A panel data analysis of firms' access to credit in the Euro Area: endogenous selection, individual heterogeneity and time-persistence

Abstract

Using panel firm-level data from the "Survey on Access to Finance of Enterprises" (SAFE), we analyse the main factors affecting firms' access to bank credit during the period 2014-2015 in twelve Euro Area countries. We focus on firm's credit demand behaviour and on bank's actual decision of granting funds, using alternative measures of credit constraints and controlling for endogenous sample selection and individual heterogeneity. Furthermore, we explicitly introduce dynamics in both the equations of our bivariate model in order to properly account the persistence of credit constraints and loan demand over time.. Empirical results show that small and informationally opaque businesses, with deteriorated public support and credit history, experience greater difficulties in accessing to bank loans and also highlight the significant role of past credit restrictions on the current probability of obtaining additional credit. Firms having already experienced credit constraints are more likely to face further new financing obstacles, while enterprises that repeatedly recur to external finance seem to have improved access to credit to display more transparency and creditworthiness.

Keywords: Access to credit; credit constraints, panel data, dynamics, endogenous sample selection.

JEL Classification: C33; C35; D22; F34; G21; G32

1. Introduction

Bank lending has been recognized as a major driver of firms' growth and this is particularly true in areas such as Europe, in which the banking system represents the main provider of external financing.

It is a well-established finding that firms' access to credit is not homogeneous among enterprises, industries and countries. This credit misallocation, having reached the peak during the Global Financial Crisis, continues to leave behind a legacy hampering economic productivity and growth also in the more recent post crisis period.

Previous theoretical and empirical studies have highlighted prices and quantities as the two main channels through which credit constraints operate: lenders can act either on interest rates required for granting financing or on quantities by rejecting (totally or partially) borrower's application. One way or another, the result is a financing constraint that leads the firm to resize or renounce to its original investment project. Credit rationing determines a business contraction that may trap the firm in a harmful economic downturn (Levenson and Willard, 2000). In this view, it is reasonable to assume that credit access difficulties tend to persist of over time, as restricted firms may be more prone to be constrained again and locked into a long-lasting credit trap (Pigini et al., 2016).

The aim of this paper is to examine the drivers of firms' access to credit in the Euro Area during the recent post crisis period. A specific focus is reserved for the persistence of past restrictions as well as past recourse to bank credit on firms' chances of obtaining new finance. The empirical analysis is carried out using a sample of SMEs in the Euro Area that participated to the "*Survey on Access to Finance of Enterprises*" (SAFE) in the four half-yearly waves of the period 2014-2015. This survey provides detailed information on firms' economic and financial characteristics and the background, in which banks play a crucial role in explaining economic fluctuations and firms' investment dynamics, creates the conditions for centering our analysis on actual financial constraints. Further, its temporal structure allows us to investigate whether and to what extent there is persistence in the demand behavior and credit restrictions.

We are able to identify firms applying for credit and the result of loan granting decisions by banks. In doing this, we decide to construct a direct measure of credit rationing based on actual denials following a loan application. The survey allows us to distinguish completely rejected, amply and weakly restricted applications in order to build three indicators including, progressively, strong, medium and weak actual credit denials.

We estimate a bivariate probit model with endogenous sample selection using an unbalanced panel of firms accounting for unobserved heterogeneity through individual effects. Credit demand and rationing probabilities are estimated jointly, allowing a correlation between the processes

governing the request for banking finance and the lender's decision of granting or denying these funds. Then, we implement a dynamic specification in both equations of the model. We use Woolridge's (2005) approach to handle the initial conditions problem and generalized by Raymond et al. (2007) to models with sample selection.

This study contributes to the empirical literature on firms' access to credit in a number of ways. First, it analyzes credit allocation in a period characterized by a slow, but constant, recovery in which bank lending should represent a financial accelerator mechanism for SMEs' investments, but creditworthiness assessments seem to be still conditioned on the severe exacerbations of the Global Financial Crisis in the most of the Euro Area. Second, we find persistence in firms' demand behavior and credit constraints highlighting two major insights. Rationing exerts its effects not only in the current period with the loss of current business opportunities, but it reduces firms' future net worth, attractiveness and possibilities of obtaining new credit in the following periods. Further, the persistence in the recourse to bank lending contributes to decrease the probability of rationing. The constant use of external financing could be assimilated either to an underlying firm-bank relationship or to a hardening of soft information due to repeated transactions with different intermediaries which are able to share borrowers' credit histories. In both cases, it allows banks to know and monitor the borrower over time partially overcoming traditional information asymmetries of SMEs.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature on firm's access to credit. Section 3 describes data and the variables included in our empirical specifications. In Section 4 we present econometric methods, while estimation results are discussed in Section 5. Section 6 offers some concluding remarks.

2. Literature overview

2.1 Imperfect information in credit markets

In Europe, banking system represents the main channel to obtain external financing and determinants leading banks' credit allocation decisions have raised their importance. The European Union has demonstrated an increasing concern on firms' access to credit and its relationship with Euro Zone's general economic prosperity. This issue is particularly relevant for small and medium enterprises representing the core of the economic system. Hassan et al. (2017) highlight that financial capital misallocation represents an important determinant of low productivity and growth characterizing European periphery.

Literature highlights the well-known problem of imperfect information and frictions in credit markets causing asymmetries between lenders and borrowers (Akerloof, 1970; Williamson, 1975).

Asymmetric information has been the most prominent factor in theoretical and empirical literature on financing constraints. Lenders are able to reduce information asymmetries by screening and monitoring activities on the borrowers. Typically, firms and banks are not in the same informative condition when a new transaction sets up and the costs of searching for information is unbalanced between lenders and borrowers (Stigler, 1961). In this view, the time spent on producing and collecting information is of key importance. The information the bank can access fosters the identification of those borrowers presenting moral hazard and adverse selection risks (Diamond, 1984; Berger and Udell, 2002). Further, the quality and the rapidity of the information is crucial for succeeding in credit market (Elsas and Krahnen, 1998; Lehmann and Neuberger, 2001; Elsas, 2005). When the consequent adverse selection is not mitigated with the use of appropriate instruments, banks being unable to address their sources to the right projects may decide to reduce the supply for financing (Jaffee and Russell, 1976; Stiglitz and Weiss, 1981). This has appeared as the most pressing issue since the onset of the global financial crisis that has drastically reduced financial institutions' available sources and exacerbated creditworthiness assessments.

2.2 Measuring financing constraints

Literature recurred to different proxies of credit constraints based alternatively on perceptions, actual restrictions or inferring from firms' statements. It is divided on which of these best captures financial restrictions. The differences between these measures are not trivial. Fazari et al. (1988) derive proxies of rationing from readily available accounting variables such as cash-flow sensitivities and low dividends. Subsequently, rationing indicators from financial statements were refined with the inclusion of additional balance sheet items such as market-to-book, leverage and cash holdings (Kaplan and Zingales, 1997). Implicit in the argument is the assumption of drawing a useful indicator of financial constraints based on the jointed fluctuations of these balance sheet items. Lamont et al. (2001) estimate an ordered logit based on Kaplan and Zingales' classification (1997). The index increases in financial constraints and it is positively linked to market-to-book and leverage and negatively to cash flow, dividends and cash. Starting off by this approach, Hadlock and Pierce (2010) derive an additional index based on firms' size and age. Farre-Mensa and Ljungqvist (2015) question the reliability of these rationing proxies built with accounting data. They find no explicit match between firms typically classified as constrained and their behaviour displaying no trouble in raising debt and in increasing payouts to shareholders. In particular, findings based on traditional measures, relying on potentially endogenous firms' characteristics to identify constraints, may capture other unobservable differences such as the growth or financing policies. On the other hand, survey data allows to derive more precise measures of financial

constraints based on firms' perceived obstacles to credit access. Firms indicating access to credit among a set of potential problems as a relevant issue or, alternatively, ranking this issue at top level in a certain scale are considered as facing finance restrictions (Beck et al., 2006; Ferrando and Griesshaber, 2011; Canton et al., 2012). It is worth remarking that the reply may be based on the general perception of the respondent whose considerations on his/her possibility of access to credit may be distorted by own optimistic or pessimistic points of view that, in some cases, could be discordant with actual financial constraints (Ferrando and Mulier, 2015). Some surveys allow to derive direct measures of rationing which are based on firms' actual experience in applying for credit and the consequent acceptance or rejection of the application. With respect to indicators derived from perceptions or financial statements, a variable built on an actual experience allows to capture directly credit constraints without the possible biases from the indirect derivation of rationing proxies depicted above. Among others, Cox and Jappelli (1990) and Chakravarty and Scott (1999) investigate households credit rationing using such as indicators of actual credit restrictions based on survey-based data.

2.3 Types of credit rationing

Keeton (1979) proposed one of the first classifications of credit constraints distinguishing between two types of rationing. The first type occurs when some applicants receive a smaller loan than they applied for, even if they are willing to pay the quoted price. In the second type some applicants are randomly credit denied by lenders and they cannot be distinguished from applicants who receive loans. This classification is based on the assumptions that banks can observe the expected return of the project but borrower's probability of default is unknown. Thus, lender may deny credit for different reasons from creditworthiness. Jaffe and Stiglitz's classification (1990) accounts for the possibility that borrowers can access to a larger amount of sources if they are willing to pay a higher interest rate. In this context, the probability of default is positively linked to the loan size due to the fact that repayment conditions are increasing in the level of indebtedness. Further, considering that some borrowers obtain different treatments, their perceptions on financing terms are remarkably. In this framework, demand side is taken into account in order to define the possibility that borrowers self-resize their loan applications due to different degrees of risk aversion. In an additional hypothesis, banks can know both borrowers' probability of default and the expected return of the project. Decisions of granting credit are based on the risk-return relationship and investments presenting a lower return with respect to their risk profile are rationed. Finally, strong rationing rises up when frictions in information transmission are so relevant which do not allow banks to properly assess the creditworthiness of the application leading to the complete

rejection. More recently, Cieply and Dejardin (2010) redefined as weak rationed those borrowers which receive a limited part of the amount desired. It is a weak degree of rationing involving more or less burdensome constraints in the loan size granted. The other cases involve complete rejection even if borrowers are willing to accept higher prices and/or heavy non-price conditions and total acceptance when applications are entirely accepted and financed.

2.4 Discouragement and self-selection of credit demand

Starting off by Keaton's framework (1979), discouragement theory has been more recently developed focusing on the behaviour of the borrower and the relevance of its attitude to be affected by a number of factors in his/her choice of applying for credit. Freel et al. (2010) define these borrowers as a latent demand for bank debt. Self-rationing reduces and affects the demand size. Some potential borrowers could decide not to apply for when access costs to external financing are perceived excessive or unfair. In other cases, individuals may refrain from demanding because they anticipate a possible rejection. Kon and Storey (2003) place on the same level discouragement effect when information asymmetries are remarkable as direct banks' credit restrictions previously investigated in literature. Han et al. (2009) show that self-selection of demand leads to efficiency in US credit market in which more creditworthy firms are less likely to be discouraged when banking markets are concentrated and firm-bank relationships are relatively long.

Linked to this evidence is the relevance of properly analysing firms' access to credit taking into account the fact that observed credit demand does not include a latent proportion of discouraged firms. Brown et al. (2011) highlight the necessity of accounting for the selection process in order to correctly investigate the access to external financing intended as banks' choice of granting their available financial sources.

2.5 Persistency in firms' access to credit

An extensive empirical literature has focused on firms' access to finance investigating the main determinants of credit demand and supply. Very limited attention has been paid to the possibility of a lock-in effect due to having experienced credit restrictions over time. Dougal et al. (2015) find the spread on loans affects significantly the price a bank requires for granting additional funds. Pigini et al. (2016) investigating credit access conditions in Italy show a significant dependence on past states of rationing specifically for medium and large firms. This duration dimension of financial constraints is more commonly known as state dependence in access to credit and it was amply highlighted in literature (Heckman and Borjas, 1980; Heckman, 1981a). In a dynamic context, state dependence operates when a borrower having experienced a total or partial restriction in the past

encounters more difficulties in obtaining additional funds with respect to an identical firm which has never been constrained. The possibility of overcoming a credit restriction state depends on observed firm characteristics, unobserved heterogeneity and true state dependence. The former reflects canonical drivers amply investigated in literature such as business size, profitability, ownership structure, internal sources, type of activity. Unobserved heterogeneity involves undefined attributes that affects the possibility of obtaining credit but that does not depend on having experienced financial restrictions in the past, such as manager's ability, risk aversion and business opportunity. The true state dependence refers to the fact that having experienced credit restrictions has a genuine and direct effect on the likelihood of being credit restricted again (Heckman, 1981a). Genuine dependence is mainly linked to financial market imperfections and procedures of creditworthiness assessment. These two drivers are not mutually exclusive. A restricted access to credit in a period can prevent firms from investing on new business opportunities whose value decreases over time due to the arrival of other competitors (Levenson and Willard, 2000; Campello et al., 2010). At the same, financial constraints lead borrowers to cut off their production and it determines a decline in net worth of collateralizable assets reducing furtherly the probability of borrowing in the future. A second factor affecting state dependence is due to frictions in information transmission. Banks' screening and scoring technologies addressing the choices of granting access to credit are mainly based on tests and mathematical models. These automated procedures tend to maintain a memory on customers' credit history which enters the function characterizing the assessments of new applications. It implies that the expected quality of the borrower having applied for credit in the past is linked to the score of the previous creditworthiness tests.

3 Data

3.1 Data sources

For our analysis, we use data from the European Central Bank and the European Commission within "*Survey on Access to Finance of Enterprises*" (SAFE), conducted on behalf of the European Commission (EC) and the European Central Bank (ECB). Since 2009, this survey is carried out every six months to capture information on European firms' access to credit considering the banking oriented nature of the financial system in the Euro area. Its main objective is to lead ECB's monetary policy and shed light on financial transmission mechanisms across European countries. Besides businesses' general characteristics, the survey collects mainly information on firms' external financing,

distinguishing between the use of bank financing and the recourse to alternative financial sources. Further, it contains enterprises' past and future views on the general economic and credit outlook.[1]

The full sample is prevailingly composed of an ample number of micro, small and medium enterprises from EU and non-EU neighbouring countries. The latter, entering the survey collected by the EC on a biennial basis, are not included in our subsample in order to focus specifically on the EU area. Further, we use the last four available rounds covering the period from April 2014 to March 2016 for a total of around 26000 country-timely observations. The panel component is between 50% and 60% depending on year and it is rotating to draw more accurately half-yearly variations. In order to guarantee representativeness of the firms, data are stratified across countries, size classes and sectors. Moreover, calibrated weights are used with regard to company size and economic activity to restore the proportion of the enterprises in our subsample. Finally, we complement SAFE survey with additional country-level data from ECB Data WareHouse and European Association of Cooperative Banks (EACB) to analyse common country-level factors affecting the banking market.

3.2 Measurement

3.2.1 Credit access variables

SAFE survey provides detailed information on firms' financial structure and on their use of external financing. It is worth remarking that our questions of interest related to applications for external financing and the effective access to required sources are asked only to those firms replying *'Relevant'* to the questions Q4b and Q4d (*'Are the following sources, i.e. grants or subsidised bank loans and bank loans, of financing relevant to your enterprise, that is, have you used them in the past or considered using them in the future?'*). For the specific structure of the questionnaire, we have to restrict the estimation sample of our model on credit demand and rationing to around 26000 firms (out of 41000) indicating as relevant at least one source of external financing between grants or subsidised bank loans and bank loans. Conditional on relevance of recurring to loan lending, we define variables of actual credit demand and rationing based on firms' answers to the following questions:

'Have you applied for bank loan in the past six months?' (question Q7A_a);

'If you applied and tried to negotiate for bank loan over the past six months, what was the outcome?' (question Q7B).

We build a binary of actual credit demand (*Credit demand*) equal to one if the firm applied for a loan in the past six months. Conditional on credit demand, we define three binaries for different

[1] Further information on the SAFE dataset and on the structure of the questionnaire are available on the ECB's website: www.ecb.europa.eu/stats/ecb_surveys/safe/html/index.en.html

degrees of constraints. Based on definition of rationing in Minetti and Zhu (2011), we first define a variable (*Rationing*) for identifying those firms having their loan application completely rejected by financial intermediaries (i.e. those firms for which *Credit demand* is equal to one and replying *'Was rejected'* to the question Q7B). Secondly, we create another broader measure (*Rationing* 2) equal to one if credit application was completely or largely rejected (i.e. those firms for which *Credit demand* is equal to one and replying *'Was rejected'* or *'Received below 75%'* to the question Q7B). Finally, we build a third binary (*Rationing* 3) including in the definition of rationed businesses also those firms whose loan application was rejected in a minimum proportion (i.e. firms for which *Credit demand* is equal to one and replying *'Was rejected'* or *'Received below 75%'* or *'Received 75% or above'* to the question Q7B).

It is worth remarking that we do not consider as rationed firms needing more credit, but deciding not to apply for it (discouraged borrowers). We focus only on actual constraints that banks decide to operate following a concrete application. In our model, enterprises choosing not to require for financing are classified as non-applying firms (for which, *Credit demand* is equal to zero) and therefore we do not include them in the estimation of the rationing equation. In this way, we are able to focus the analysis specifically on actual demand for credit and on the conditional probability of credit rejection with respect to the probability of obtaining additional financial sources.[2] For the same reason, we do not include in our subsample for estimating the probability of being rationed all those firms that, after their application, refused the bank's offer because the cost was too high. This decision depends on firms choosing self-rationing and it does not properly reflect and effective measure of external constraints.

[Table 1 about here]

Table 1 displays the countries with the highest level of applications for loans in the four waves are France and Spain, whereas Ireland and Greece show the lowest rate. The Netherlands as well as Greece and Ireland present the highest difficulties in access to credit. Rationing is particularly burdensome for Hellenic firms whose rejection rate ranges from 21.08% to 57.77% when also weakly rationed applications are included in the definition. Greek difficulties in access to credit reflect a relevant sovereign debt crisis on going whose repercussions destabilized unavoidably the internal banking system. Italy, Spain and Portugal are in the same way characterized by remarkable levels of partially rejected applications with respect to Finland, Belgium and Germany displaying

[2] Other empirical analyses face this issue differently. Becchetti et al. (2010) consider as rationed also discouraged firms needing additional funds and deciding not to apply for. Differently, Cenni et al. (2015) classify discouraged enterprises as unconstrained.

minimum denial rates. It suggests that firms in economies which faced the financial crisis with more difficulties are also more subject to be somehow financially constrained.

[Table 2 about here]

Table 2 gives the weighted means of credit demand and rationing indicators for each half year of our sample. Loan application proportion remained constant, around 35%, over the four semesters considered. By contrast, credit constraints have recently decreased remarkably. The proportion of completely rejected applications has been halved since the beginning of 2014 and a similar reduction characterizes also the alternative rationing indicators in each semester. This trend may be linked to the moving away from the recent global financial crisis. The slow but evident economic recovery and the perspectives of growth that are coming up over the main European countries have beneficial effects on the general health of the financial system. In turn, financial conditions represent an accelerating mechanism of economic fluctuations (Bernanke and Gertler, 1989). Better credit conditions appear to highlight an improvement in lenders' stability and their expectations on firms' creditworthy indicate the incoming of a business upturn.

[Table 3 about here]

Table 3 shows the proportion of observations and the means of loan demand and rationing variables for each pattern of enterprises' presence in the unbalanced panel. We report the pattern structure of the sample utilized in the static model in which also non-consecutive observations are used in the estimation. Overall, there are 14041 firms in our sample. When we turn to the dynamic model, a firm must be present in at least two consecutive waves of the dataset in order to be included in the analysis and the estimation sample reduces to 6067 observations. About one third of the enterprises are present in three or four consecutive waves, whereas one half of the firms appear in two adjacent periods. The observations appearing in the remaining patterns do not enter the dynamic sample. Using the unbalanced panel allows us to obtain more precise estimates with the inclusion of a broader number of enterprises and also to increase firms' heterogeneity as rotating enterprises are allowed to enter and exit the sample at any period.

3.2.2 Control variables

With the aim to provide for an accurate and deep analysis on firms' access to credit across the UE, we include an ample set of firm characteristics controls.

Firstly, we account for firms' dimension and age as standard drivers of information asymmetries. For size, we are able to distinguish micro (with less than 10 employees), small (from 10 to 49 employees), medium (from 50 to 249 employees) and large (with 250 or more employees). Another binary for firms set up in the two years before the survey is included in order to identify possible age discrimination due to opacity and banks' difficulties in assessing the potentiality of start-ups (Hyytinen and Pajarinen, 2008).

We add a dummy indicating whether the firm is autonomous in decision-taking process with respect to subsidiaries or branches. Further, we include some controls for firms' corporate governance. Given the large diffusion of individual and family-managed firms in some countries of our sample, such as Italy, Spain and Germany, we add two dummies to identify whether the owner is an unique person or a family.

Firms' internationalization is captured by a binary for having invested or not in exports during the previous semester. Literature highlights that exporters are more efficient than non-exporters (Bernard and Jensen, 2004). On the one hand, exporters must have relevant internal sources, abilities and knowledge needed to set up a business in the target foreign country. On the other hand, internationalized firms are able to develop new competences and skills by exploiting foreign markets' externalities. Thus, exporter status could be more likely to result in a better access to credit.

We account for firms' innovative activity by means of a binary indicating whether businesses' objective of financing is developing and launching new products and services. Due to the relevant sources needed for carrying out such R&D projects and the high uncertainty characterising such activities, banks could be unwilling to provide for financing when the objective is supporting a new unknown product or service (Lee et al., 2015). By contrast, financial institutions could be better disposed to grant credit when it will be addressed towards tangible and pledgeable investments (Steijvers and Voordeckers, 2009). In order to control for project discrimination, we add a binary whether the firm's application for financial sources is motivated by a fixed investment with the expectation of a negative impact on rationing probability.

Given the relevance of flow dimension in banking choice to grant credit, we add a categorical variable grouping loan size in five modalities. We distinguish whether a firm applied for a micro loan (up to 25000 euro), a small loan (more than 25000 and less than 100000 euro), a medium-large loan (more than 2500000 and less than 1 million), a large loan (over 1 million). On the one hand, when credit demand increases banks could be unwilling to satisfy the entire application intensifying weak rationing in order to reduce default risk associated with a unique borrower (Jaffee and Russell, 1976). On the other hand, applications for large loans are typical of large companies which

are more likely to be solid and well established in the market (Shumway, 2001). Therefore, these large borrowers appearing more credit-worthy could face less difficulties in being granted credit.

Firms' ability to generate income is accounted for and we expect enterprises reporting low or decreased levels of turnover to be more likely to need for additional funds and less likely to access to new credit. In order to take into account firms' indebtedness structure, we add two dummies indicating whether the debt asset ratio decreased or remained unchanged in the past six months. Banks' credit constraints are not independent on the level of the firm's actual indebtedness and credit risk increases in businesses' financial exposure. Following analogous reasons, an additional control for the deterioration of credit history is included. Information availability about the evolution of firms' creditworthiness is not trivial and banks' credit allocation is strictly linked to the history of the firm in serving its existing debts and the rating obtained in the past. A dummy for whether a firm received public financial support is included. The inclusion of this variable is aimed at considering concerns that observed constraints in access to credit are driven by possible government subsidies that could be designed by policy makers to correct any failure or bias occurring in credit markets (Mascia and Rossi, 2017). We expect firms having received public funds to reduce credit demand and the probability of being rationed. Further, fixed effects are included to control for sectoral heterogeneity.

As a measure of the credit market structure at country-level, we firstly add the Herfindahl-Hirschman index. In concentrated credit markets, few banking groups, whose headquarters are often far from the local context, may exploit their monopolistic power in lending to small and medium enterprises. For this reason, a high level of concentration could be associated with a reduction of granted sources. We include also the ratio of non-performing loans to total gross loans in order to capture the general health of banking markets. A reduction in the firm's possibility of access to credit is expected in countries characterized by a high level of NPLs in circulation. Further, we control for the share of cooperative banks. Regions where intermediaries with objectives not mainly aimed at profit maximizations are more diffused are expected to present lower inclination to restrict credit.

Finally, aggregate common shocks are taken into account by adding half-yearly time dummies, sectors and macro-region indicators.

4. Econometric methods

4.1 A static sample selection probit model with random effects

As in Brown et al. (2011), we have to account for sample selectivity in the analysis of credit rationed firms. Since we observe the denial of financial funds only if the firm actually applies for external financing, this may generate a substantial self-selection bias due to a non-random sample

of demanding firms. In particular, only firms which are more likely to obtain credit are also more likely to actually apply for external financing. Therefore, our sample of demanding firms may be self-selected and neglect a large share of firms which consider access to credit difficult and refrain from applying. In order to face this selectivity issue, we recur to a bivariate probit accounting for endogenous sample selection as in Wynand and van Praag (1981). In implementing this model, we take into account the panel structure of our sample assuming that effects of unobserved heterogeneity are random. Our bivariate probit is composed of one equation to model the probability of applying for more credit and of an outcome equation to model the probability of being credit rationed. Formally:

Selection equation (*credit demand*):

$$D_{it} = \mathbf{1}\left(\boldsymbol{z}'_{it}\boldsymbol{\gamma} + \eta_i + \mu_{it} > 0 \right) \quad (1)$$

Outcome equation (*credit rationing*):

$$R_{it} = \mathbf{1}\left(\boldsymbol{x}'_{it}\boldsymbol{\beta} + \alpha_i + \varepsilon_{it} > 0 \right) \quad (2)$$

The first equation is the selection equation and the outcome variable R_{it} is observed only if $D_{it} = 1$. $\boldsymbol{x_{it}}$ and $\boldsymbol{z_{it}}$ represent the vectors of explanatory variables for R_{it} and D_{it}, respectively, and $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ are the corresponding vectors of parameters. α_i and η_i capture individual unobserved heterogeneity, while μ_{it} and ε_{it} represent idiosyncratic error terms. In particular, we assume that:

$\mu_{it}, \varepsilon_{it}\,|_{x_{it}, z_{it}, \eta_i, \alpha_i} \sim \boldsymbol{N}(\mathbf{0}, \Sigma_{\varepsilon\mu})$; $\eta_i, \alpha_i\,|_{x_{it}, z_{it}} \sim \boldsymbol{N}(\mathbf{0},\ \Sigma_{\alpha\eta})$, where $\Sigma_{\varepsilon\mu}$, $\Sigma_{\alpha\eta}$ are given by:

$$\Sigma_{\varepsilon\mu} = \begin{pmatrix} 1 & \rho_{\varepsilon\mu} \\ \rho_{\varepsilon\mu} & 1 \end{pmatrix},\ \Sigma_{\alpha\eta} = \begin{pmatrix} \sigma_\alpha^2 & \rho_{\alpha\eta}\sigma_\alpha\sigma_\eta \\ \rho_{\alpha\eta}\sigma_\alpha\sigma_\eta & \sigma_\eta^2 \end{pmatrix} \quad (3)$$

Selectivity operates through correlation of the error terms (Greene, 2012). In particular, as discussed in Raymond et al. (2010), equations (1) and (2) are correlated through the idiosyncratic errors ($\rho_{\varepsilon\mu}$) and the individual effects ($\rho_{\alpha\eta}$), and the "total" correlation between the two equations can be computed as:

$$\rho_{tot} = \frac{\rho_{\alpha\eta}\sigma_\alpha\sigma_\eta + \rho_{\varepsilon\mu}}{\sqrt{(\sigma_\alpha^2+1)(\sigma_\eta^2+1)}} \quad (3)$$

If $\rho_{tot} \neq 0$, we have to account for selection in order not to incur in biased estimates. In this case, the sub-sample of credit rationed firms is not a random draw from the underlying population and selectivity will produce systematically biased parameters. Conversely, if $\rho_{tot} = 0$, the parameters in (1) and (2) can be estimated by means of two standard univariate probits: one for the probability of requiring credit and another one for the probability of being rationed, estimated on the sub-sample of firms having applied for.

The endogeneity of the sample selection mechanism implies that the probability of being credit rationed for the i^{th} individual ($i = 1, \dots, N$) at time t_i ($t_i = 0_i, \dots, T_i$), conditional on applying for more credit, is given by:

$$\text{Prob}(R_{it} = 1 | D_{it} = 1) = \text{Prob}(\boldsymbol{x}'_{it}\boldsymbol{\beta} + \alpha_i + \varepsilon_{it} > 0 | D_{it} = 1) = \frac{\Phi_2(\boldsymbol{x}'_{it}\boldsymbol{\beta}, \boldsymbol{z}'_{it}\boldsymbol{\gamma}, \rho_{\varepsilon\mu}, \rho_{\alpha\eta})}{\Phi(\boldsymbol{z}'_{it}\boldsymbol{\gamma})} \quad (4)$$

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

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

$$\begin{aligned} \log L_i(\beta, \boldsymbol{\gamma}, \rho_{\varepsilon\mu}, \rho_{\alpha\eta}) = {} & \sum_{t=0_i}^{T_i}\left[\Phi_2(\mathbf{x}'_{it}\boldsymbol{\beta}, \mathbf{z}'_{it}\boldsymbol{\gamma}, \rho_{\varepsilon ot})\right] R_{it} D_{it} + \sum_{t=0_i}^{T_i}\left[\Phi_2(-\mathbf{x}'_{it}\boldsymbol{\beta}, \mathbf{z}'_{it}\boldsymbol{\gamma}, -\rho_{tot})\right](1 - R_{it}) D_{it} \\ & + \sum_{t=0_i}^{T_i}\left[\Phi(-\mathbf{z}'_{it}\boldsymbol{\gamma})\right](1 - D_{it}) \end{aligned} \quad (5)$$

If $\rho_{tot} = 0$, the log-likelihood for the probit model with sample selection reduces to the sum of the log-likelihoods of two standard univariate probit models.

4.2 Empirical specification

We analyse the effects of firm-level determinants on credit demand and rationing probability taking into account firm-effects, country-specific factors, the role of loan size and price and non-price conditions. We formalize our empirical specification for credit demand and rationing equations as:

Selection equation (*credit demand*):

$$D_{it} = \mathbf{1}(\boldsymbol{Z}'_{it}\boldsymbol{\gamma_1} + \boldsymbol{M}'_{it}\boldsymbol{\gamma_2} + \eta_i + \mu_{it} > 0) \quad (6)$$

Outcome equation (*credit rationing*):

$$R_{it} = \mathbf{1}(\boldsymbol{X}'_{it}\boldsymbol{\beta_1} + \boldsymbol{M}'_{it}\boldsymbol{\beta_2} + \alpha_i + \varepsilon_{it} > 0) \quad (7)$$

We include a wide range of controls reflecting firm's characteristics. Specifically, the vectors of explanatory variables $\boldsymbol{Z_{it}}$ and $\boldsymbol{X_{it}}$ contain variables on firm's property structure and management, investments, creditworthiness and solvency, as well as sectoral dummies and time indicators. $\boldsymbol{M_{it}}$ is the vector of country-level variables. In the complete model specification, we extend $\boldsymbol{X_{it}}$ to include the size of the bank loan that the firm demanded. Furthermore, in order to improve model identifiability, we impose exclusion restrictions only in the selection equation (i.e., only in $\boldsymbol{Z_{it}}$). Based on Brown et al. (2011), the first one reflects firm's perception about general is a composite indicator summarizing how important the enterprise consider a number of problems about competition, market and regulation. Secondly, we use a proxy for the demand of alternative sources of external financing including trade credit and funds from firm's network. Finally, the past recourse to internal funds, debt securities issues or equity capital is considered as an additional instrument affecting actual demand of loans. Our basic assumption is that firm's perceptions about difficulties in doing business as well as

its demand and recourse to alternative financing are able to affect bank loan applications, but they do not exert a direct impact on bank's choice of granting credit.

4.3 Modelling the dynamics of credit demand and rationing

We extend the static model to a dynamic specification in order to control for the effects of past credit demand and financing constraints on current firm's loan application behaviour and bank's loan granting decisions. The dynamic extension of our model of firm's access to credit is as follows:

Selection equation (*credit demand*):

$$D_{it} = \mathbf{1}(R_{it-1}\gamma_1 + D_{it-1}\gamma_2 + \boldsymbol{Z}'_{it}\boldsymbol{\gamma_3} + \boldsymbol{M}'_{it}\boldsymbol{\gamma_4} + \eta_i + \mu_{it} > 0) \quad (8)$$

Outcome equation (*credit rationing*):

$$R_{it} = \mathbf{1}(R_{it-1}\beta_1 + D_{it-1}\beta_2 + \boldsymbol{X}'_{it}\boldsymbol{\beta_3} + \boldsymbol{M}'_{it}\boldsymbol{\beta_4} + \alpha_i + \varepsilon_{it} > 0) \quad (9)$$

where R_{it-1} and D_{it-1} represent the lagged dependent variables for rationing and loan demand. In our case R_{it-1} is not observed for those firms that did not apply in $t-1$. We recoded the missing values in the lagged restriction outcome as 0 (unrestricted). The new lagged variable is a measure of actual restriction state taking value 1 for firms which state they applied for credit and experienced an actual restriction in credit supply in $t-1$ and 0 both for non-rejected applicants and for those firms which did not apply for credit in $t-1$ whose possible rationing outcome is unobservable (Pigini et al., 2016).

Heckman (1981) refers to true state dependence and spurious state dependence. The first phenomenon states that past rationing affects positively the probability of being rationed again. The second issue might result from the correlation of unobserved time constant heterogeneity or left-out regressors with the lagged variables. In order to distinguish spurious from true state dependence (*true persistence*), it is necessary to properly account for the correlation of unobserved heterogeneity as well as for the endogeneity of the initial conditions.[3] The parameters associated to lagged variables might be additionally inconsistent due to the correlation of initial conditions with unobserved heterogeneity. Wooldridge (2005) proposes to control for the correlation of the random effects with the initial states by explicitly including R_{i0_i} and D_{i0_i} as additional explanatory variables. Wooldridge's approach has been originally applied to autoregressive non-linear single equation models with individual effects. Following Raymond et al. (2010, 2015) and Mosthaf (2017), we adapt this approach to a multi-equations model to simultaneously analyse the probability of being rationed, conditional on loan demand, taking into account initial conditions problem as well as serial error correlation. Formally:

$$\eta_i = b_{10} + b_{11}D_{i0_i} + \boldsymbol{X}'_i\boldsymbol{b}_{12} + a_{1i} \quad (10)$$

$$\alpha_i = b_{20} + b_{21}R_{i0_i} + \boldsymbol{Z}'_i\boldsymbol{b}_{22} + a_{2i} \quad (11)$$

[3] In the remainder of the paper, when the term persistence is used without any further explanation, it is to be understood as true persistence.

where R_{i0_i} and D_{i0_i} represent the initial values of the dependent variables. Given the unbalanced structure of our panel dataset, we need at least two or more consecutive observation over time in order to identify the parameters of the lagged dependent variables in equations (8) and (9) and those of the individual effects in equations (10) and (11). The inclusions of firms with only two consecutive observations available, for which the lagged value of the dependent variable coincides with the initial condition, increases the number of observations without harming the identification of the above parameters since we have some firms with three or four consecutive observations (Raymond et al., 2010). $\boldsymbol{X}_i = (\boldsymbol{X}_{i0_{i+1}}, \dots, \boldsymbol{X}_{iT_i})'$ and $\boldsymbol{Z}_i = (\boldsymbol{Z}_{i0_{i+1}}, \dots, \boldsymbol{Z}_{iT_i})'$ represent the history of the observations of the time-varying explanatory variables, a_{1i} and a_{2i} denote the projection errors assumed orthogonal to R_{i0_i}, D_{i0_i}, $\boldsymbol{X}_i$, $\boldsymbol{Z}_i$, μ_{it} and ε_{it}. The ancillary parameters b_{kj} $(k = 1,2;\ j = 0,1,2)$ have to be estimated alongside the parameters of interest. If the coefficient vectors $\boldsymbol{\gamma_3}$ and $\boldsymbol{\beta_3}$ contain the intercepts, only the sum of those intercepts with $\boldsymbol{b}_{10}$ and $\boldsymbol{b}_{20}$ are identified. If the explanatory variables are time-invariant or do not show a sufficient within variation, then the corresponding coefficients $\boldsymbol{\gamma_3}$, $\boldsymbol{\gamma_4}$, $\boldsymbol{b}_{12}$ and $\boldsymbol{\beta_3}$, $\boldsymbol{\beta_4}$, $\boldsymbol{b}_{22}$ cannot be separately identified. As a result, only sufficiently time-varying explanatory variables enter equations (10) and (11). Furthermore, we include the initial value of each dependent variable in the corresponding equation, to account for the effects of the initial conditions. Because of the short time dimension characterizing our dataset, we substitute $\boldsymbol{X}_i = (\boldsymbol{X}_{i0_{i+1}}, \dots, \boldsymbol{X}_{iT_i})'$ and $\boldsymbol{Z}_i = (\boldsymbol{Z}_{i0_{i+1}}, \dots, \boldsymbol{Z}_{iT_i})'$ with the corresponding within-means computed on all available periods excluding first (Rabe-Hesketh and Skrondal, 2013).[4] Following Wooldridge (2005) and Raymond et al. (2015), we make the following distributional assumptions:

$\mu_{it}, \varepsilon_{it}\,|_{D_{it-1}, R_{it-1}, \eta_i, \alpha_i} \sim \boldsymbol{N}(\boldsymbol{0}, \Sigma_{\varepsilon\mu})$; $a_1, a_2\,|_{D_{i0_i}, R_{i0_i}} \sim \boldsymbol{N}(\boldsymbol{0}, \Sigma_{a_1 a_2})$, where $\Sigma_{\varepsilon\mu}$,$\Sigma_{a_1 a_2}$ are given by:

$$\Sigma_{\varepsilon\mu} = \begin{pmatrix} 1 & \rho_{\varepsilon\mu} \\ \rho_{\varepsilon\mu} & 1 \end{pmatrix},\ \Sigma_{a_1 a_2} = \begin{pmatrix} \sigma_{a_1}^2 & \rho_{a_1 a_2}\sigma_{a_1}\sigma_{a_2} \\ \rho_{a_1 a_2}\sigma_{a_1}\sigma_{a_2} & \sigma_{a_2}^2 \end{pmatrix} \quad (12)$$

4.3.1 State dependence in credit rationing, loan demand experience and discouragement effect

The structure of the model allows taking into account the issues of state dependence in access to credit, "experience" effect coming from a constant recourse to external financing and discouragement effect. As Cappellari and Jenkins (2004), we compute these measures in terms of probability changes by computing average partial effects on demand and rationing probabilities deriving from past demand behaviours and past credit restrictions. Specifically, we calculate for each individual the difference between the predicted probability of being rationed conditional on having been rationed in the previous period and, the predicted probability of being rationed

[4] Rabe-Hesketh and Skrondal (2013) show that the popular constrained version of Wooldridge's (2005) approach to the initial conditions problem, which includes within-means of time-varying explanatory variables based on all periods including the first, can be severely biased in short panels and propose several alternative ways to avoid this problem.

conditional on having been not rationed in the previous period (13). Further, we calculate the effect of the demand behaviour on the current probability of being rationed for each individual as the difference between the predicted probability of being rationed conditional on having applied for credit in the previous period and the probability of being rationed conditional on having not applied for in the previous period (14), and then taking the average across all the individuals.

$$\bar{R}_{R_{t-1}} = \frac{1}{N}\sum_{i=1}^{N}[P(R_{it} = 1 \,|D_{it} = 1, R_{it-1} = 1, D_{it-1} = 1) - P(R_{it} = 1 \,|D_{it} = 1, R_{it-1} = 0, D_{it-1} = 1)] \quad (13)$$

$$\bar{R}_{D_{t-1}} = \frac{1}{N}\sum_{i=1}^{N}[P(R_{it} = 1 \,|D_{it} = 1, D_{it-1} = 1) - P(R_{it} = 1 \,|D_{it} = 1, D_{it-1} = 0)] \quad (14)$$

Similarly, we compute the discouragement effect in loan applications as well as the persistence of credit demand over time. The first one is calculated as the difference between the predicted probability of applying for conditional on having demanded in the previous period and the probability of applying for conditional on having not applied for in the previous period (15). The second one is obtained as the average difference between the predicted probability of applying for conditional on having been rationed in the previous period and the predicted probability of applying for conditional on having not been rationed in the previous period (16), and then taking the average across all the individuals..

$$\bar{D}_{D_{t-1}} = \frac{1}{N}\sum_{i=1}^{N}[P(D_{it} = 1 \mid D_{it-1} = 1) - P(D_{it} = 1 \mid D_{it-1} = 0)] \quad (15)$$

$$\bar{D}_{R_{t-1}} = \frac{1}{N}\sum_{i=1}^{N}[P(D_{it} = 1 \mid R_{it-1} = 1, D_{it-1} = 1) - P(D_{it} = 1|R_{it-1} = 0, D_{it-1} = 1)] \quad (16)$$

It is worth remarking that these indicators take into account individual heterogeneity since they are obtained as a function of differences in individual probabilities, which are then averaged over the whole sample.

5 Estimation results

We now turn to the results of the estimates of the model considering three specifications. We shall comment on the general evidence before discussing the core results of interest, namely the dynamic interrelations between rationing and access to credit. Tables 4-6 present the results of the static approach together with estimates of robustness checks using alternative definitions of rationing, and Table 7-8 displays the results of the dynamic model.

5.1 Determinants of credit demand and rationing

We now turn to the results of the estimation of the model. We shall first comment on the general evidence using a static panel approach before discussing the core results of interest, namely the estimated effects of the dynamics in credit access.

[Table 4 about here]

The significance and negative sign of $\rho_{\varepsilon\mu}$ highlight the presence of endogenous self-selectivity in estimating the rationing probability needs to be accounted for (Brown et al., 2011; Aristei and Gallo, 2015; Pigini et al. 2016). Its value indicates a negative correlation between the credit demand and supply for which firms expecting to have a high probability of being rationed refrain from applying for. Neglecting this selection mechanism leads to severely biased estimates in our outcome equation. In order to capture enterprises' unobserved propensity to apply for and be denied we account for individual effects in each equation of the model. We also observe the correlation of the random effects in the two equations $\rho_{\alpha\eta}$ is significant and negative, suggesting that there are time-invariant unobserved characteristics affecting both individual probability of applying for credit and being rationed. Finally, we compute the total correlation between the two equations using (3) and the overall evidence remains negative as well as in all the following specifications. The estimates of ρ_{tot} can range from -0.37 to -0.75 depending on the specification.

[Table 5 about here]

Tables 4-5 shows that large companies are more likely to apply for financing and their more demanding but profitable investments are assessed as more creditworthy. The evidence highlights the inverse relationship between firm size and rationing probability consistently with the extensive literature on firms' credit constraints (Beck et al., 2005, 2006; Presbitero and Rabellotti, 2014; Ferri and Murro, 2015), where micro firms show the highest difficulties in access to credit, whereas large companies are the least likely to obtain the complete or ample rejection of their application. Autonomous firms do not seem to face relevant problems in access to credit. Making independent financial decisions may mean either that the firm is not integrated inside a network or the firm has an autonomous position within the group. In particular, the latter case could be interpreted as a signal of strategic importance and banks may perceive firms' application as a less risky and profitable investment. Credit demand is not independent on turnover movements. Enterprises registering low levels of sales and contractions in the growth rate are less likely to stay out of the credit market either because they do not apply for financing or because they do not obtain it. This finding seems to suggest the presence of a low performance-credit constraint trap involving firms in a vicious circle (Banerjee and Duflo, 2014). Turnover movements represent the main screening criteria during banks' assessments. Firms suffering from a contraction in their revenues or low performances on sales are also more likely to be discouraged and credit denied. Constrained businesses, in turn, have to limit their investments for improving their performance trapped in a downturn condition. Another factor affecting significantly firms' access to credit is public support. Our evidence suggests businesses

which remained outside of recent correcting policy designs have also encountered more difficulties in access to credit. It may be due to a non-random distribution of public funds aimed at incentivizing more efficient businesses. As in Grundy and Verwijmeren (2017), the type of investment for which firms need financing contributes significantly to make access to credit less or more complicated depending on the risk and the possibility of pledging the investment. Consistently with Myers and Majluf (1984), we find businesses are more likely to require bank loans for fixed investments and the applications for financing this kind of projects being able to be collateralized are less likely to be rationed. An opposite evidence appears when financing is required for developing and launching new products or services. In line with trade-off theory predicting that investments with highly volatile payoffs are more likely to be financed with alternative financial instruments rather than bank financing (Mayers, 1998), we find that the uncertain nature of innovative projects affects negatively the probability of applying for loans and these applications are also more likely to be rejected or partially constrained. A positive relationship between an increase in the firm's perceived default risk and rationing probability is evident. Enterprises asserting their credit history has recently deteriorated present also a higher probability of being constrained remarking access to credit is relevantly dependent on businesses' reputation built over the years.

As regards sectoral evidence, we find construction is the sector encountering more difficulties in access to credit. It represents a further barrier for the recovery post-crisis in an industry amply damaged by market stagnation in the recent post-crisis years. In this sector, the discouragement effect seems to prevail as well as complete loan denials for those applications being submitted. Finally, businesses in Continental and Mediterranean areas present a higher demand and they appear less likely to be denied with respect to firms collocated in the European northern countries.

Table 5 includes firstly loan size indicators in the outcome equation in order to control for the dimension of applications. Even though, loan size parameters do not seem to exert a significant effect on rationing probability, controlling for borrowing dimensions improves the general stability of the model. The parameters of loan demand and rationing equations preserve their directions with respect to the baseline specification and their statistical significance improves considerably.

Country level variables are then added in both equations of a further specification taking into account also the specific structure of financial market in the eleven Euro regions considered. In line with Angelini et al. (1998) and Ferri (2012), firms present a higher loan demand and a lower rationing probability in the regions where cooperative banking sector is more diffused. The presence of intermediaries with a different business model based on stronger firm-bank relationships leading to be less inclined to ration their customers in quantities or price terms appears particularly beneficial for firms' access to credit. Further, we find that the increase of non-

performing loans in the European banking sector is pushing intermediaries to assume more conservative lending policies. Even though NPLs do not represent a direct drag for credit market, their constant growth in the recent years has caused a contraction in the supply of credit (Accornero et al. 2017). Finally, our evidence highlights that bank concentration increases financing obstacles discouraging loan demand and reducing the quantity of lending in the market. As in Beck et al. (2004), the structure-performance hypothesis supporting the negative effects of bank power in the credit market appears more consistent in our period with respect to information-based hypothesis stressing the potential positive effects of bank concentration (Petersen and Rajan, 1995).

5.2 Investigating the determinants of access to credit using alternative measures of rationing

In order to verify the robustness of our results, we provide here the estimates of the model using alternative rationing measures as dependent variables. In particular, the comparison allows to verify whether the determinants of credit access can vary across more comprehensive definitions of restrictions. Results are displayed in Table 6.

[Table 6 about here]

It is first of all remarkable and comforting to notice that the results are quite consistent and robust across specifications. The correlation of idiosyncratic error terms in the two equations is negative and significant confirming the strong presence of endogenous self-selectivity in estimating the rationing probability. Enterprises' unobserved heterogeneity is accounted for in each equation and the individual effects are significantly and negatively correlated in the two equations when the second definition of rationing is used while correlation does not seem to be significant for the last check in which every type of restriction is considered.

The coefficients of explanatory variables corroborate the previous evidence displaying the same direction and significance across the various specifications highlighting a certain level of reliability and stability of the estimates throughout the alternative rationing definitions. Results are particularly close for Rationing (only rejected applications) and Rationing 2 (rejected and strongly restricted applications) since this kind of constraints reflects a real barrier in the access to credit. Further, even considering all the applications somewhat restricted (i.e. rejected, strongly restricted, amply but not completely granted applications) the direction of causality is confirmed underlying that the drivers affecting bank's choice of rejecting credit completely or partially with more or less intensity seem to be similar.

5.3 Dynamics of credit demand and rationing

Let us now turn to the central issue of the paper, namely the persistence of credit demand and rationing over time. Credit rationing is not independent on past access to external sources. Firstly, having obtained financing or not affects the actual need of funds and, therefore, the demand. Secondly, there may be a persistence in credit denial due to the fact that bank's assessments are unavoidably conditioned on past decisions of granting credit. We display the dynamics of access to external funds in the table 7.

In order to show the importance of accounting for individual effects and handling the initial conditions assumed to be endogenous, we report the estimates of these extra parameters at the end of the table. Initial values of rationing and loan demand are positive and statistically significant in selection and outcome equations. Random effects and idiosyncratic errors are significant and negatively correlated as well as the total correlation.

[Table 7 about here]

In specification c), the key parameter associated to R^{*}_{t-1} in the credit restriction equation is positive and statistically significant, suggesting that, once a firm has been restricted in access to credit in the last period, its probability of experiencing a new restriction is higher than for firms which were not restricted or did not apply for a loan in the past half year. This coefficient remarks a persistence of banks in maintaining a negative assessment on firm creditworthiness from one period to the other one. We do not find instead a significant linkage between experiencing a loan denial in the last period and applying for new credit. Further, the parameters associated to D_{t-1} in selection and outcome equations highlight a persistence in the recourse to bank loan financing and, at the same time, firms which have already been in an assessment process in previous periods are less likely to be rationed in new applications.

From the estimates of the dynamic model, we can calculate measures of state dependence in credit rationing and the discouragement effect as presented in section 4.3.1. These quantities are obtained as average partial effects on the probability of being constrained or discouraged conditional on credit restrictions in the previous period. We report the results in table 9, where the measures of rationing are compared to the alternative definitions used for additional comparisons, whose estimates using a static approach are reported in subsection 3.2.[5]

[Table 8 about here]

[5] For the sake of brevity, we report directly average partial effects of lagged demand and rationing. Estimates of the complete dynamic models using Rationing 2 and Rationing 3 instead of Rationing are available upon request.

On average, firms being rationed in the last period are 9.4% more likely to be credit denied again than borrowers which were not restricted in the previous semester ($\bar{R}_{R_{t-1}}$). This persistency in being credit constrained is even more incisive when also measures taking into account partial constraints are added highlighting rationing operates specially in soft restrictions. The latter increases to 16.86% and 18.98% when we use Rationing 2 and 3, respectively. Two major drivers may foster these difficulties in access to credit once the borrower has been restrinced. First of all, the effects of financial restrictions on firm's net worth operating as a trap in which constrained firms having to reduce their investments may miss business opportunities. Additionally, difficulties in access to credit determine a direct contraction of assets in the case that the borrower is unable to secure liquid sources to repay short-term liabilities. Secondly, the negative signaling of credit restrictions about firm's creditworthiness especially under imperfect screening technologies and the fact that banks' assessments are characterized by a certain level of memory whose relevance is related to the borrower's opacity. In other words, firms' credit history on past restrictions enters the scoring function and its weight is increasing in information asymmetries. Linked to this evidence is the significant positive relationship of having demanded credit in the previous period and being currently unconstrained. Enterprises presenting a persistence in the use of external financing are 2.83% less likely to obtain an actual loan denial with respect to those businesses which did not apply for credit in the previous half year ($\bar{R}_{D_{t-1}}$). The dependence on past recourse to credit increases when we adopt more comprehensive measures of rationing. Overall, our results of lagged variables on rationing probability highlight that previous assessments unavoidably condition actual credit restrictions as well as a positive impact of demand persistence on access to credit is evident over the time. Businesses having been rationed previously are more likely to be assessed as non-creditworthy again. On the other hand, we highlight a significant dependence on past credit demand. Firms which have already applied for and, consequently, screened and known by the intermediaries due to the past recourse to external financing are more likely to be transparent and well assessed also in the following applications.

Past experiences on credit restrictions do not affect significantly the probability of applying for bank loans compared to those firms having not experienced denials previously ($\bar{D}_{R_{t-1}}$). It may depend on the period considered during which major European economies were characterized by a slow but evident recovery after the Global Financial Crisis. If it is true that discouragement could represent a particularly tightening problem in periods of financial instability, its effect could be mitigated in tranquil times when firms turn to increase their global production manifesting the need of access to credit in order to expand their investments. By contrast, we find a significant

persistence in the recourse to bank loans due probably to the fact that financial credit represents the major source of financing in the countries analysed. Borrowers having demanded in the last half year are also 20.6% more likely to apply for credit again ($\overline{D}_{D_{t-1}}$) highlighting firms recurring to external financing tend to maintain their demand constant over time. Taken together the dynamic evidence on the probability of applying for seems to be driven by two explanations. Firstly, the context of economic recovery contributes to smooth the discouragement effect since firms' better perceptions of an upturn foster credit demand overcoming the fear of incurring again in denials. Secondly, banks moving away from the crisis may attach less importance to the values of firms' past constraints occurred in times characterized by a higher financial instability.

6. Conclusions

This study provides insights on the main factors shaping firms' loan demand behaviour and credit constraints in the Euro Area. We firstly estimate a static bivariate model, in order to highlight the impacts of firm-level and market characteristics, and we then consider a dynamic model focusing on persistence in credit access. We use three alternative indicators of credit rationing, which progressively include completely rejected, severely restricted and amply accepted applications, in order to verify whether our empirical results depend on the definition of financing constraints. We find robust evidence across these three indicators suggesting that the type and intensity of rationing depend on similar drivers. In particular, banks' choice of granting credit depend on firms' size, management and ownership structure as well as on the type of the investment, which plays a key role in mitigating credit risk. Furthermore, the inclusion of loan size allows us to assess the role of loan amount on credit rationing probability. In particular, when we properly control for the dynamics of credit demand and rationing, we find that large loans are less likely to be denied. According to our data, around the 80% of the applications for large loans come from large firms and, in line with firm size theory of credit rationing, this can contribute to explain the heterogeneity of credit rejection probability with respect to loan amount.

Our empirical findings provide support to the existence of strong (true) persistence and discouragement effect in firms' access to credit. Having experienced credit restriction may be associated with adverse changes in firms' characteristics that make less profitable for banks to fund them in the future. At the same time, past credit denial may have forced constrained firms to reduce their investment and production levels, making less valuable for them to apply for a loan. Moreover, previous rejected borrowers are not only more likely to be denied credit in the future as banks tend to keep unchanged the negative assessment on their credit-worthiness, but they may also be discouraged from applying for a loan as they anticipate rejection. We also find that firms'

demand to external financing contributes to increase the likelihood of obtaining credit. Due to asymmetric information issues and to costly information acquisition, firms that have already been monitored and screened by banks are characterized by lower information asymmetries with respect to a new applicants and this represents a rewarding driver for high quality borrowers, .

To sum up, our results confirm the inherent characteristics of access to credit identified by the economic theory. However, the differences in access to credit cannot be solely attributed to observable discrepancies across firms. Unobserved heterogeneity plays a crucial role and, therefore, it must be properly modelled. Furthermore, accounting for the dynamics of credit demand and rationing is relevant for the understanding of banks' assessment processes and lending behaviour. Lending decisions depends strictly on formal or informal assessments of borrowers' default probability. Credit scoring models and soft information-based screening technologies are characterized by a certain degree of memory. This implies that the results of a firm's assessment process are to some extent linked to the scores of its previous evaluation, potentially locking the firm into a long-lasting state of credit restriction. On the other hand, maintaining stable banking relationships allows to overcome informational opacity issues and may be a relevant strategy for the firm in order to overcome the financing obstacles due to previous bad assessment. This is particularly relevant in the current upturn period in which firms' health and market opportunities are slowly beginning to grow again after financial constraints exacerbations of the last Global Financial Crisis and bank lending may represent the major accelerator mechanism of economic recovery.

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Tables

Table 1 – Country means for indicators of credit demand and constraints

	Loan demand	Rationing	Rationing 2	Rationing 3
AT	0.3174	0.0435	0.1244	0.1985
BE	0.3640	0.0418	0.0871	0.1404
DE	0.2902	0.0250	0.0476	0.0843
ES	0.4360	0.0448	0.1545	0.2933
FI	0.3009	0.0376	0.0925	0.1307
FR	0.4382	0.0648	0.1115	0.1522
GR	0.2357	0.2108	0.4093	0.5777
IE	0.1718	0.1250	0.2323	0.3509
IT	0.4002	0.0753	0.1843	0.2848
NL	0.2043	0.1894	0.2635	0.3489
PT	0.2492	0.0470	0.1456	0.3084
All sample	0.3558	0.0585	0.1311	0.2098

Notes: statistics are calculated using sample weights on the static estimation sample.

Table 2 – Average indicators of credit demand and rationing

	2014H1	2014H2	2015H3	2015H4
Loan demand	0.3659	0.3512	0.3486	0.3574
Rationing	0.0782	0.0583	0.0552	0.0394
Rationing 2	0.1744	0.1237	0.1137	0.1079
Rationing 3	0.2577	0.2142	0.1866	0.1746

Notes: statistics are calculated using sample weights on the static estimation sample.

Table 3 – Loan demand and rationing for each pattern of the unbalanced panel data sample

	Patterns											
	0011	0101	0110	0111	1001	1010	1011	1100	1101	1110	1111	Total
Number of observations												
Enterprises	1350	1006	1486	1467	908	1176	882	1844	936	1158	1828	14041
% in total	0.0961	0.0716	0.1058	0.1045	0.0647	0.0838	0.0628	0.1313	0.0667	0.0825	0.1302	1
Means of loan demand and rationing												
Loan demand	0.3393	0.3016	0.3359	0.3610	0.3369	0.3066	0.3830	0.3281	0.3266	0.3992	0.4499	0.3558
Rationing	0.0573	0.0465	0.0777	0.0581	0.0834	0.0722	0.0295	0.0990	0.0394	0.0431	0.0358	0.0585
Rationing 2	0.1377	0.1309	0.1371	0.1192	0.1605	0.1549	0.1020	0.1858	0.1511	0.1101	0.0859	0.1311
Rationing 3	0.2022	0.2070	0.2149	0.1962	0.2271	0.2254	0.1720	0.2847	0.2798	0.2206	0.1366	0.2098

Notes: patterns refer to the presence/absence of firms in the four successive waves. Statistics are calculated using sample weights on the static estimation sample.

Table 4 – The determinants of loan demand and rationing

	Specification a)			
	Rationing		Loan Demand	
Small	-0.3048*	(0.1628)	0.1983***	(0.068)
Medium	-0.5903**	(0.2307)	0.2414***	(0.0884)
Large	-1.1019***	(0.342)	0.3930***	(0.1117)
Autonomous firm	-0.4739**	(0.2052)	0.2915***	(0.0805)
Individual owner	0.2378	(0.2024)	0.0231	(0.0784)
Family managed	0.0707	(0.1739)	-0.0339	(0.0684)
Young	0.4437	(0.5298)	0.1353	(0.2227)
Exporter	-0.0263	(0.1255)	-0.0081	(0.0494)
Low turnover	0.4536***	(0.1715)	-0.2957***	(0.0702)
Turnover down	0.1325	(0.1519)	0.0624	(0.0582)
Turnover unchanged	0.0735	(0.1416)	-0.0464	(0.0531)
Public support down	0.9516***	(0.3433)	0.0861	(0.0638)
Public support unchanged	0.3200*	(0.1691)	-0.0163	(0.0516)
Credit history down	0.5864*	(0.306)	0.1444*	(0.0791)
Credit history unchanged	0.1636	(0.1372)	-0.0601	(0.0507)
Fixed investment	-0.8052***	(0.1272)	0.6235***	(0.047)
New products investment	0.3870**	(0.1562)	-0.1194**	(0.0609)
Construction	0.3609*	(0.2185)	-0.1707*	(0.0874)
Trade	0.2354	(0.1707)	-0.067	(0.0646)
Services	0.088	(0.1575)	-0.1105*	(0.0618)
Continental	-0.4666**	(0.2275)	0.3848***	(0.0833)
Mediterranean	-0.6817***	(0.2269)	0.5881***	(0.084)
Perceived growth obstacles			-0.0762	(0.0472)
Alternative funding use			0.1307**	(0.0518)
Alternative financing demand			0.5543***	(0.0488)
Intercept	-0.2585	(1.0269)	-1.6879***	(0.1618)
Time dummies	*Yes* [0.6906]		*Yes* [0.6906]	
Random effects				
σ_α	1.3612***			
	(0.2589)			
σ_η	0.8666***			
	(0.0245)			
$\rho_{\alpha\eta}$	-0.4354*			
	(0.2631)			
Idiosyncratic errors				
$\rho_{\varepsilon\mu}$	-0.9021***			
	(0.1159)			
Total correlation (ρ_{tot})	*-0.6334*			
Number of observations	14041			
Log-likelihood	-8785.86			

Notes: Row coefficient of specification a) including firm-level effects is used as a baseline.
Micro businesses, Industry sector and Northern EU are used as base level for the categorical variables of firm size, sectors and aggregated country-level areas.
***, **, * denote significance at 1, 5 and 10% levels respectively.

Table 5 – The role of loan size and financial markets in firms' access to credit

	Specification b)				Specification c)			
	Rationing		Loan Demand		Rationing		Loan Demand	
Small	-0.3340**	(0.1571)	0.1976***	(0.0652)	-0.2845*	(0.1582)	0.1838***	(0.0643)
Medium	-0.5902***	(0.2125)	0.2402***	(0.0851)	-0.5751***	(0.2144)	0.2404***	(0.0839)
Large	-1.0454***	(0.3129)	0.3928***	(0.1078)	-1.0472***	(0.3188)	0.3834***	(0.1063)
Autonomous firm	-0.4636**	(0.1894)	0.2921***	(0.0780)	-0.4832**	(0.1938)	0.2979***	(0.0770)
Individual owner	0.3240*	(0.1871)	0.0231	(0.0757)	0.3045	(0.1898)	0.0371	(0.0746)
Family managed	0.1806	(0.1693)	-0.0340	(0.0663)	0.1540	(0.1728)	-0.0149	(0.0655)
Young	0.5277	(0.4588)	0.1359	(0.2153)	0.5789	(0.4514)	0.1286	(0.2111)
Exporter	-0.0720	(0.1161)	-0.0082	(0.0476)	-0.0927	(0.1193)	0.0205	(0.0471)
Low turnover	0.4444***	(0.1660)	-0.2968***	(0.0674)	0.4484***	(0.1693)	-0.3011***	(0.0664)
Turnover down	0.1414	(0.1323)	0.0624	(0.0560)	0.1440	(0.1344)	0.0457	(0.0554)
Turnover unchanged	0.0390	(0.1339)	-0.0462	(0.0513)	0.0461	(0.1370)	-0.0599	(0.0505)
Public support down	0.8903***	(0.1405)	0.0848	(0.0601)	0.8074***	(0.1422)	0.1035*	(0.0599)
Public support unchanged	0.2573*	(0.1354)	-0.0170	(0.0500)	0.2535*	(0.1375)	-0.0230	(0.0493)
Credit history down	0.5359***	(0.1558)	0.1449*	(0.0752)	0.5780***	(0.1586)	0.1214	(0.0743)
Credit history unchanged	0.1374	(0.1273)	-0.0600	(0.0491)	0.1426	(0.1291)	-0.0739	(0.0484)
Fixed investment	-0.7579***	(0.1129)	0.6249***	(0.0456)	-0.7240***	(0.1168)	0.6061***	(0.0449)
New products investment	0.3938***	(0.1244)	-0.1195**	(0.0580)	0.3799***	(0.1276)	-0.1132**	(0.0571)
Small loan	0.033	(0.1753)			0.0280	(0.1766)		
Medium loan	0.3050	(0.1869)			0.2687	(0.1885)		
Medium-large loan	0.1512	(0.2144)			0.0965	(0.2158)		
Large loan	0.0697	(0.2472)			0.0076	(0.2531)		
Construction	0.3619*	(0.1930)	-0.1714**	(0.0835)	0.3418*	(0.1941)	-0.1365*	(0.0824)
Trade	0.2199	(0.1533)	-0.0674	(0.0623)	0.1192	(0.1573)	-0.0058	(0.0619)
Services	0.1119	(0.1492)	-0.1110*	(0.0599)	0.1024	(0.1502)	-0.0814	(0.0591)
Continental	-0.5510***	(0.2119)	0.3843***	(0.0806)	-0.1030	(0.2725)	0.1131	(0.0918)
Mediterranean	-0.6444***	(0.2078)	0.5886***	(0.0811)	-0.7611**	(0.3010)	0.6215***	(0.0941)
Cooperative					-0.3878	(0.3054)	0.8721***	(0.1256)
HHI					1.8425*	(0.9828)	-0.6593*	(0.3383)
NPL					0.0360***	(0.0083)	-0.0107***	(0.0032)
Perceived growth obstacles			-0.0772*	(0.0455)			-0.0835*	(0.0452)
Alternative funding use			0.1312**	(0.0513)			0.1233**	(0.0507)
Alternative financing demand			0.5527***	(0.0480)			0.5542***	(0.0473)
Intercept	-0.3113	(0.4152)	-1.6863***	(0.1568)	-0.8021	(0.5045)	-1.6533***	(0.1748)
Time dummies	*Yes* [0.5843]		*Yes* [0.5843]		*Yes* [0.5843]		*Yes* [0.5843]	
Random effects								
σ_α	1.2968*** (0.0765)				1.2849*** (0.0733)			
σ_η	0.8680*** (0.0244)				0.8443*** (0.0242)			
$\rho_{\alpha\eta}$	-0.4308*** (0.0629)				-0.4286*** (0.0592)			
Idiosyncratic errors								
$\rho_{\varepsilon\mu}$	-0.9253*** (0.0391)				-0.9250*** (0.0327)			
Total correlation (ρ_{tot})	*-0.6503*				*-0.6523*			
Number of observations	14041				14041			
Log-likelihood	-8735.25				-8669.98			

Notes: Row coefficients of specification b) adding loan size to the baseline and specification c) including additionally the macro variables.

Micro businesses, Micro loans, Industry sector and Northern EU are used as base level for the categorical variables of firm size, loan size and sectors and aggregated country-level areas.

***, **, * denote significance at 1, 5 and 10% levels respectively.

Table 6 – The determinants of firms' access to credit using alternative definitions: Rationing 2 and 3

	Specification c)		Specification c)	
	Rationing 2	Loan Demand	Rationing 3	Loan Demand
Small	-0.2501** (0.1137)	0.1809*** (0.0638)	-0.0913 (0.1360)	0.1785*** (0.0657)
Medium	-0.3870***(0.1491)	0.2450*** (0.0832)	-0.1334 (0.1737)	0.2414*** (0.0855)
Large	-0.4576** (0.2098)	0.3850*** (0.1048)	-0.0420 (0.2326)	0.3702*** (0.1077)
Autonomous firm	-0.3355** (0.1399)	0.3035*** (0.0755)	-0.4245*** (0.1626)	0.3028*** (0.0778)
Individual owner	0.2452* (0.1328)	0.0358 (0.0735)	0.1911 (0.1549)	0.0341 (0.0758)
Family managed	0.1124 (0.1211)	-0.0136 (0.0646)	0.0489 (0.1347)	-0.0124 (0.0662)
Young	0.6058** (0.2821)	0.1230 (0.2038)	0.8649** (0.4020)	0.1247 (0.2182)
Exporter	-0.0626 (0.0861)	0.0198 (0.0467)	-0.0044 (0.1005)	0.0208 (0.0481)
Low turnover	0.3097** (0.1224)	-0.2958***(0.0658)	0.3468** (0.1426)	-0.2925*** (0.0678)
Turnover down	0.1285 (0.0933)	0.0452 (0.0545)	0.1312 (0.1093)	0.0444 (0.0564)
Turnover unchanged	0.1501 (0.0930)	-0.0594 (0.0496)	0.1040 (0.1069)	-0.0585 (0.0512)
Public support down	0.7112*** (0.1007)	0.1034* (0.0589)	0.8274*** (0.1203)	0.0976 (0.0610)
Public support unchanged	0.2319** (0.0933)	-0.0247 (0.0484)	0.2273** (0.1050)	-0.0239 (0.0498)
Credit history down	0.4880*** (0.1138)	0.1152 (0.0735)	0.5208*** (0.1392)	0.1188 (0.0769)
Credit history unchanged	0.0480 (0.0868)	-0.0729 (0.0475)	-0.0270 (0.0997)	-0.0679 (0.0490)
Fixed investment	-0.6064***(0.0785)	0.6051*** (0.0440)	-0.5828*** (0.0923)	0.6063*** (0.0456)
New products investment	0.2032** (0.0948)	-0.1120** (0.0568)	0.2906** (0.1161)	-0.1134* (0.0592)
Small loan	0.1479 (0.1221)		0.1746 (0.1533)	
Medium loan	0.2092 (0.1408)		0.3502** (0.1712)	
Medium-large loan	0.0075 (0.1537)		0.1537 (0.1840)	
Large loan	-0.1755 (0.1790)		-0.1323 (0.2068)	
Construction	0.0049 (0.1506)	-0.1381* (0.0818)	0.1634 (0.1735)	-0.1322 (0.0846)
Trade	0.0277 (0.1088)	-0.0048 (0.0611)	0.1668 (0.1269)	-0.0006 (0.0631)
Services	0.0078 (0.1026)	-0.0866 (0.0582)	0.0165 (0.1217)	-0.0819 (0.0601)
Continental	-0.0282 (0.1810)	0.0600 (0.0928)	-0.1100 (0.2101)	0.0552 (0.0947)
Mediterranean	-0.2750 (0.1837)	0.6311*** (0.0935)	-0.0195 (0.2072)	0.6253*** (0.0947)
Cooperative	-0.3914* (0.2140)	0.7242*** (0.1265)	-0.5230** (0.2486)	0.7233*** (0.1316)
HHI	1.5693** (0.6718)	-0.7773** (0.3378)	1.8056** (0.7892)	-0.7910** (0.3433)
NPL	0.0221*** (0.0044)	-0.0125*** (0.0025)	0.0219*** (0.0054)	-0.0125*** (0.0026)
Perceived growth obstacles		-0.0702 (0.0447)		-0.0717 (0.0460)
Alternative funding use		0.1160** (0.0497)		0.1262** (0.0517)
Alternative financing demand		0.5640*** (0.0468)		0.5582*** (0.0485)
Intercept	-0.2294 (0.3421)	-1.4871***(0.1777)	-0.7236* (0.4076)	-1.4778*** (0.1836)
Time dummies	*Yes* [0.0434]	*Yes* [0.0434]	*Yes* [0.2253]	*Yes* [0.2253]
Random effects				
σ_α	1.0267*** (0.0534)		1.1905*** (0.0582)	
σ_η	0.8402*** (0.0246)		0.8240*** (0.0240)	
$\rho_{\alpha\eta}$	-0.3669*** (0.0539)		-0.0191 (0.0704)	
Idiosyncratic errors				
$\rho_{\varepsilon\mu}$	-0.9391*** (0.0226)		-0.7269 *** (0.0369)	
Total correlation (ρ_{tot})	*-0.6707*		*-0.3701*	
Number of observations	14041		14041	
Log-likelihood	-9285.57		-9742.51	

Notes: Row coefficients of the specification c) using alternative definitions of rationing.
Micro businesses, Micro loans, Industry sector and Northern EU are used as base level for the categorical variables of firm size, loan size and sectors and aggregated country-level areas.
***, **, * denote significance at 1, 5 and 10% levels respectively.

Table 7 – The dynamics of firm's access to credit

	Specification d)			
	Rationing		Loan demand	
R^*_{t-1}	1.0792***	(0.2329)	-0.0614	(0.1135)
D_{t-1}	-0.6704***	(0.0938)	0.6231***	(0.0621)
Small	-0.2510*	(0.1330)	0.1519**	(0.0621)
Medium	-0.1894	(0.1874)	0.1243	(0.0816)
Large	-0.5209*	(0.2980)	0.2788***	(0.1049)
Autonomous firm	-0.6117	(0.3942)	0.1999	(0.2603)
Individual owner	0.1813	(0.3644)	0.3325*	(0.2007)
Family managed	0.7352**	(0.3452)	0.1074	(0.1744)
Young	-0.0472	(0.7816)	-0.1988	(0.4207)
Exporter	0.1719	(0.2237)	0.1035	(0.1072)
Low turnover	-0.4062	(0.3749)	-0.2949	(0.1862)
Turnover down	0.1337	(0.1800)	0.0306	(0.0822)
Turnover unchanged	0.2646	(0.1652)	-0.1281*	(0.0709)
Public support down	0.5965***	(0.1896)	0.0667	(0.0877)
Public support unchanged	0.3253*	(0.1735)	0.0282	(0.0651)
Credit history down	-0.0653	(0.1726)	0.0986	(0.1012)
Credit history unchanged	0.0161	(0.1320)	-0.0413	(0.0657)
Fixed investment	-0.4580***	(0.1473)	0.5206***	(0.0648)
New products investment	0.4856***	(0.1511)	-0.1541*	(0.0791)
Small loan	-0.4088	(0.2762)		
Medium loan	-0.4727	(0.3170)		
Medium-large loan	-0.4171	(0.3386)		
Large loan	-0.9725**	(0.4880)		
Construction	0.4032***	(0.1479)	-0.1424*	(0.0765)
Trade	0.1274	(0.1276)	-0.0443	(0.0578)
Services	0.0920	(0.1211)	-0.0589	(0.0560)
Continental	0.4674**	(0.2382)	0.1150	(0.0895)
Mediterranean	0.0527	(0.2612)	0.6029***	(0.0898)
Cooperative	-0.1921	(0.2688)	0.7016***	(0.1237)
HHI	3.0190***	(0.9077)	-0.6829**	(0.3315)
NPL	0.0091*	(0.0052)	-0.0061***	(0.0023)
Perceived growth obstacles			-0.0988**	(0.0419)
Alternative funding use			0.1037**	(0.0464)
Alternative financing demand			0.4322***	(0.0448)
Intercept	-1.3675***	(0.4724)	-1.6364***	(0.1783)
Time dummies	Yes [0.4882]		Yes [0.4882]	
Initial conditions				
$\text{Rationing}^*_{0_i}$	0.8233***	(0.2118)		
Loan demand_{0_i}			0.2958***	(0.0633)
Random effects				
σ_α	0.1329 (0.1341)			
σ_η	0.3575*** (0.0603)			
$\rho_{\alpha\eta}$	-0.9999*** (0.0000)			
Idiosyncratic errors				
$\rho_{\varepsilon\mu}$	-0.7617*** (0.0364)			
Total correlation (ρ_{tot})	*-0.7553*			
Number of observations	6067			
Log-likelihood	-3448.83			

Notes: Row coefficients of specification d) adding lagged dependent variables to specification c).
Micro businesses, Micro loans, Industry sector and Northern EU are used as base level for the categorical variables of firm size, loan size and sectors and aggregated country-level areas.
***, **, * denote significance at 1, 5 and 10% levels respectively.

Table 8 – Persistence and discouragement/experience effects in firms' access to credit

	Rationing	Rationing 2	Rationing 3
$\bar{R}_{R_{t-1}}$ *(persistence in rationing)*	0.0940***	0.1687***	0.1898***
	(0.0226)	(0.0256)	(0.0342)
$\bar{R}_{D_{t-1}}$ *(experience effect)*	-0.0284***	-0.0570***	-0.0549***
	(0.0092)	(0.0137)	(0.0181)
$\bar{D}_{R_{t-1}}$ *(discouragement effect)*	-0.0203	0.0228	0.0392
	(0.0375)	(0.0291)	(0.0266)
$\bar{D}_{D_{t-1}}$ *(persistence in demand)*	0.2061***	0.1956***	0.1892***
	(0.0199)	(0.0210)	(0.0214)

Notes: Average partial effects of the lagged loan demand and rationing 1, 2 and three on the predicted probability of applying for and being constrained.
***, **, * denote significance at 1, 5 and 10% levels respectively.

Appendix A

Table A1 – Definitions of variables

Dependent variables	
Credit demand	Equal to 1 if the firm has applied for bank loan in the past six months, 0 otherwise
Rationing	Equal to 1 if the firm applied for bank loan, but its application was completely rejected, 0 otherwise
Rationing 2	Equal to 1 if the firm applied for bank loan, but its application was completely rejected or it received below 75%, 0 otherwise
Rationing 3	Equal to 1 if the firm applied for bank loan, but its application was completely rejected or it received below 75% or it receive 75% and above, 0 otherwise
Firm's characteristics	
Small	Equal to 1 if the firm has 10 employees or more and less than 49, 0 otherwise
Medium	Equal to 1 if the firm has 49 employees or more and less than 249, 0 otherwise
Large	Equal to 1 if the firm has 249 employees or more, 0 otherwise
Autonomous firm	Equal to 1 if the firm is autonomous and profit-oriented, making independent financial decisions, 0 otherwise
Individual owner	Equal to 1 if the owner is one individual natural person, 0 otherwise
Family managed	Equal to 1 if the owner is a family or a group of enterpreneurs, 0 otherwise
Young	Equal to 1 if the firm is less than 2 years old, 0 otherwise
Export	Equal to 1 if the firm is an exporter, 0 otherwise
Low turnover	Equal to 1 if firm's turnover was lower than 2 millions euro in last year, 0 otherwise
Turnover down	Equal to 1 if firm's turnover decreased over the past six months, 0 otherwise
Turnover unchanged	Equal to 1 if firm's turnover remained unchanged over the past six months, 0 otherwise
Fixed investments	Equal to 1 if the firm has used the financing for investments in property, plant or equipment during the past six months, 0 otherwise
Public support unchanged	Equal to 1 if firm's access to public funds, including guarantees, remained unchanged over the past six months, 0 otherwise
Credit history down	Equal to 1 if firm's credit history has deteriorated over the past six months, 0 otherwise
Credit history unchanged	Equal to 1 if firm's credit history remained unchanged over the past six months, 0 otherwise
New product investment	Equal to 1 if the firm has used the financing for developing or lauching new products or services during the past six months, 0 otherwise
Public support down	Equal to 1 if firm's access to public funds, including guarantees, has deteriorated over the past six months, 0 otherwise
Small loan	Equal to 1 if firm's last bank loan was more than euro 25000 and up to 100000, 0 otherwise
Medium loan	Equal to 1 if firm's last bank loan was more than euro 100000 and up to 250000, 0 otherwise
Medium-high loan	Equal to 1 if firm's last bank loan was more than euro 250000 and up to 1000000, 0 otherwise
High loan	Equal to 1 if firm's last bank loan was more than 1000000 euro, 0 otherwise
Country-level and credit market characteristics	
Cooperative	Cooperative banking sector share (Source: EACB)
Herfindahl index	Herfindahl index for Credit institutions: total assets (Source: ECB)
Non-performing loans	Bank nonperforming loans to total gross loans (Source: ECB)
Identification variables	
Perceived growth obstacles	Equal to 1 if firm's perceives finding market, competition, know-how and regulation restrictions as a relevant problem, 0 otherwise
Alternative funding use	Equal to 1 if firm's used equity, debt securities or retained earnings or sale of assets in the past six months, 0 otherwise
Alternative financing demand	Equal to 1 if firm applied for trade credit or other external financing, 0 otherwise

Supplementary appendix

Table B1 – The dynamics of firm's access to credit using Rationing 2

	d) Rationing 2		Loan demand	
R^*_{t-1}	1.0724***	(0.1626)	0.0690	(0.0880)
D_{t-1}	-0.6500***	(0.0823)	0.5923***	(0.0652)
Small	-0.0230	(0.1187)	0.1499**	(0.0637)
Medium	0.1218	(0.1630)	0.1242	(0.0843)
Large	0.1644	(0.2265)	0.2853***	(0.1077)
Autonomous firm	-0.5732	(0.3897)	0.1994	(0.2696)
Individual owner	0.5511	(0.3905)	0.3393	(0.2131)
Family managed	0.3666	(0.3673)	0.1013	(0.1837)
Young	0.8796*	(0.5086)	-0.1883	(0.4075)
Exporter	-0.2086	(0.1928)	0.1066	(0.1100)
Low turnover	-0.1326	(0.3633)	-0.2937	(0.1957)
Turnover down	0.0537	(0.1520)	0.0285	(0.0833)
Turnover unchanged	0.2470*	(0.1377)	-0.1254*	(0.0721)
Public support down	0.2494	(0.1586)	0.0562	(0.0897)
Public support unchanged	0.0658	(0.1293)	0.0280	(0.0662)
Credit history down	0.3365*	(0.1738)	0.1056	(0.1063)
Credit history unchanged	0.1843	(0.1226)	-0.0437	(0.0674)
Fixed investment	-0.1577	(0.1138)	0.5244***	(0.0659)
New products investment	0.0049	(0.1440)	-0.1522*	(0.0823)
Small loan	0.0581	(0.2837)		
Medium loan	-0.2473	(0.3266)		
Medium-large loan	-0.3056	(0.3682)		
Large loan	-0.1075	(0.4820)		
Construction	0.2479*	(0.1441)	-0.1426*	(0.0792)
Trade	0.1381	(0.1060)	-0.0495	(0.0592)
Services	0.0163	(0.1022)	-0.0589	(0.0573)
Continental	0.0803	(0.1816)	0.1172	(0.0916)
Mediterranean	-0.1246	(0.1976)	0.6105***	(0.0926)
Cooperative	-0.7565***	(0.2220)	0.7196***	(0.1262)
HHI	0.4538	(0.7752)	-0.6723**	(0.3391)
NPL	0.0070	(0.0043)	-0.0061**	(0.0024)
Perceived growth obstacles			-0.0819*	(0.0428)
Alternative funding use			0.0982**	(0.0475)
Alternative financing demand			0.4431***	(0.0462)
Intercept	-0.2707	(0.3507)	-1.6520***	(0.1802)
Time dummies	Yes [0.2830]		Yes [0.2830]	
Initial conditions				
$\text{Rationing}^*_{0_i}$	0.4422***	(0.1506)		
Loan demand_{0_i}			0.3093***	(0.0657)
Random effects				
σ_α	0.0328 (0.09559)			
σ_η	0.3844*** 0.0577			
$\rho_{\alpha\eta}$	0.9999*** (0.0000)			
Idiosyncratic errors				
$\rho_{\varepsilon\mu}$	-0.6605*** (0.04199)			
Total correlation (ρ_{tot})	*-0.3015*			
Number of observations	6067			
Log-likelihood	-3705.00			

Notes: Row coefficients of specification d) adding lagged dependent variables to specification c) using Rationing 2.
Micro businesses, Micro loans, Industry sector and Northern EU are used as base level for the categorical variables of firm size, loan size and sectors and aggregated country-level areas.
***, **, * denote significance at 1, 5 and 10% levels respectively.

Table B2 – The dynamics of firm's access to credit using Rationing 3

	d) Rationing 3		Loan demand	
R^*_{t-1}	0.8889***	(0.1663)	0.1187	(0.0805)
D_{t-1}	-0.4945***	(0.0842)	0.5725***	(0.0659)
Small	-0.0064	(0.1247)	0.1502**	(0.0635)
Medium	0.3347**	(0.1618)	0.1284	(0.0834)
Large	0.2593	(0.2084)	0.2821***	(0.1067)
Autonomous firm	0.0702	(0.4613)	0.2078	(0.2748)
Individual owner	0.1408	(0.3752)	0.3494*	(0.2111)
Family managed	-0.1281	(0.3399)	0.1187	(0.1820)
Young	0.4329	(0.6842)	-0.1978	(0.4083)
Exporter	-0.0939	(0.2104)	0.1053	(0.1104)
Low turnover	-0.2584	(0.3448)	-0.2939	(0.1916)
Turnover down	0.1454	(0.1550)	0.0257	(0.0836)
Turnover unchanged	0.2983**	(0.1346)	-0.1285*	(0.0721)
Public support down	0.3904**	(0.1643)	0.0589	(0.0896)
Public support unchanged	0.2016	(0.1257)	0.0266	(0.0659)
Credit history down	0.4775***	(0.1799)	0.1100	(0.1061)
Credit history unchanged	0.2012	(0.1226)	-0.0433	(0.0672)
Fixed investment	-0.1871	(0.1176)	0.5273***	(0.0655)
New products investment	-0.0198	(0.1461)	-0.1523*	(0.0827)
Small loan	-0.0668	(0.3129)		
Medium loan	-0.0146	(0.3412)		
Medium-large loan	-0.0190	(0.3770)		
Large loan	0.1177	(0.4465)		
Construction	0.2885*	(0.1557)	-0.1396*	(0.0800)
Trade	0.2534**	(0.1099)	-0.0470	(0.0592)
Services	0.1283	(0.1069)	-0.0592	(0.0574)
Continental	-0.0265	(0.1925)	0.1204	(0.0912)
Mediterranean	-0.0878	(0.1950)	0.6101***	(0.0918)
Cooperative	-0.9597***	(0.2251)	0.7164***	(0.1264)
HHI	0.4632	(0.7731)	-0.6861**	(0.3377)
NPL	0.0059	(0.0044)	-0.0062**	(0.0024)
Perceived growth obstacles			-0.0884**	(0.0427)
Alternative funding use			0.1031**	(0.0476)
Alternative financing demand			0.4324***	(0.0461)
Intercept	-0.1940	(0.3642)	-1.6490***	(0.1804)
Time dummies	Yes [0.2161]		Yes [0.2161]	
Initial conditions				
$\text{Rationing}^*_{0_i}$	0.6069***	(0.1563)		
Loan demand_{0_i}			0.3121***	(0.0658)
Random effects				
σ_α	0.4172*** (0.1021)			
σ_η	0.3774*** (0.0603)			
$\rho_{\alpha\eta}$	-0.0977 (0.3886)			
Idiosyncratic errors				
$\rho_{\varepsilon\mu}$	-0.5782*** (0.0553)			
Total correlation (ρ_{tot})	*-0.2562*			
Number of observations	6067			
Log-likelihood	-3919.93			

Notes: Row coefficients of specification d) adding lagged dependent variables to specification c) using Rationing 3.
Micro businesses, Micro loans, Industry sector and Northern EU are used as base level for the categorical variables of firm size, loan size and sectors and aggregated country-level areas.
***, **, * denote significance at 1, 5 and 10% levels respectively.