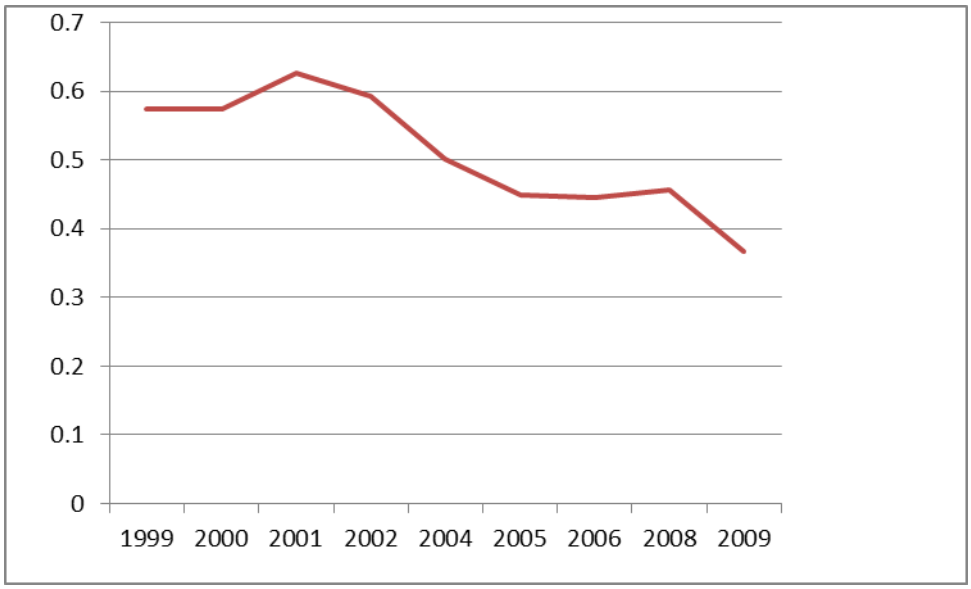
An increase in the interest rate originates a decrease in the demand for loans, because the cost of capital increases. Nevertheless, the impact is small, since 1 p.p. increase in the interest rate reduces loans demand by only 64.3 euro (1.2% of the average loan). The demand of credit is quite homogenous across industries, with only one dummy variable (the one for technical activities) being statistically significant at 10%. All the other variables considered do not present statistically significant results.

In terms of credit supply, the main prediction of the above model was that banks lend smaller amounts to clients with larger risk. This prediction is confirmed by the empirical model in two ways. Firstly, when macroeconomic risk increases, as translated by a decrease in GDP, banks reduce the size of loans. A reduction in quarterly GDP by 400 million euro reduces the loan amount by 180 euro (3.5% of the average loan). Secondly, an increase in the years of schooling of the borrower tends to increase the loan amount. An increase in one year of education increases the size of the loan by 124 euro (2.4% of the average loan). As discussed above, banks use this variable to assess clients' credit risk when deciding the amount of credit to grant. Despite these results, we did not find statistical significance for the industry default rate.
Also, financial institutions seem to discriminate slightly against women when deciding the amount of credit, since loans to women are on average 596 euro smaller than to men (which is

11.3% of the average loan). This goes in the direction of Brana (2011) who found discrimination against women in the amount of credit granted by France microfinance institutions. In contrast, the difference between immigrants and no immigrants is not statistically significant. Also, the remaining variables did not proved to affect loans supply.

Finally, confronting supply and demand of credit and using equation (3), there is a decline in the proportion of loans suffering credit rationing during the period 1999-2009 (Figure 1). We can point two explanations for this evolution. Firstly, as the market matured banks improved their understanding of the microcredit segment and of the true risk involved, and thus started lending larger amounts. Secondly, the entrance of more banks from 2006 may also have lead, after some years of adjustment, to a decline in credit rationing. The reduction of credit rationing in 2009 is even more impressing since macroeconomic conditions were much worse in that year than in previous years.

Figure 1 – Evolution of credit rationing



4. CONCLUSION

The main goal of this paper is to understand how banks determine conditions of loans in microcredit and to assess the extent of credit rationing. We started by developing a model to explain the interest rate and the amount of credit granted by microcredit institutions. The theoretical model predicts that banks grant larger amounts to clients with less credit risk.

We then tested empirically that model using the data on the Portuguese social microcredit market and focusing in the size of microcredit loans. This market is organised by a non-for-profit institution in collaboration with commercial banks. Our theoretical model shows that the work of that institution reduces the interest rate charged to clients, because it helps to reduce the banks' cost of information. Empirical results confirm that banks actively adjust loan amount to both clients and macroeconomic risk, offering larger loans to clients with higher level of education and in periods of higher GDP. We also found evidence of strong credit rationing in the market that however has been decreasing, probably due to the maturation of the market and the increment in competition between banks.

Results indicate that further competition should be promoted in the microcredit market in order to reduce interest rates. Our research also suggests that it is necessary further work on the determinants of default rates of microcredit loans.

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6. APPENDIX

6.1 Proof of Proposition 1

Let us look how we can reach to a pooling equilibrium where both types of firms choose the same contract $\{r_{eg}^l, r_{eb}^l\}$ contingent in the result of the evaluation, and the bank performs the evaluation.

Given the out-of-equilibrium beliefs, a firm (good or bad) may deviate from the pooling contract and identify itself as a bad firm. The best deviating contract is an unconditional price contract.

For the pooling equilibrium to exist, each entrepreneur should prefer the pooling contract to the best deviating contract. The good firm prefers the pooling contract to the unconditional price contract if

$$r_{eg}^l < r_u^l \Leftrightarrow c < c_1 = \left(\frac{\rho_{eg}}{\rho_u} - 1\right)(1 + r^m)I.$$

The bad firm prefers the pooling contract to the unconditional price contract if

$$y r_{eg}^l + (1 - y) r_{eb}^l < r_u^l$$

$$\Leftrightarrow c < c_2 = \left(\frac{\rho_{eg}\rho_{eb}}{\rho_u\left[\rho_{eb}y + \rho_{eg}(1 - y)\right]} - 1\right)(1 + r^m)I$$

The proof is completed with

$$c_v = min\{c_1, c_2\}.$$

6.2 Proof of Proposition 3

It is assumed that the firm receiving a good evaluation has a zero or positive profit: $k \geq r_{eg}^l$. Also, in the deviating contract, a good or bad firm has a zero or positive profit if $k \geq r_u^l$. These restrictions imply that in both of the previous cases banks finance the full amount *I*. We have to guarantee that the good firm is not interested in deviating from the pooling equilibrium: $r_{eg}^l < r_u^l$. This leads to the condition shown above: $c < c_1$. With this condition, imposing $k \geq r_u^l$ implies $k \geq r_{eg}^l$.

The pooling contract is preferable for the type bad entrepreneur if its profit is larger with this contract than with the deviating contract:

$$kI - r_u^l I < y\left(kI - r_{eg}^l I\right)$$

$$\Leftrightarrow \frac{k - r_u^l}{k - r_{eg}^l} = y_1 < y.$$

Notice that the bad firm has a profit zero when it receives a bad evaluation.

6.3 Descriptive statistics

Table 2 – Descriptive statistics

Variables	Mean	Std. E.	Min	Max	Variables	Mean	Std. E.	Min	Max
Loan	5129.7	1677.2	999.2	10000	Agriculture	0.033	0.181	0	1
GDP	39892.9	993.7	36829.7	41448.4	Clothing industry	0.033	0.181	0	1
Unemp. rate	7.27	1.75	3.7	10.1	Construction	0.052	0.222	0	1
Change industry sales	0.054	0.213	-0.986	0.965	Wholesale trade	0.048	0.214	0	1
Ind. default rate	0.131	0.0455	0	0.347	Retail trade	0.334	0.472	0	1
Interest rate	0.068	0.029	0.011	0.246	Restaurants	0.126	0.341	0	1
Institut. Sponsor	0.026	0.159	0	1	Communicat.	0.0281	0.165	0	1
Experience	20.45	11.01	0	58	Technical activities	0.0368	0.188	0	1
Women	0.521	0.499	0	1	Support services	0.0271	0.162	0	1
Schooling	9.08	3.63	0	16	Education	0.0271	0.162	0	1
Immigrant	0.145	0.352	0	1	Cultural activities	0.0242	0.153	0	1
					Others	0.2269	0.419	0	1