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Determinants of financing constraints: Evidence from European SMEs

Anabela Santos

PhD, Economic Analyst

European Commission, Joint Research Centre, unit B3 (Spain)

The views expressed are purely those of the author and may not in any circumstances be regarded as stating an official position of the European Commission.

Université libre de Bruxelles (Belgium)

Michele Cincera

Prof. of Economics

Université libre de Bruxelles (Belgium)

The scientific literature identifies access to finance as one of the main limitation of firms' investment behavior, but the nature of the investment also influences their access to finance. Innovative firms are more financially constrained due to asymmetric information, lack of collateral and sunk cost. Despite a vast contribution of empirical studies about firms' characteristics explaining financial frictions, analysis of supply-side characteristics justifying such statements remains less explored. Using a Recursive Bivariate Probit Model and survey data, the present paper aims to assess which factors in the financial market (supply side) have a higher impact on firms' likelihood to be financially constrained when they have growth ambitions and need external finance. The results show that after controlling for potential endogenous bias due to unobservable firm characteristics, being an innovative firm increases the probability of being financially constrained between 24% and 33%. For financially constrained firms, the main factors that limit future financing for growth ambitions are the lack of collateral and too high a price. The main results indicate that measures to facilitate equity investments and making

existing public measures easier are the most important factors for future financing while tax incentives only play a minor role.

The results of the study can be particularly useful for policy makers, providing evidence of the set of policies needed to improve financial inclusion, especially for companies most in need and playing a key role in the economy, as innovative SMEs. As a complement to direct or indirect support for R&D and Innovation (more focused on investment in fixed assets), innovative companies also need financial support for daily activities. Launching a new product on the market has not only new production costs but also implies higher working capital needs, in order to pay suppliers and workers while the company finds new customers or markets and generates liquidity. Making venture capital operations easier, providing access to credit lines or secured loans could be complements to direct and indirect support to reduce the financing pressure on innovative firms and entrepreneurs across Europe.

Keywords: Access to finance; innovative firms; European Union.



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1. Introduction

Joseph Schumpeter (1934) was the first to defend that financial intermediaries in the capital market are essential for innovation and economic growth. However, due to asymmetric information between entrepreneurs and investors several firms are faced with financing constraints. Usually, innovative firms are more financially constrained than non-innovative ones (Aghion et al. 2004; Belin et al. 2011). Indeed, in addition to the problem of asymmetric information, innovative firms have fewer collateralizable assets (Hall and Lerner 2010) because "the capital created by R&D is largely intangible and firm-specific, limiting its resale market value" (Hall 2009:11). This situation could be associated with a higher risk for lenders if the firm has not enough valuable collateral since, in the case of non-payment of the debt by the borrower, the investor's loss is also higher. For this reason, lenders generally request higher collateral, in order to reduce their loss and considering the observed-risk hypothesis (Blazy and Weill 2013). So due to uncertainty and risk, financial institutions are reluctant to invest in R&D projects compared to more traditional business projects (Mazzucato 2013).

Financing constraints have been highlighted by many authors (Canepa and Stoneman 2008; Iammarino et al. 2009) as a significant obstacle to innovation, but the degree of exposure to this problem is not homogeneous among firms. The identification of constrained firms is particularly important for policymakers in order to design effective policy orientation and to give public support to firms most in need (Hottenrott and Peters 2012).

The present paper focuses on direct assessment of financing constraints through the anonymous survey on SMEs' access to finance in the euro area (SAFE), undertaken together by the European Commission and the European Central Bank (ECB).

Using a Recursive Bivariate model, where the first equation is to demonstrate an innovative behavior and the second to be a financially constrained firm, the paper aims to: i) identify which factors, both internal and external to the firm, have a higher impact on hindering access to finance; and ii) assess how far innovative behavior can induce financing constraints. On the other hand, the present study also aims to assess differences between innovative firms and non-innovative ones, as regards firms' perception about the characteristics of the supply side of the financial market. The study centers on European SMEs that have growth ambitions and therefore need external finance since information about obstacles is only available for this group of firms.

The contribution and originality of the paper are based on the inclusion in the model of variables related to firms' external factors and linked with financial market characteristics, considered limiting as regards obtaining finance for growth ambitions. Indeed, most studies carried out have focused more on firms' characteristics or countries' institutional factors as the main determinants of firms' financing constraints. However, the paper intends to go further and assess which constraints on the supply side lead to financing constraints. Difficulties in access to finance have been highlighted as an important obstacle to innovative activities, but the reverse relationship remains little explored. Finally, we use a data source (SAFE) that, as far as we are aware, has not previously been used to this end.

The paper is structured as follows. Section 2 presents the theoretical framework of the study. Section 3 describes the database. Section 4 defines the conceptual framework and methodology. Section 5 presents the results. Section 6 concludes and provides some policy recommendations.

2. Background theory and literature review

From the corporate finance perspective, the decision to invest depends on the price or cost of such an investment and the required rate of return. The neo-classical long-run model of Jorgenson (1963) explains that the investment demand or the desired amount of capital stock is a function of a firm's output and of user capital cost, where the output takes into account the price and quantity of goods and services, and the user capital cost is estimated taking in the rate of taxation, interest rate and rate of investment replacement. Furthermore, the cost of capital is also determined by a firm's capital structure, i.e., a mix between internal and external (debt and equity) financing. According to the Modigliani and Miller (1958) theorem, internal and external sources of financing are perfect substitutes. However, the main limitations of this hypothesis lie in the

authors' assumptions regarding perfect markets (without asymmetric information, risk, uncertainty, taxes and bankruptcy costs) and the same cost of capital irrespective of financing sources and investment type (Hall and Lerner 2010). Indeed, there are several reasons why internal and external not perfect substitutes are, namely the availability of internal finance, access to debt or equity financing, or the functioning of the credit market (Fazzari et al. 1988).

The use of internal sources of financing is influenced by its availability and by moral hazard problems and tax considerations. Moral hazard refers to the difficulty in separating the interests of management and ownership, and when the manager's investment strategy does not tie in with the owner's goal of maximizing the firm's value

(Hall and Lerner 2010). In such cases, in order to reduce agency cost, owners can influence the value of the R&D investment to protect themselves from risk and by limiting access to the use of internal capital (Jensen and Meckling 1976). Tax considerations relate to the fact that debt and retained earnings are taxed differently (Auerbach 1984). For example, debt is tax-deductible at the corporate level (tax savings for interest paid on the debt), whereas using retained earnings as a source of finance could lead to the owner avoiding personal tax on dividends, but the firm's capital gains are still taxed at the corporate level (Hall and Lerner 2010).

Nonetheless, despite the entrepreneur's preference for internal or external sources of finance, after-tax considerations, their choices could also be influenced by credit rationing. Stiglitz and Weiss (1981) were among the main contributors in explaining the phenomena of credit rationing, arguing that if rationing exists, it is due to market failures. These authors explained that excessive demand for loans should be solved by an increase in price (interest rate), leading to an adjustment of demand and supply until reaching the market equilibrium. However, imperfect information and adverse selection lead banks to limit the supply because it is difficult for them to identify borrowers who are more likely to repay their loans. So, given the uncertainty about the expected return, due to potential risk, banks prefer to ration the supply of loans, despite the existence of demand.

Consequently, firms can face financing constraints due to the difficulty in accessing external finance but also to the insufficiency or non-availability of internal funds. A major challenge in identifying a financially constrained firm concerns also the nature of the concept, which is more subjective to each firm than empirically observable or directly measurable (Silva and Carreira 2012a).

Fazzari et al. (1988) introduced the sensitivity of investment

to cash-flow as an indirect measure of financing constraints, on the basis that this indicator can reflect firm liquidity, availability of internal funds for debt repayment and net worth positions, which can also have an impact on the cost of new debt. Despite some criticism and limitations¹, this method has been used by many authors to test the effect of financing constraints on the firm's decision to invest, both in traditional tangible assets (Moyen 2004; Fee et al. 2009) and in innovation or R&D (Himmelberg and Petersen 1994; Bond et al. 2005; Cincera and Ravet 2010). Besides cash flow having a positive effect on investment, Himmelberg and Petersen (1994) also defend that its effect on R&D investment could be higher than on an ordinary investment given their different characteristics (tangibility and collateralization).

A more recent alternative to measuring financing constraints is using survey data (Canepa and Stoneman 2002; Iammarino et al. 2009; Coad et al. 2016) or company report information (Hadlock and Pierce 2010). These indicators are built on the results of entrepreneur perception and self-evaluation of financing constraints. Direct measures of financing constraints can avoid some bias affecting indirect measures (Hall et al. 2016), but due to the subjective nature of self-assessment, this could also be a potential source of bias (Silva and Carreira 2012b).

The present study focuses on direct assessment of financing constraints through an anonymous survey on SMEs' access to finance in the euro area (SAFE). Ferrando and Mulier (2013), assessing firms' financing constraints using a SAFE database and firms' financial statements, demonstrated that firms which perceived financing constraints have similar characteristics to those faced with an actual situation. So, we can deduce that the potential source of bias due to the self-assessment used for the SAFE database is minimal.

3. Database and sample selection

The database comes from the anonymous "Survey on the Access to Finance of SMEs in the euro area" (SAFE). SAFE is conducted bi-annually together by the European Central Bank and the European Commission since 2009.

We used data from the first round in 2015 of SAFE, which covers the period from April to September 2015. Firms are asked to answer, among other topics, about the availability of financing and market conditions over the past six months, as well as their growth ambitions for the period 2015 to 2017, underlining financing obstacles to growth.

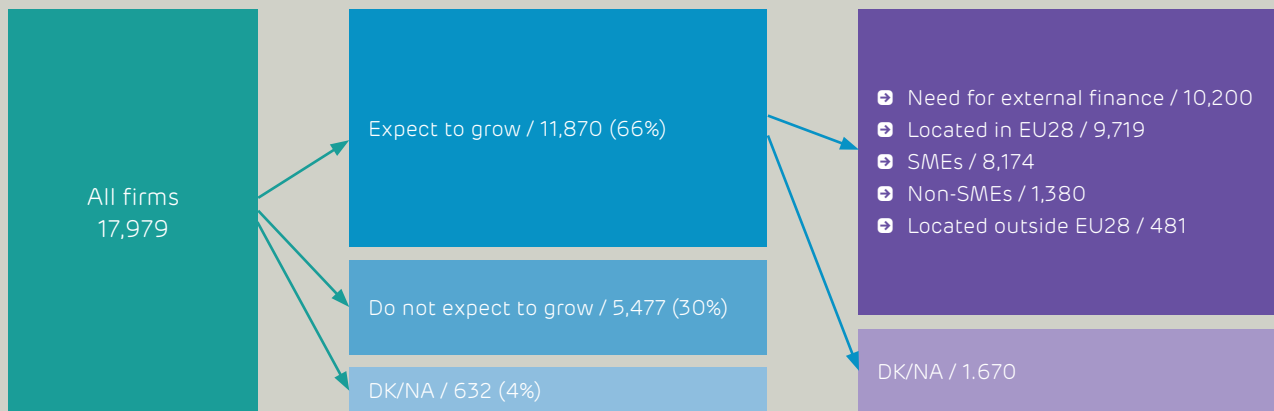
The present study focuses on SMEs located in EU28 that expect to grow and need external finance to carry out their

growth ambitions since we have information on SAFE about the main dimensions we want to assess only for this group of firms. Only firms answering that they need external financing to realize their growth ambitions are asked about the most limiting factor in acquiring this finance. Similarly, only firms expecting to grow were asked about the amount of external finance to realize their growth ambitions. Taking into account all these criteria, the initial sample (Figure 1) comprises 8,174 SMEs located in EU28, which expect to increase their turnover in the next two to three years and need external finance to do so. However, only 5,391 firms provided a valid answer to all questions on the survey, and these form the sample used in the present study.

¹ For more details, see Kaplan and Zingales (1997 and 2000) or Hall et al. (2016) for a survey of the literature.

Figure 1

→ Sample repartition by group



Source: Authors' own elaboration based on SAFE database.
 Note: DK/NA = do not know or not applicable.

The firm size is divided into three categories (micro, small, and medium-sized firms) considering as criteria, the number

of employees and turnover, as reported in the Commission Recommendation 2003/361.

4. Conceptual framework and methodology

The paper aims at identifying, firstly, which factors on the supply side of financial markets have the highest impact on hindering European firms' access to finance, and, secondly, assessing how far innovative behavior can induce financing constraints. Therefore, the first two steps involve the definition of being financially constrained and being an innovative firm. Innovative firms are those answering in the SAFE questionnaire that they had introduced in the past 12 months a new (or significantly improved) product, service, process, method, management organization, or way of selling goods or services. This classification also corresponds to the Schumpeter (1934) and OECD (2005) definition of an innovative firm.

Concerning firms' financial status of being financially constrained, we used the answer to the question about how great problem access to finance was for their business in the past six months. The answer is on a scale of 1 to 10, where 1 means it is not at all important and 10 means it is extremely important. In order to define the firms' financial status, we need to determine the limit from which firms are considered financially constrained. Authors (Canepa and Stoneman 2008; Iammarino et al. 2009) using survey data, as Community Innovation Survey (CIS), where the degree of importance of obstacles to innovation activities is on a 4-point Likert scale, from 0 (no effect or not relevant) to 3 (high or very important), classified firms as constrained if they responded 2 (important) or 3 (very important).

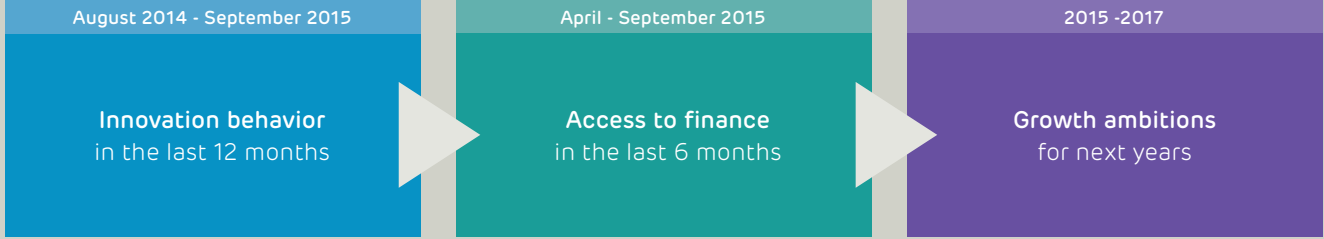
Following this approach and converting the SAFE scale to the CIS scale, we obtain the limit of 7.5 or more precisely of 8. However, if we observe the mean of the degree of the problem for those firms that considered access to finance as the most pressing of all the problems listed in the survey (Table III in Appendix), these firms reported a score of almost 9. Therefore, we performed preliminary estimations² using three possibilities for financing constraints, considering the degree of access to finance as an important problem between 7-10, 8-10 and 9-10. The model where access to finance is on a scale between 9 and 10 explains the data better, for the reasons that it has higher overall rate of correct classification, pseudo R², and likelihood functions. Therefore, we defined financially constrained firms as those rating the degree of access to finance as a pressing problem at 9 and 10.

The conceptual framework is based on the fact that innovative behavior can affect access to finance, which consequently could be an obstacle to firm growth ambitions. The underlying dynamic of this process is schematized in Figure II, where innovation behavior is observed before or simultaneously to the firms' perception of access to finance as a pressing problem. As innovation behavior is observed before access to finance as a pressing problem, the inverse relationship (impact of financing on innovation) cannot be precisely tested.

² Results available upon request

Figure 2

→ Conceptual framework timeline



Source: Authors' own elaboration.

Endogeneity represents a major issue when we assess the effect of innovation behavior on whatever firms' reported statement. According to Savignac (2008), the decision to undertake an innovative project is subject to a selective process, and both innovation behavior and financial constraints are affected by common unobservable individual characteristics. One way to deal with unobservable problems is to use a switching simultaneous-equations model, as suggested by Maddala (1983), when selectivity is due to more than one source of bias. An example of this model is the Recursive Bivariate Probit Model (RBPM), used by Savignac (2008), to assess the effect of financing constraints on the innovation or R&D decision, respectively. The Bivariate Probit Model is based on a Probit model with

sample selection, following Heckman (1979).

The RBPM adopts a structural approach in which the second equation (y_{2i}^*) includes the dependent variable of the first equation (y_{1i}) as an endogenous variable, and both variables of interest are binary variables. Explanatory variables (x_i) of both equations can have common elements, but also need to have some different exogenous variables in each equation (Maddala 1983). The RBPM assumes that the error terms (ϵ_{1i} and ϵ_{2i}) are independent and follow a bivariate standard normalization distribution (2). However, the joint estimation of both equations is only required if the correlation coefficient of the two error terms is $\rho \neq 0$, in order to generate consistent estimates.

$$\begin{cases} y_{1i}^* = x_{1i}\beta_1 + \epsilon_{1i}, \\ y_{2i}^* = x_{2i}\beta_2 + \theta_1 y_{1i} + \epsilon_{2i}, \end{cases} \quad \begin{cases} y_{1i} = 1 \text{ if } y_{1i}^* > 0; 0 \text{ otherwise,} \\ y_{2i} = 1 \text{ if } y_{2i}^* > 0; 0 \text{ otherwise} \end{cases} \quad (1)$$

$$\begin{pmatrix} \epsilon_{1i} \\ \epsilon_{2i} \end{pmatrix} \rightarrow \Phi_2 \left[\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix} \right] \quad (2)$$

where Φ_2 refers to the bivariate standard normal-distribution function

The ρ also reports the magnitude and direction of bias due to the endogenous nature of y_{1i} in the second equation. For example, when $\rho > 0$ this means that ignoring the endogeneity of y_{1i} biases the result of the coefficient θ_1 upwards in comparison to estimation taking into account the endogeneity of y_{1i} , whereas when $\rho < 0$ this implies

a downward bias of the results of θ_1 , when the second equation is estimated ignoring the endogenous nature of y_{1i} (Chiburis et al. 2011).

In the present study, the dependent variable of the first equation (y_{1i}), the endogenous variable, refers to firm

innovation behavior. The dependent variable of the second equation (y_{2i}^*) refers to the extent to which firms may be financially constrained. Explanatory variables included in the first equation refer to determinants of innovation activities (Crépon et al. 1998; Savignac 2008) namely, firm characteristics (size, age, type of ownership and international position of sales) and the degree of competition (proxy for market power).

The second equation is based on the model of Aghion et al. (2004), where being a financially constrained firm is explained by innovation behavior and firms' characteristics. According to the literature, firm characteristics include size, age, type of ownership, activity sector, international position of sales and firms' liquidity indicators (decrease of sales and increase of cost, increased own capital, and decreased availability of bank debt). We also add to the model other factors able to explain the dependent variable, such as future financial needs, factors in the financial market limiting future finance for growth, and the importance of factors for future financing. The amount of financing is likely to affect access to finance since higher investment projects tend to be riskier, and due to asymmetric information, firms are faced with credit rationing. As regards the second and third groups of explanatory variables, they included factors explaining market conditions in the financial market,

namely obstacles and limitations identified by firms, which could influence future financing and explain the financing constraints. These explanatory variables include factors that can be considered as problems on the supply side (such as collateral requirement, price, and bureaucracy) and variables that reflect potential solutions (important factors to obtain future financing) to facilitate access to finance. A positive relationship between these explanatory variables and the dependent variable (to be financially constrained) could indicate that the more important an obstacle for future financing, the more difficult it is for a firm to access external finance. On the other hand, a negative relationship between these explanatory variables and the variable of interest could indicate that policy intervention in this area or for this kind of firm is less relevant. Both equations also included country and industry fixed effects, which allow capturing the demand for external finance. For more details about variables' definition see Table II in Appendix.

All regression estimations are weighted, in order to control for firms' characteristics (size, industry sector and country) representativeness in their country and in the EU. We used the weight variable present in the SAFE database, where the weight of each enterprise is adjusted in each size class, economic sector, and country.

5. Results and discussion

5.1. Sample description: financially constrained vs non-constrained firms

Table III in Appendix reports the distribution of the sample by firm characteristics and financial indicators. The sample is composed of micro (31%), small (32%), and medium-sized firms (37%). Around 92,5% are more than five years old and are owned mainly by one or more natural person (79.6%). Regarding the distribution by sector, all categories are quite well represented, despite a higher proportion of services to businesses or individuals (36.3%) and a smaller one for the construction sector (10.2%). Nearly 55% of firms sold their goods and/or services in foreign markets in 2014, and about 67.4% have launched an innovation³ in the market or their own organization (such as a new process, work restructuring, or new way of selling).

Financially constrained firms and non-financially constrained ones show significant differences in almost all categories. Innovative, smaller, and younger firms are more frequently financially constrained. Nearly 39% of the observed firms have increased their own capital in the last six months, and non-financially constrained firms show a higher growth of their own capital in comparison with their counterparts. Around 8% of the sample have experienced in the last six months, a simultaneous decrease in turnover and an increase in costs, and this situation is more frequent for financially constrained firms. Modifications in bank financing regarding the size of loan or credit line available have affected 2.7% of the sample, with a significantly higher proportion in the financially constrained group (8%).

³ This proportion of innovative firms is a little higher than the percentage of innovative firms in the last Community Innovation Survey (CIS) of 49%, but if we consider the whole sample, this value is closer to the 2014 CIS, with a representativeness of 60%. This finding suggests that in the group of firms with growth ambitions, there is a higher proportion of innovative firms.

Concerning the amount of external financing needed to realize growth ambitions, about 71.6% of the sample answered they needed more than €25,000 and up to €1 million, and 16.2% over €1 million. Financially constrained firms indicated a higher amount of financing for expected future growth than non-constrained ones, especially for amounts over €1 million.

Approximately 43% of the sampled firms reported no

obstacles for obtaining future financing to realize their growth ambitions, despite around 21% of them declared to be financially constrained. Insufficient collateral or guarantee (18.9%) and too high-interest rate or price (14.1%) were the two most commonly obstacles reported by firms. Differences of means between financially constrained and non-constrained firms are only observed in the collateral requirement, high price, and other factors, the first two being the main obstacles for financially constrained firms.

5.2. Interpretation of model estimations: Financing constraints for growth ambitions

Starting with the estimation of a univariate Probit model where innovation behavior is considered an exogenous variable⁴, we observe that being an innovative firm has a positive but non-significant effect on the probability of being financially constrained. Nevertheless, when testing for endogeneity of innovation behavior, including those in an equation system composed of two Probit models (first equation referring to innovation behavior and the second to the probability of being financially constrained), the results of Recursive Bivariate Probit Model estimation (Table I) show a significant negative correlation between the errors of both equations ($\rho = -0.66$). This conclusion means that to obtain consistent estimators, both Probit equations need to be estimated jointly, in order to control for endogeneity bias.

The negative value of ρ also means that the existing bias due to endogeneity lowers the effect of innovation behavior on the firm's financial statement of being financially constrained. This assumption is confirmed when we compare the results of the coefficients of innovation behavior obtained with the univariate Probit⁵ ($\beta = 0.004$) and the recursive bivariate Probit ($\beta = 1.056$). This difference reveals that unobservable firm characteristics affecting both equations and the selection process play a vital role and need to be considered to reduce potential bias.

The Goodness-of-fit test of RBPM, which assesses if the data are consistent with a specified distribution, reports that our model fits data well. The multicollinearity diagnostic⁶ performed using a correlation matrix and variance inflation factor (VIF), shows that our independent variables are not correlated with each other, leading to precise estimation.

Regarding the suitability of the first equation, interpretation of the coefficients in column (1) of Table I reveals that innovation behavior is positively affected by the degree of competition by a linear relationship and a 100% increase in the degree of firms' competition pressure increases by 0.8% the probability of a firm introducing an innovation in the market, everything else remaining constant. The presence in international markets (exporter) and being an equity-backed firm, compared to the reference category, also have a positive impact on the likelihood to innovate. Being an exporter increases by 8.4% the probability of firms having innovation behavior and being equity-backed firms by 20.6%.

Despite firm size and age have the expected sign (larger and younger firms are more likely to innovate), they are non-significant. As equation 1 model reports consistent results, it could be considered as a good predictor of innovation behavior, which affects the probability of being financially constrained.

⁴ Results are available upon request.

⁵ Not reported, but available upon request.

⁶ Results available upon request.

Table 1

→ Effect of financing in period 't-1' on innovation behavior in period 't'

Variables	Equation 1: Being an innovation firm			Equation 2: Being financially constrained		
	Coeff. (1)	Std. Err. (2)	dy/dx (3)	Coeff. (4)	Std. Err. (5)	dy/dx (6)
Innovative firm	-	-		1.056 ***	0.182	0.235
Size: Small	-0.032	0.054	-0.011	-0.050	0.067	-0.011
Size: Medium	-0.026	0.056	-0.009	-0.157 **	0.076	-0.035
Age: Young firm	0.103	0.083	0.036	0.080	0.096	0.018
Ownership: public shareholders	0.029	0.136	0.010	-0.092	0.151	-0.020
Ownership: VC or business angel	0.584 *	0.318	0.206	0.056	0.239	0.012
Exporter	0.238 ***	0.046	0.084	-0.100 *	0.061	-0.022
Decrease sales and increase cost	-	-		0.100	0.076	0.022
Bank decreases available debt	-	-		0.528 ***	0.121	0.118
Increase own capital	-	-		-0.096 *	0.051	-0.021
Future need: Up to €25,000	-	-		-0.419 ***	0.109	-0.093
Future need: €25,000 - €100,000	-	-		-0.291 ***	0.084	-0.065
Future need: €100,000 - €250,000	-	-		-0.202 ***	0.078	-0.045
Future need: €250,000 - €1 million	-	-		-0.218 ***	0.075	-0.048
Obstacle: price	-	-		0.363 ***	0.078	0.081
Obstacle: loss of control	-	-		0.292 **	0.119	0.065
Obstacle: bureaucracy	-	-		0.309 ***	0.086	0.069
Obstacle: collateral	-	-		0.533 ***	0.075	0.119
Obstacle: other	-	-		0.485 ***	0.082	0.108
Importance: guarantees for loans	-	-		0.051 ***	0.010	0.011
Importance: easier access to equity	-	-		0.043 ***	0.011	0.010
Importance: export credit	-	-		0.023 **	0.010	0.005
Importance: tax incentives	-	-		0.029 ***	0.011	0.006
Importance: business support services	-	-		-0.013	0.012	-0.003
Importance: easier access to public measures	-	-		0.042 ***	0.013	0.009
Competition	0.022 **	0.009	0.008	-	-	
Constant	0.077	0.095		-2.487 ***	0.158	
Activity sector and country dummy		YES			YES	
Log likelihood functions			-3,627.03			
Wald test – H0: All coefficients = 0			0.0000			
Coefficient correlation: rho			-0.660***			
Wald test – H0: rho=0			0.0001			
Goodness-of-fit test – H0: model fits well data			0.2500			
Number of observations (firms)			5,391			

Source: Authors' own elaboration based on SAFE database.

Note: Industry and country dummies are included in the estimation but not reported in the table.

Robust standard errors in parentheses. Significance: *** p<0.01, ** p<0.05, * p<0.1 Reference category for firm size: micro, for activity sector: services, for main ownership: all other categories (one or more individuals, other enterprises and others not listed), for future external financing needs: over €1 million and for obstacle to future financing: no obstacles. Results of goodness-of-fit test in RBPM refer to Murphy's score test.

The results of the second equation reveal that after controlling for endogeneity and firms' characteristics, being an innovative firm now has a positive and significant effect on being financially constrained and increases the probability of having difficulties in accessing external finance by 23.5%, everything else being equal. This result is also in line with the conclusions of Lee et al. (2015), who found that being an innovative firm increases the probability of facing strong credit rationing between 20% and 40%.⁷

As expected, external financing constraints decrease with firm size, if firms have improved their capital provided by owners or shareholders, and if firms sold their goods and services in the international market. These findings are in line with Savignac (2008) and Coad et al. (2016), respectively. Being an exporter decreases by 2.2% the probability of being an innovative firm, and the improvement of firm capital by their owners by 2.1%. Medium-sized firms, in comparison with micro-sized firms, are 3.5% less likely to be financially constrained, whereas no significant difference exists between small and micro-sized firms.

Indicators representing a temporary loss of liquidity, such as a decrease in the size of loans or credit lines available from banks, increase the likelihood of being financially constrained by 11.8%. Nevertheless, no significant evidence was found concerning the effect of different types of ownership, firm age, and the loss of cash-flow due to a simultaneous decrease of turnover and an increase of costs on the likelihood of being financially constrained.

The size of the future external financial need is also a relevant indicator of being financially constrained. The likelihood of being financially constrained increases with the amount of finance and firms that need more than 1€ million for their growth ambitions are more likely to have difficulties in accessing external finance.

Regarding the main factors limiting future financing for

firms' growth ambitions, the results of marginal effects illustrate that firms' insufficient collateral or guarantee (11.9%) and too high an interest rate or price (8.1%) are the two factors with the highest impact on the probability of being financially constrained, compared to a situation with no obstacles, excluding the category of other factors not listed (10.8%). All other factors (too much paperwork involved and reduced control over the enterprise) also have a positive effect on our dependent variable, but their effects are smaller (6.9% and 6.5%, respectively).

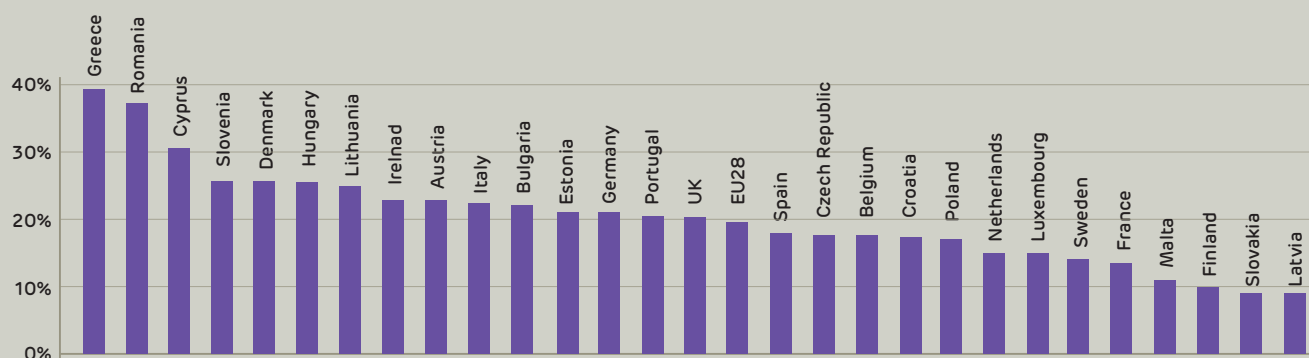
Concerning the degree of importance of factors for firms' financing in the future, marginal effects of RBPM show that guarantees for loans (1.1%), measures to facilitate equity investment (1%) and making existing public measures easier to obtain (0.9%) have the highest impact on the probability of being financially constrained. For example, an increase of 100% in the degree of importance of guarantees for loans leads to an increased likelihood of being financially constrained by 1.1%, whereas easier access to equity financing or public support increases the likelihood by 1% and by 0.9%, respectively. Business support services for firms do not appear to be a significant factor explaining the dependent variable. Tax incentives represent the factor with the lowest significant positive effect, despite this factor being the one with the second-highest score reported by surveyed firms. This may reveal that although important, this instrument is not the most relevant to solve the problem of financing constraints.

A cross country analysis (Figure III) shows that in EU28 the average probability of being financially constrained for firms with growth ambitions is 19.4%. Firms located in Greece (38.4%), Romania (36.2%) and Cyprus (29.6%) are much more constrained than the EU average, whereas those in Finland (10.1%), Slovakia (9.3%) and Latvia (9.3%) are less constrained. Above the average, we also find the United Kingdom (19.8%), Portugal (20.1%), and Germany (20.6%) and below, Spain (17.8%), the Czech Republic (17.4%), Belgium (17.3%) and Croatia (17.1%).

⁷ Lee et al. (2015) assessed firms' difficulties in accessing finance using as dependent variables: i) Having difficulties in obtaining financing; ii) Not receiving all the financing requested in the application; iii) Not receiving any finance from first or any source. In order to compare results, we estimated the marginal effect on the basis of the coefficient reported in the mentioned paper for "not receiving any financing after application submission", because this situation refers to stronger credit rationing than not receiving all of what was requested or simply finding trouble in receiving financing.

Figure 1

Sample repartition by group



Source: Authors' own elaboration.
Note: Number of observations = 3,786.

Additionally, and in order to validate the results obtained, we performed several robustness tests. The first of them was to use panel data to control for firms' specific unobserved effects covering two years (2014 and 2015) of SAFE and to estimate the same RBPM, but the main limitation of this approach is the substantial reduction of the sample size. Only 16% of the firms surveyed in 2015 answered the questionnaire in 2014 and provided valid answers to all the dimensions under analysis in both surveys. Furthermore, firms located in some countries (such as Malta, Luxembourg, and Cyprus) were excluded due to the lack of information about them. Results⁸ indicate that being an innovative firm still has a positive and significant effect on being financially constrained, and increases the probability of having difficulties in accessing external finance by 33.3%.

Regarding the main factors limiting future financing for firms' growth ambitions, the results of marginal effects also reveal that firms' insufficient collateral or guarantee and too high an interest rate or price are the two factors with the highest impact on the probability of being financially constrained, which is in line with the conclusions of RBPM using cross-sectional data. Concerning the degree of importance of factors for firms' future financing, only guarantees for loans have a positive and significant effect. However, the size of the marginal effect is the highest (in its category), which confirms the previous result obtained. Nevertheless, the degree of importance of measures for easier access to equity financing or public support seems now to be non-significant.

5.3. Complementary analysis: assessing differences regarding innovative and non-innovative firms

As a complementary analysis and in order to assess differences between innovative and non-innovative firms, we also estimated for both groups a univariate Probit regression for being financially constrained (not reported, but available upon request). The marginal effects of the main explanatory variables under analysis are displayed in Table IV in Appendix.

Starting with the amount of future financing needs, we can see that for both groups, being financially constrained increases with the amount of financing, but the difference lies in the threshold of financial needs to realize growth ambitions from which firms are considered constrained. For non-innovative firms, there is no difference above €100,000 in comparison with the reference category

over €1 million, whereas for innovative firms, all categories of financing needs are always significant. One possible justification for this finding could be that innovative firms need a higher amount of financing for growth ambitions, as illustrated in Table V in Appendix where differences in means are reported.

Regarding the main factors limiting future financing for firms' growth ambitions, for both innovative and non-innovative ones, firms' insufficient collateral or guarantee is the factor with the highest impact on the probability of being financially constrained, compared to a situation with no obstacles. Excluding the category of other factors not listed, differences between innovative firms and non-innovative ones appear in terms of perceiving interest rates

⁸ Not reported but available upon request.

or prices to high, which for innovative firms has the second-highest impact on the dependent variable, whereas for non-innovative firms, it appears in the third position.

Concerning the importance of different factors in obtaining future financing, for both groups guarantees for loans, measures to facilitate equity investments and making existing public measures easier to obtain are the most relevant factors. The importance of tax incentives and export credits are only significant variables explaining firms' financial status for innovative firms, but the size of the effect is smaller in comparison with the other significant variable in this category. These findings suggest that on the one hand, firms for which tax incentives are a relevant factor in future financing are less financially constrained, perhaps because this policy measure implies financial compensation for an investment, or an expenditure already made. Hence, firms have a priori financial resources to

do so. On the other hand, considering that financing constraints are essentially linked with liquidity problems, the lesser importance of tax incentives could be due to the inappropriate use of this instrument in all stages of the firm's life and product cycle. Indeed, tax incentives for R&D provide financial support at the starting point of the innovation process, but do not help firms in the next steps, to place innovation in the market. To obtain financial resources for cash flow, firms can usually resort to a credit line or bank overdraft. However, a recent study (Cincera and Santos 2018) showed that innovative firms, due to their riskier activities, have to pay a higher interest rate and are more likely to see the collateral requirement increased than non-innovative firms. These conclusions are in line with the findings of the present study, where guarantees for loans are one of the main causes of firms' problems in accessing finance.

6. Conclusion

The present study presents a direct assessment of financing constraints through the anonymous survey of SMEs in the euro area (SAFE) as regards access to finance. Using a Recursive Bivariate Probit Model, the paper contributes to the literature, firstly by identifying which factors on the supply side of the financial market have the most impact on hindering firms' access to finance and secondly assessing how far innovative behavior can induce financing constraints.

The results show that some firms are more constrained and have more difficulties in accessing external finance. Both internal and external factors affect firms' access to financing. In line with the literature, smaller firms and firms with liquidity problems are more financially constrained, whereas increasing the firm's own capital and selling in the international market decrease the likelihood of being financially constrained.

Innovative firms are more constrained and are between 23.5% and 33.3% more likely to be financially constrained than their non-innovative counterparts.

The size of future financing needs to realize growth ambitions also matters, and on average, an increase in this amount leads to a higher likelihood of being financially constrained. Concerning characteristics of the supply side of the financial market, insufficient collateral and too high-interest rate appear to be the most important factors limiting access to future finance. Besides, guarantees for loans, measures to facilitate equity investments and making existing public measures easier to obtain external finance

appear as the main solutions for alleviating financing constraints. These findings suggest that in the absence of financing possibilities with banks, firms need to find alternative solutions, such as equity financing (Venture Capital or Business Angels) or public support.

Innovative and non-innovative financially constrained firms have the same main limiting factor regarding future financing, i.e., insufficient collateral or guarantee. However, the results also suggest that too high interest rate or price have a higher negative impact for innovative firms than for non-innovative ones. Additionally, public support (e.g., tax incentives and other public measures to support investment) is only a significant factor explaining the financing constraints of innovative firms.

The results of the study can be particularly useful for policymakers, providing evidence of the set of policies needed to improve financial inclusion, especially for companies most in need and playing a key role in the economy, as innovative SMEs. As a complement to direct or indirect support for R&D and Innovation (more focused on investment in fixed assets), innovative companies also need financial support for daily activities. Launching a new product on the market has not only new production costs but also implies higher working capital needs, in order to pay suppliers and workers while the company finds new customers or markets and generates liquidity. Making venture capital operations easier, providing access to credit lines or secured loans could be complements to direct and indirect support to reduce the financing pressure on innovative firms and entrepreneurs across Europe.

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Appendix

Table 2

→ Variable definition and description

Variable name	Variable description
Dependent variable – Equation 1	
Finance	Degree of access to finance pressing problem for the firm in the past six months. Answer on a scale of 1-10, where 1 means it is not at all important and 10 means it is extremely important.
Financing constraints	= 1 if firm has answered 9 or 10, on a scale of up to 10 where 10 means extremely important, to the following question: How pressing a problem has access to finance been for the firm in the past six months?; 0 otherwise.
Dependent variable – Equation 2	
Innovative firm	= 1 if firm has introduced during the past 12 months, one of the following types of innovative activities: a) new or improved product or service; b) new or improved production process or method; c) new organization of management; d) new way of selling goods or services (marketing); 0 otherwise.
N° innovation type	N° of different type of innovation introduced by the firm during the past 12 months, among the four listed. Zero means no innovation has been introduced in the market and firm is considered a non-innovative one.
Independent variables	
Firm size	
<i>Firm size considering the criteria: number of employees and amount of turnover, as reported in the Commission Recommendation 2003/361.</i>	
Size: Micro	= 1 if micro firm; 0 otherwise (reference category).
Size: Small	= 1 if small firm; 0 otherwise.
Size: Medium	= 1 if medium-sized firm; 0 otherwise.
Firm's main ownership	
Ownership: VC or business angel	= 1 if firm's main ownership lies with venture capital enterprises or business angels; 0 otherwise.
Ownership: public shareholders	= 1 if firm's main ownership lies with public shareholders, as firm is listed on the stock market; 0 otherwise.
Ownership: one or more owner	= 1 if firm's main ownership lies with one owner only, family or entrepreneurs; 0 otherwise (reference category).
Ownership: other enterprises	= 1 if firm's main ownership lies with other enterprises; 0 otherwise (reference category).
Ownership: other	= 1 if firm's main ownership lies with other business associates or others not previously listed; 0 otherwise (reference category).
Firm age	
<i>Firm age was divided in three categories considering the criteria of Criscuolo et al. (2014).</i>	
Age: Young firm	= 1 if it is a young firm less than 5 years old; 0 otherwise.
Age: Mature firm	= 1 if it is a mature firm between 5 and 10 years old; 0 otherwise (reference category).
Age: Old firm	= 1 if it is an old firm more than 10 years old; 0 otherwise.
Liquidity indicators	
Increase own capital	= 1 if the firm has improved firm's capital provided by owners or shareholders over the past six months; 0 otherwise.
Decrease sales and increase cost	= 1 if the firm has simultaneously decreased its turnover and increase any type of cost over the past six months; 0 otherwise.
Bank decrease available debt size	= 1 if bank has decreased the available size of loan or credit line over the past six months; 0 otherwise.
Firm international behavior	
Exporter	= 1 if firm sells to international market (exporter); 0 otherwise.
Amount of external financing needs to realize firms' growth ambitious	
Future need: Up to €25,000	= 1 if the amount of future financing needs is up to €25,000; 0 otherwise.
Future need: €25,000 - €100,000	= 1 if the amount of future financing needs is more than €25,000 and up to €100,000; 0 otherwise.

Source: Authors' own elaboration based on SAFE Survey template.

Table 2

➔ Variable definition and description

Variable name	Variable description
Future need: €100,000 - €250,000	= 1 if the amount of future financing needs is more than €100,000 and up to €250,000; 0 otherwise.
Future need: €250,000 - €1 million	= 1 if the amount of future financing needs is more than €250,000 and up to €1,000,000; 0 otherwise.
Future need: €1 million	= 1 if the amount of future financing needs is over €1,000,000; 0 otherwise (reference category).

Main determinants of innovation behavior

Competition	How important is competition a problem for firms in the past six months? Answer is on a scale of 1-10, where 1 means it is not at all important and 10 means it is extremely important. Variable in natural logarithm.
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Most important factor limiting access to future financing

What do firms see as the most important limiting factor regarding future financing? Only one answer.

Obstacle: price	= 1 if interest rates or price are too high; 0 otherwise.
Obstacle: loss of control	= 1 if reduced control over the enterprise; 0 otherwise.
Obstacle: bureaucracy	= 1 if too much paperwork is involved; 0 otherwise.
Obstacle: financing availability	= 1 if financing not being available at all; 0 otherwise.
Obstacle: collateral	= 1 if it is insufficient collateral or guarantee; 0 otherwise.
Obstacle: other	= 1 if is other; 0 otherwise.
No obstacles	= 1 if there are no obstacles; 0 otherwise (reference category).

Relevance of factors in obtaining future financing

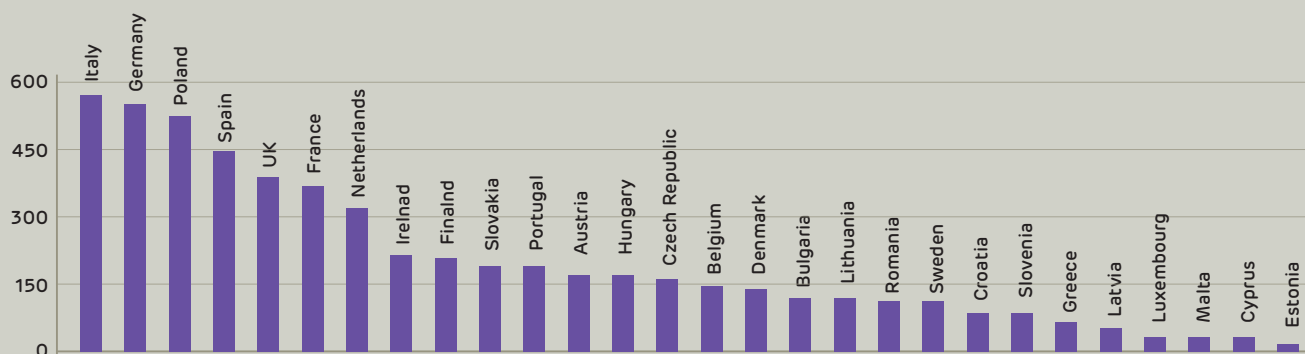
How important are each of the following factors for the firm's financing in the future? Answer is on a scale of 1-10, where 1 means it is not at all important and 10 means it is extremely important.

Importance: guarantees	Guarantees for loans (a commitment by a third party to pay the debt of borrowers when the latter cannot pay it themselves; the guarantor is liable to cover any shortfall or default on the borrower's debt).
Importance: easier access to equity	Measures to facilitate equity investments for firms, for example support for venture capital or business angels.
Importance: export credit	Export credits or guarantees (types of protection for an exporter against non-payment by an importer).
Importance: tax incentives	Tax incentives (deductions or exemption from a tax, usually offered by the government to encourage specific activities).
Importance: business support services	Business support services, for example, advisory services, training, business networks, credit mediation, match-making services.
Importance: easier access to public measures	Making existing public measures easier to obtain, for example, through the reduction of administrative burdens.

Source: Authors' own elaboration based on SAFE Survey template.

Figure 4

➔ Geographical distribution of the sample



Source: Authors own elaboration based on SAFE database.

Note: Total observations = 5,391.

Table 3

T-tests on the equality of means: financing constrained versus non-constrained

Characteristics	Financing constrained		Non-financing constrained		Differences of means	All sample	
	Mean	Std. Err.	Mean	Std. Err.		Mean	Std. Dev.
Finance pressing problem (score between 1-10)		4.763	3.006				
Finance score for those who reported it the most pressing problem (7%)		8.765	1.365				
Finance score for those who reported it to be not the most pressing problem (93%)	4.461	2.877					
To be financing constraints						0.139	0.346
N° of different innovation type	1.631	0.049	1.353	0.018	0.278 ***	1.391	1.253
Innovative firm	0.726	0.016	0.666	0.007	0.060 ***	0.674	0.469
Size: Micro	0.345	0.017	0.305	0.007	0.040 **	0.311	0.463
Size: Small	0.339	0.017	0.317	0.007	0.022	0.320	0.466
Size: Medium	0.316	0.017	0.378	0.007	-0.062 ***	0.370	0.483
Age: Young firm	0.095	0.011	0.072	0.004	0.023 **	0.075	0.264
Ownership: public shareholders	0.017	0.005	0.026	0.002	-0.008	0.024	0.155
Ownership: VC or business angel	0.015	0.004	0.007	0.001	0.008 **	0.008	0.090
Ownership: one or more individuals	0.827	0.014	0.790	0.006	0.037 **	0.796	0.403
Ownership: other enterprises	0.120	0.012	0.142	0.005	-0.021	0.139	0.346
Ownership: other	0.968	0.006	0.967	0.003	0.001	0.967	0.178
Exporter	0.554	0.018	0.551	0.007	0.003	0.551	0.497
Decrease sales and increase cost	0.123	0.012	0.076	0.004	0.048 ***	0.082	0.275
Bank decrease available debt size	0.080	0.010	0.019	0.002	0.062 ***	0.027	0.163
Increase own capital	0.319	0.017	0.402	0.007	-0.084 ***	0.391	0.488
Future need: up to €25,000	0.079	0.010	0.128	0.005	-0.049 ***	0.121	0.326
Future need: €25,000 - €100,000	0.250	0.016	0.269	0.007	-0.018	0.266	0.442
Future need: €100,000 - €250,000	0.250	0.016	0.218	0.006	0.032 **	0.223	0.416
Future need: €250,000 - €1 million	0.225	0.015	0.228	0.006	-0.003	0.228	0.419
Future need: €1 million	0.195	0.015	0.157	0.005	0.038 ***	0.162	0.369
No obstacles	0.205	0.015	0.470	0.007	-0.265 ***	0.433	0.496
Obstacle: price	0.169	0.014	0.136	0.005	0.032 **	0.141	0.348
Obstacle: collateral	0.321	0.017	0.167	0.005	0.154 ***	0.189	0.391
Obstacle: loss of control	0.040	0.007	0.035	0.003	0.005	0.036	0.186
Obstacle: bureaucracy	0.103	0.011	0.086	0.004	0.017	0.089	0.284
Obstacle: other	0.162	0.013	0.105	0.004	0.057 ***	0.113	0.316
Importance: guarantees for loans	7.050	0.105	5.256	0.043	1.793 ***	5.505	3.016
Importance: easier access to equity	5.501	0.113	3.843	0.039	1.658 ***	4.073	2.802
Importance: export credit	4.545	0.118	3.371	0.040	1.174 ***	3.534	2.817
Importance: tax incentives	7.290	0.101	6.176	0.041	1.114 ***	6.331	2.831
Importance: business support services	6.059	0.103	5.063	0.038	0.996 ***	5.201	2.643
Importance: easier access to public measures	7.475	0.095	6.279	0.039	1.196 ***	6.445	2.702
Activity: Industry	0.289	0.017	0.287	0.007	0.002	0.288	0.453
Activity: Trade	0.274	0.016	0.242	0.006	0.032 *	0.247	0.431
Activity: Services	0.331	0.017	0.368	0.007	-0.038 **	0.363	0.481
Activity: Construction	0.106	0.011	0.102	0.004	0.004	0.102	0.303

Source: Authors' own elaboration based on SAFE database.

Note: Total number of observations = 5,391, with non-financing constraints firms = 4,644 and financing constraints = 747. Financing constrained firms are those who have reported a score of 9 or 10 for access to finance as pressing problem. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 4

→ Marginal effects of Probit model: Being financially constrained, by innovation behavior

Variables	Innovative firm dy/dx		Non-Innovative firm dy/dx	
Future need: Up to €25,000	-0.089	***	-0.090	**
Future need: €25,000 - €100,000	-0.061	***	-0.062	**
Future need: €100,000 - €250,000	-0.043	**	-0.040	
Future need: €250,000 - €1 million	-0.058	***	-0.016	
Obstacle: collateral	0.116	***	0.119	***
Obstacle: price	0.084	***	0.073	***
Obstacle: loss of control	0.063	**	0.084	*
Obstacle: bureaucracy	0.075	***	0.056	*
Obstacle: other	0.105	***	0.111	***
Importance: guarantees for loans	0.013	***	0.008	**
Importance: easier access to equity	0.010	***	0.008	**
Importance: export credit	0.007	**	0.001	
Importance: tax incentives	0.007	**	0.003	
Importance: business support services	-0.005		0.001	
Importance: easier access to public measures	0.011	***	0.007	*
Log likelihood functions	-895.69		-381.37	
Pseudo R2	0.1608		0.1782	
Number of observations	3,635		1,756	

Source: Authors' own elaboration based on SAFE database.

Note: Robust standard errors in parentheses. Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Complete results available under request. The reference category for future external financing needs is over €1 million and for obstacle to future financing it is no obstacles. Firms' characteristics, firms' liquidity indicators, activity sector dummy and country dummy are included in the regression but not reported.

Table 5

T-tests on the equality of means: innovative versus non-innovative firms

Variables	Innovative		Non-Innovative		Difference of means	
	Mean	Std. Err.	Mean	Std. Err.		
Size: Micro	0.302	0.008	0.329	0.011	-0.028	**
Size: Small	0.321	0.008	0.317	0.011	0.004	
Size: Medium	0.377	0.008	0.354	0.011	0.024	*
Age: Young firm	0.011	0.002	0.003	0.001	0.008	***
Ownership: public shareholders	0.026	0.003	0.022	0.004	0.003	
Ownership: VC or business angel	0.011	0.002	0.003	0.001	0.008	***
Export	0.600	0.008	0.450	0.012	0.150	***
Decrease sales and increase cost	0.083	0.005	0.080	0.006	0.004	
Bank decreases available debt	0.031	0.003	0.019	0.003	0.012	**
Increase own capital	0.418	0.008	0.334	0.011	0.084	***
Future need: up to €25,000	0.092	0.005	0.181	0.009	-0.089	***
Future need: €25,000 - €100,000	0.257	0.007	0.284	0.011	-0.027	**
Future need: €100,000 - €250,000	0.231	0.007	0.206	0.010	0.024	**
Future need: €250,000 - €1 million	0.243	0.007	0.197	0.009	0.046	***
Future need: €1 million	0.177	0.006	0.132	0.008	0.046	***
No obstacles	0.420	0.008	0.461	0.012	-0.041	***
Obstacle: price	0.136	0.006	0.150	0.009	-0.014	
Obstacle: collateral	0.193	0.007	0.179	0.009	0.014	
Obstacle: loss of control	0.040	0.003	0.026	0.004	0.014	***
Obstacle: bureaucracy	0.092	0.005	0.083	0.007	0.009	
Obstacle: other	0.119	0.005	0.101	0.007	0.018	**
Importance: guarantees for loans	5.613	0.050	5.280	0.073	0.333	***
Importance: easier access to equity	4.239	0.047	3.729	0.064	0.510	***
Importance: export credit	3.845	0.048	2.888	0.061	0.957	***
Importance: tax incentives	6.520	0.046	5.938	0.070	0.582	***
Importance: business support services	5.373	0.044	4.845	0.063	0.528	***
Importance: easier access to public measures	6.627	0.043	6.067	0.067	0.560	***

Source: Authors' own elaboration based on SAFE database.

 Note: Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Number of observations = 5,391, with 3,635 innovative firms and 1,756 non-innovative ones.



EUROPEAN
MICROFINANCE
NETWORK

European Microfinance Network (EMN) aisbl
Avenue des Arts 7-8, 1210 Brussels - Belgium
emn@european-microfinance.org
www.european-microfinance.org



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