The external financing of innovative small-medium-enterprises (SMEs): unpacking bank credit with respect to innovation typologies and combinations

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Abstract [Max 250 words]

We investigate the extent to which SMEs' external financing vary with the innovative profiles they reveal in terms of introduced and combined innovation typologies. Using SAFE data, we address this research issue with respect to 11 European countries over the period 2014-19 and overcome the context-specificity of previous analyses. Results suggest that the innovative profile of SMEs is responsible for several important nuances in both their bank credit demand and supply. Being innovator raises SMEs' credit demand, but this demand increases also and above all with their involvement in different innovation typologies. Having an innovative profile, of nearly whatever kind, does not make SMEs refraining more from credit demand because of a feared rejection, but a wide innovation involvement reduces the chance that their internal funds make them refrain from asking external credit. Generically innovative SMEs are significantly more likely to be credit constrained than non-innovative ones, but the probability of not receiving credit increases only for firms that involve in innovation to an extensive margin: a larger margin than that making innovative SMEs more credit seeking than non-innovative ones. A generic innovative status of SMEs apparently makes banks more selective in the decision of full lending, but the chance of reducing this decision increases only with respect to few and mainly multiple innovative profiles. Overall, the extent to which SMEs innovate in different and/or multiple domains appears a crucial dimension to consider in future research and in devising policies to attenuate the financial constraints to firms' innovation.

Key-words: innovation; SMEs; external finance.
JEL codes: G32, O16, O30.

1. Introduction

A long-lasting research line already exists about the relationship between innovation and finance at the firm level (Hall et al., 2016). Furthermore, the interest for the topic has been revamped by the last double-deep crisis, not to say of the post-Covid19 one, and by the high financialization of economic systems this kind of crises has revealed (Mazzucato, 2013). In particular, the credit shortage entailed by times of crisis has drawn novel attention to the problematic financing of already innovative firms, especially small and medium enterprises (SMEs) (Czarnitzki, 2006; Freel, 2007; Bellucci et al., 2014; Lee et al., 2015; 2016; Hain and Christensen, 2019).

In spite of these intense research efforts, the results about the external financing of innovative firms, and SMEs in particular, are far from conclusive. On the supply side, contrasting theoretical arguments have been developed and mixed country-specific empirical results have been obtained about the alleged disadvantages innovative firms would experience in obtaining external finance (Canepa and Stoneman, 2007; Freel, 2007; Bellucci et al., 2014; Brancati, 2015; Mina et al., 2013; Hain and Christensen, 2019). On the demand side, research has been thinner and even more inconclusive about the hypothesis that innovative SMEs would be more in need of external finance than non-innovative ones, rather than being conversely discouraged in the seek for it (Mina et al., 2013; Lee et al., 2015; Lee and Brown, 2016). An important part of the heterogeneity in results is due to the context-specificity of the relative research, to overcome which more general multi-country studies would be desirable. However, relevant is also the heterogenous accuracy with which firms' innovation is considered in these studies. The majority of them refer to R&D expenditures and/or patents in measuring innovation (Canepa and Stoneman, 2007; Savignac, 2008) and, in spite of the wider availability and codifiability of this kind of data, are incapable to disentangle the specific nature of the relative innovative outcome: e.g. product vs. process innovations, or radical vs.

incremental ones. Some few recent studies have instead resorted to survey data and, in spite of the response biases they could suffer from, have shown that the particular kind of innovation that SMEs introduce does make a difference in both credit demand and supply (e.g. Mina et al., 2013; Hain and Christensen, 2019). However, this issue has been only partially addressed so far. On the one hand, the spectrum of innovators that face financing problems among SMEs is much wider and heterogeneous than that addressed by the extant literature so far, especially in the light of the different combinations of innovation typologies to which firms can resort. Indeed, firms often combine innovation kinds between them (Agwu et al., 2020) and innovate in a complex way, across their technological (product and process) and non-technological (organizational and marketing) domains (Evaneglista and Vezzani, 2010, 2012). On the other hand, the features and channels through which these different innovation (and combination of) typologies can affect the external credit of firms (and SMEs) have been only superficially addressed and deserve closer scrutiny.

The present paper aims to fill this research gap in three respects. First of all, we look at whether innovative SMEs differ from non-innovative ones in their access to external finance, not only by distinguishing different types of innovation (product, process, marketing and organizational), as some previous studies have already done (see Section 2), but also by considering their possible combinations: that is, by distinguishing the different configurations of finance-seeking innovative SMEs that emerge by looking at the combinations of innovation typologies they introduce. In brief, we augment previous analyses of multiple innovation measures with that of the complexity that derives from multiple combined innovation measures. Second, we investigate whether innovative SMEs distinguish from non-innovative ones, not only in the extent to which they seek and obtain (or not) external finance, but also in the reasons and amounts of their respective decisions. Third, by merging different waves of the Survey on the Access to Finance of Enterprises (SAFE) by the

European Commission and the European Central Bank, for the first time, we address these research questions with respect to as many as 11 EU countries over the period 2014-19 and obtain results amenable of a wider generalisation.

Results suggest that the innovative profile of SMEs is responsible for several important nuances in the relationship between external financing and firm innovation, which the extant literature has so far unfortunately neglected. Being an innovator raises SMEs' credit demand, but this demand increases also and above all with their involvement in different innovation typologies. Having an innovative profile, of nearly whatever kind, does not make SMEs refraining more from credit demand because of a feared rejection, but a wide innovation involvement reduces the chance that their internal funds make them refrain from asking external credit. Generically innovative SMEs are significantly more likely to be credit constrained than non-innovative ones, but the probability of not receiving credit increases only for firms that involve in innovation to an extensive margin: a larger margin than that making innovative SMEs more credit seeking than non-innovative ones. A generic innovative status of SMEs apparently makes banks more selective in the decision of full lending, but the chance of reducing this decision increases only with respect to few and mainly multiple innovator profiles. Overall, the extent to which SMEs innovate in different and/or multiple domains appears a crucial dimension to consider in future research and in devising policies to attenuate the financial constraints to innovation.

The rest of the paper is structured as follows. Section 2 positions the paper in the existing literature. Section 3 illustrates the empirical application and Section 4 presents its results. Section 5 concludes with policy implications, limitations and opportunities of future research.

2. Background literature

In spite of the pessimistic views of the first papers on the topic, innovative firms' resort to bank finance has not been as prohibitive and rare as initially predicted (Brown et al., 2009). On the contrary, external sources of finance appear common among innovators too, as well as their use of patents (Hall, 2019) and intellectual property rights (IPR) as collaterals to access them (for a review of this evidence, see Kerr and Nanda, 2015).[1]

In the case of innovative SMEs, however, external financing reveals several obstacles, which could be responsible for their insufficiency of funds in front of potentially profitable investment opportunities (Cosh et al., 2009). In the existing literature, this alleged "finance gap" has been mainly addressed by looking at the credit that innovative SMEs (and innovative firms, in general) receive (or not) from banks, that is, at the *supply* of credit. The analysis of their credit *demand* is instead still scanty, but interesting results have been obtained with respect to which we need to position too. In both respects, the kind of innovations that SMEs introduce can be claimed to have a role that existing studies have unfortunately marginalized so far and on which we therefore concentrate in the following. In particular, while previous research has in some cases distinguished between product and process innovations, and more rarely between incremental and radical ones, to the best of our knowledge, no studies exist on the possible combined use that firms can make of different innovation typologies. As we will argue in the following, this combination brings to the front the role that complexity in innovating can be expected to have in firms' external financing and on which we focus in the following.

[1] Empirical evidence also reveals that, while not infrequent, the innovators' resort to debt financing is however "secondary" with respect to other means of financing and consistent with the so-called "pecking order theory" of finance (Myers and Majluf, 1984; Myers, 2000), about which we will say in Section 2.2.

2.1. Credit supply to (different kinds of) innovative SMEs

The fact that innovative firms can easily end out credit rationed has been largely investigated in the academic literature (for a review, see Kerr and Nanda, 2015). Several studies have identified a set of factors that render lenders more alert, but also less effective, in evaluating the risk/return profile of prospected innovative investments: the inner uncertainty and difficult collateralization of R&D projects, the idiosyncratic distribution of innovation payoffs, and the asymmetric information between innovators financiers, are the most relevant. Because of these factors, the costs of external financing for innovators turn out higher than for non-innovators. The extent to which innovative firms, and SMEs in particular, could access credit thus decreases and some of their potentially profitable innovative projects could remain undone (Hall et al., 2016).

The previous finance-inhibiting factors are usually listed in a rapid sequence as pertaining to innovation in general, but their incidence is arguably variable across different innovation typologies. Just to make few examples, radical innovations are usually more uncertain than incremental ones, and the degree of novelty and risk is inherently higher in front of new products rather than new processes (Murat and Baki, 2011). Looking at another financing barrier, organizational and marketing innovations are more inherently intangible than technological ones and thus hardly guaranteed by proper collaterals (Laforet, 2011).

Because of these differences, in the few studies that have considered it, the typology of innovation has emerged to matter in accounting for the credit rationing of innovative SMEs. This is the case of a stream of research about the financing of British SMEs showing that, although with both temporal

(e.g. before and after the crisis (Freel, 2007; Lee et al., 2015)) and geographical nuances (e.g. between core and peripheral regions (Lee and Brown, 2016)), it is product rather process innovation to make them credit rationed, in particular when it is radical rather than simply incremental.

Similar results are obtained by Hain and Christensen (2019) with respect to a sample of small-medium Danish firms over the period 2000-2013. Controlling for non-linear credit rationing effects, out of the firms that have sought external financing, radical innovators show greater chances to experience credit constraints than incremental ones. Conversely, the alleged credit rationing of innovative SMEs gets even reversed in the comparative study of UK and US firms (2002-2004) by Mina et al. (2013). Unlike input variables of innovation (like R&D, which reveals non-significant), output ones, in the form of introduced product and process innovations, actually increase, rather than decrease, the chances of receiving credit (especially for US firms). As the authors suggest, this result points to another set of financing issues that counteract the innovators' financial-gap thesis. Overall, these factors refer to the positive "signalling effects" that innovative firms, unlike non-innovative ones, can exert on lenders, being perceived by them capable to: achieve high returns from their R&D projects (Coad and Rao, 2008); obtain a costly recognition of their inventive activities in terms of intellectual property rights (Hottenrott et al., 2016; Hall, 2019); and, when relevant, pass the screening that public authorities make in eventually allowing them R&D grants or subsidies (Howell, 2017). Once more, also these financing effects are innovation-specific. In the same study by Mina et al. (2013), for example, a reduction in credit constraint does not emerge with respect to organizational innovations, which on the contrary reduce the probability of getting financed (though of US firms only): possibly because of the negative signal associated to the entailed need of complex reorganizations for the financing firm.

As the previous literature review reveals, innovation typologies emerge as a relevant determinant of innovative SMEs' credit rationing with respect to selected individual countries. In particular, the evidence about its unfolding changes when other countries than the UK are investigated, pointing to the possible incidence of national financial regulations, institutions and markets. More systematic cross-country evidence is therefore needed to ascertain whether different kinds of innovators actually face financial constraints to a different extent.

In addition to this empirical research gap, a possibly more important gap remains to be filled with respect to the combination of innovation typologies in which firms can engage, rather than their specific nature. Different streams of research in innovation studies have actually shown that, side by side to "single innovators" – of the four classical kinds we have referred to above (i.e., product, process, organizational and marketing)[2] – there are firms that introduce, complementarily or even simultaneously, different types of innovation, through which they try to benefit from the synergies of hybrid modes of learning and innovating (Jensen et al., 2007). The simplest case at stake is represented by what we could call "full technological innovators": firms that innovate across the board in the technological domain, by introducing both product and process innovations, but keeping their organizational and marketing structures unaltered. While the two kinds of technological innovations are generally treated as dichotomous, and possibly revealing divergent firm strategies (e.g. quality- vs. cost-based), recent studies have shown they could be complementary to each other, if not even super-modular, allowing firms to purse superior business performance through their combination (Fonseca, 2014). A parallel case is represented by "full non-technological innovators": firms that "saturate" the spectrum of "soft" innovation activities, by

[2] For a standard definition of these four categories of innovation, see the benchmark reference represented by the OECD Oslo Manual (https://www.oecd.org/science/oslo-manual-2018-9789264304604-en.htm).

combining organization and marketing innovations relying on their pre-existing technological base, that is, in the absence of product and process innovations (Schubert, 2010). On an upper combination level, we finally find what the literature has called "complex" innovators (Evangelista and Vezzani, 2010, 2012; Filippetti, 2010), referring to firms that walk in the shoes of both the technological and non-technological domain, by combining the introduction of a new product and/or production process with that of a new organizational structure/procedure and/or marketing system/practice. The extent to which the two domains could be complemented is variable: spanning from the combination of one innovation typology per domain only (for example, product and marketing innovations, or process and organizational innovations) to that of all the four typologies ("super complex innovators"), and passing through a single cross-domain augmentation of the full technological profile (product and process plus organizational innovations, or plus marketing ones) or of the full non-technological profile (organizational and marketing plus product innovations, or process ones).

Do the previous innovation combinations affect the extent to which innovative SMEs can run into credit rationing? In the absence of focal literature on the topic, we do not have strong a priori expectations, not to say hypotheses about that, and we can't do much more than being conjectural. On the one hand, it could be claimed that "non-single" innovators appear riskier than single ones to the lenders' eyes, as they add uncertainty and agency costs across different projects, and that such a perception increases when the borrowing firm embarks in the hazard of combining technological and non-technological innovations. On the other hand, it could be conversely argued that being also involved in a riskless kind of innovative activity (e.g. process innovation) could attenuate the lender's aversion to riskier ones (e.g. product innovations) as it provides to it a sort of "quasi-guarantee" of returns. Following the same argument, a full technological/non-technological or even

complex innovation profile, when contrasted to that of a single (or even occasional) one, could amplify the positive signalling effects to the lenders that we have recalled above. In one way or another, even in the absence of strong predictions, as we will see in our empirical application, the diffusion of non-single innovators is so pervasive to make their analysis essential in evaluating the credit supply to innovative SMEs.

2.2. Credit demand by (different kinds of) innovative SMEs

The kind of data on which the majority of the extant studies rely makes it very hard to distinguish between the demand for external finance and its supply (Mina et al., 2013). This is quite unfortunate, as a propensity differential between innovators and non-innovators in seeking bank credit could represent an additional source of the finance gap we are investigating.

From a theoretical point of view, the literature about the factors that could make the demand of external finance idiosyncratic for innovators is substantially thinner than that about credit supply and revolve around two contrasting hypotheses. On the one hand, by referring to the notable "pecking order theory" of finance (Myers and Majluf, 1984; Myers, 2000)[3], and applying it to the financing of innovative projects, it has been argued that innovative firms would run out of internal funds more promptly than non-innovative ones and thus end out more in need of external financing than them, especially if they are of a small-medium size (Hall and Lerner, 2010). On the other hand, a recent theory about the existence of "discouraged borrowers" (Kon and Storey, 2003; Han et al., 2009)[4] has led to argue that an innovation strategy could be among the conditioning factors of the

[3] According to it, unlike the Modigliani and Miller theorem (1958; 1961) predicts, firms would not be indifferent among alternative sources of finance and rather start the financing of new (innovative) projects by resorting to internal cash flows. The search for external finance would occur only once internal funds have been exhausted, making external equity the least preferred option in the absence of proper collaterals.

[4] In brief, in the presence of 'good' and 'bad' (SME) borrowers, marked by heterogeneous costs of debt application, and with an only imperfect capacity of banks to screen them, even some 'good' borrowers would refrain from applying as they fear to be rejected.

relative model[5]: committing to such a strategy could increase the incidence of discouragement, and this would make us expect a reduced, rather than increased, credit demand by innovative vs. non-innovative firms (Freel et al., 2012).

Unfortunately, the empirical evidence about these contrasting hypotheses is still scant and not decisive yet. What is more, to a larger extent than with respect to credit supply, the possible differentiating role of heterogeneous innovation typologies is only partially addressed. In the few studies that integrate the analysis of credit supply to innovative SMEs with a first econometric step about their demand for it, firm's innovation usually turns out non-significant in accounting for the latter. This is the case of the study about UK and US SMEs by Mina et al. (2013), who find that neither their R&D intensity (expenditures over assets), nor their innovation outputs (product, process and organizational) attenuate or aggravate their financial needs (both are not significant). Similarly, firms' innovation does not appear to matter for the demand of external financing also in the study of Danish SMEs by Hain and Christensen (2019), who find that such a demand is actually inelastic to both incremental and radical innovations. By considering the kind of introduced innovations in isolation[6], both studies interpret their results by arguing that innovation is not so demanding to make internal funds insufficient for its financing. Crossing the same results with those about the negative effect that they both find for realized positive profits on the demand of external finance, the authors conclude by supporting the predictions of the pecking order theory. As Mina et al. (2013) suggest: "the overwhelming majority of firms that did not seek external finance did not need any (Cosh and Hughes, 2007; Fraser, 2009)".

[5] Other factors are: the magnitude of the banks' screening error, the size of the firms' application costs, the interest rate differential between banks and the moneylender, and the amount of available information.

[6] As it is standard with the use of innovation surveys, like the Community Innovation Survey (CIS), respondent firms are asked to reply whether they have introduced a certain type of innovation (e.g. product or process), which than enters in the estimates as a dummy, irrespectively from its introduction of other types of innovation, which are at most controlled for.

The fact that internal resources could actually be sufficient for making innovative firms refrain from changing their demand of external finance might however be due to the kind of the considered innovation or, better to say, of the not considered one. As we said, previous studies do not (at least explicitly) address the role of non-single and complex innovators (see above), whose demand for credit could however be different from that of single ones. Once more, irrespectively from the types of combined innovations that we have identified in the previous Section, the combination itself could put an important stress on the financial resources that firms have internally. In general, non-single innovators are in fact pursuing changes that have more pervasive implications than the introduction of one single innovation and that, accordingly, pose to them additional costs to those of the relative innovation inputs (e.g. R&D, and other intangible and tangible investments). Just to make an example, the combination of product and process innovations could make firms incur in costs of adapting, if not even reconfiguring the production process and the value chain, which are expectedly higher than in front of only one of the two typologies. Of course, the specific kind of combination could make the difference. The typical 'bundling' of product and marketing innovations (Lewandowska and Gołębiowski, 2012), or of process and organizational innovations (Alänge and Steiber, 2011), for example, could enable firms to make economies of scale in the costs for innovating, and make the pecking-order-theory hold even in presence of non-single innovators. On the contrary, "super-complex" innovators (product, process, organizational and marketing ones) might find the need of switching to external financing more urgent. In one way or another, the typologies of innovation combinations on which we focus in this paper appear important also in the analysis of credit demand.

Innovation typologies and combinations appear relevant also with respect to the other theoretical argument about credit demand we have referred to: the discouraged borrower effect. In the few

empirical studies that have tried to test it, the focus is simply on whether innovation makes firms afraid of demanding external credit, and results are once more contradictory. With respect to a sample of small UK firms in 2005, Freel et al. (2012) do not find confirmation of an expected correlation between credit discouragement and the variable innovation captured as part of the firms' competitive strength. On the contrary, supportive evidence emerges from the study by Lee and Brown (2016) on UK firms at the regional level: innovative firms in peripheral regions are more likely to be discouraged from applying for bank finance than both non-innovative firms in the same regions and innovative firms elsewhere.

In searching for more consistent empirical evidence about the discouraged borrower hypothesis, it seems to us that the explicit consideration of non-single, if not even complex innovators would allow us to better capture the underlying mechanisms. In particular, we might expect that firms anticipate and discount that lenders could turn out more incapable to screen debt applications from more complex innovators, as these span across multiple innovation domains (see the previous Section). By incorporating this expectation into the cost function of their debt application, they could thus refrain from applying in the fear to be rejected, possibly to a greater extent than single innovators. Once more, the effect could be different for different kinds of innovative combinations in a way that, in the absence of focal literature, we find hard to predict. Still, following our previous arguments, we expect the discouraged borrower effect could be greater for complex than for non-complex (and single) innovators.

As we repeatedly said already, possibly more than with respect to credit supply, wider and more systematic empirical evidence is required to ascertain the role of innovation and innovation typologies/combinations for credit demand: the evidence is actually nearly exclusively related to the UK. As we will see in the next Section, our empirical application makes use of a survey-based

dataset (the SAFE survey) that covers a large set of countries, with respect to which detailed questions about innovation, credit supply and credit demand are posed to SMEs. In particular, the set of items the survey offers to the respondents when asking about their credit demand, includes both the availability of internal funds and the fear to be turned down, thus allowing us a closer inspection of the theoretical arguments we have reviewed above.

3. Empirical analysis

Our empirical investigation is based on data from the Survey on the Access to Finance of Enterprises (SAFE): the semi-annual survey on European SMEs managed by the European Commission and the European Central Bank.[7] Starting from 2009, each six-monthly wave of the survey is administered to a randomly selected sample of non-financial SMEs, comprised in the Dun & Bradstreet business register, operating in Industry, Construction, Trade and Services.

Using the SAFE waves from the 11th to the 21st, covering the 6-year period that goes from April 2014 to November 2019, we are capable to cross information on the experience of SMEs in accessing (demand and supply) finance with qualitative but disaggregated information about their innovation status and a with a suitable set of controls. SAFE actually covers a large spectrum of homogeneous and harmonized firm-level data for all the European countries, which allow us to reduce usual problems of non-observed heterogeneity. Nonetheless, in order to reduce confounding effects due to the idiosyncratic financial markets of peripheral countries, our analysis refers to SMEs belonging to eleven countries of the EU15 – i.e., the EU prior to the accession of May 1, 2014 – for which data are available for the full set of our variables, over the period 2014-2019. These eleven countries are: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain.

[7] Information on Safe are available at https://www.ecb.europa.eu/stats/ecb_surveys/safe/html/index.en.html

As the firms included in the survey are randomly selected in each of the considered waves (11th – 21st), the dataset that can be obtained by combining them for the EU15 is a non-balanced panel of 36,699 firm-level observations. On the other hand, as we will see, in order to attenuate problems of reverse causality in our estimates, we used a lagged value of our focal innovation variables and this forced us to drop four countries of the EU15 and consider a smaller panel of 15,020 firms that are present in consecutive waves for eleven countries over the period 2014-2019. While this entails an observation loss of more than 50% of the initial firms, we deem it a necessary price to pay for increasing the accuracy of our estimates.

3.1 Variables and econometric strategy

Following previous studies (Mina et al., 2013; Hain and Christensen (2019)), we unfold our econometric strategy in two steps, referring to (bank) credit demand and supply, respectively.

3.1.1. Credit demand

We start our analysis of SMEs' credit demand by looking at their propensity to seek for bank loans, using as dependent variable a dummy, $Credit\_Demand_i$, taking value 1 if firm *i* has applied for them over the past 6 months, and 0 otherwise (question Q7A_a of the SAFE). It should be noted that the variable captures a generic demand of credit expressed by the focal firm, *i*, and does not refer to a financial need specifically linked with the realization of an innovation project by it.[8] In so doing, we investigate whether the innovative status of the sample firms has financial implications on their

[8] While question Q7A_d of the SAFE also refers to other forms of bank financing to firms (e.g., credit line, bank overdraft or credit cards overdraft), we have focused on bank loans only as these typically cover the kind of investment expenses that typically drive innovation projects, while the former are instead more used for current expenses.

financial operations across the board (i.e. in entering a new market, rather than in acquiring new participations), and whether the same status can have risk and signalling implications, which could make the difference to the lender also in front of credit needs not strictly related to an innovation project.

In order to perform the previous analysis, we run the following logit regression:

$$P(Credit\_Demand_i = 1|X_i, Z_i) = \Lambda(\beta_i X_i + \delta Z_i) \quad (1)$$

where $\Lambda_{(}Z_{)} = e^z/(1 + e^z)$ is the logistic function, X_i is a vector of explanatory variables, including those related to innovation, and Z_i indicates a series of firm-specific control variables.

As far as the explanatory variables are concerned, X_i comprehends the qualitative variables through which SAFE allows us to retain the firm's corporate finance. These are the following: *Profit_change*$_i$, with increasingly higher categorical values ranging from 1, if profit has decreased, to 2, when it remained stable, up to 3, when it increased during the wave time; *Leverage_down*$_i$, equal to 1 if the debt/assets ratio of firm *i* has decreased in the same period, and 0 otherwise; *Public_finance*$_i$, accounting with 1 the case in which the focal firm has had accessed to public financial support, including guarantees, and with 0 the opposite case.[9] The financial status of the sample firms is integrated with other two dummies: *Single/family_owner*$_i$, referring to firms that are individually or family owned; *Independent*$_i$, capturing firms that are not part of business groups. Although for different reasons, pertaining to the difficulties in accessing the capital market (the former two) and

[9] As we have argued in Section 2, this could affect the demand for credit both directly, in a substitutive way, as supported firms might need less financing, and indirectly, as the received public support could provide the lenders with a certification about its financial reliability.

the lack of intra-group capital financing (the third), these kinds of SMEs can be expected more reliant on bank loans than their counterpart (Mina et al. 2013).

Vector Z_i includes a set of non-financial, structural controls for the observed firms. First of all, we consider the following three structural features of the focal firms: Age_i, assuming progressively higher categorical values for increasingly older firms (between two and four, five and nine, ten years old and more) against the benchmark of young ones (younger than two years); $Size_i$, denoting increasingly larger SMEs with increasingly higher categorical values (between 10 and 49, as small, and between 50 and 249 employees, as medium) against the benchmark value for micro-firms (between 1 and 9 employees); and $Export_i$, measuring three increasing percental classes (in-between 0 and 25%, in-between 25 and 50%, and larger than 50%) of firm *i*'s total turnover accounted by its exports, against the nil benchmark. Secondly, we also try to control for the financial "health" of the focal firms with the following dummy variables: $Exper\_growth_i$, identifying the sample firms that declared to have actually experienced an increase in their specific outlook (with respect to sales, profitability or business plan); $Expect\_growth_i$, referring to firms that declared to expect progressively higher growth rates per year in their future turnover (over the next two to three ones) – i.e. nil, moderate (below 20%), and substantial (over 20%) - with respect to the benchmark case of a negative rate (i.e. to become smaller). Finally, sector ($Industry_i$, $Construction_i$, $Trade_i$ and $Services_i$), country (our 11 EU ones) and temporal fixed effects, *wave*, denoting the ordered number of the SAFE wave survey to which observations refer, are inserted too.[10]

[10] As for the sector, SAFE releases information only at the NACE 1-digit. Using this information we include in our estimates sector dummies for Industry, Construction, Trade, and Services equal to 1 if the firm belongs to the Industry (which includes manufacturing, mining and electricity, gas and water supply), Construction, and Trade and Service, respectively. Services (Tullio è questo il gruppo di controllo???) is the controlling group for the sector.

In order to address our focal research questions, we augment the previous explanatory variables with a set of innovation variables. To start with, we define a generic innovation dummy, $Inno_i$, taking value 1 if the focal firm is innovative across the board (and 0 otherwise), having introduced at least one (and possibly more) of the four innovation typologies (and combinations) that the SAFE survey allows us to consider: product, process, organisational, and marketing innovations. While neglecting the specific nature of innovative SMEs, this is an important variable that serves to distinguish the extent to which they differ from non-innovative ones in credit supply and demand. We then start looking at the profile firms reveal in their innovation activities and, instead of using the dummy $Inno_i$, we distinguish innovative SMEs according to their being involved in technological innovations - $Inno\_Tech_i$ - rather than in non-technological ones only - $Inno\_NTech_i$ - and by contrasting them with non-innovative SMEs (as benchmark). More precisely, $Inno\_Tech_i$ is a dummy variable taking value 1 if firm i has introduced a product or/and a process innovation, irrespectively from whether it has done so in the non-technological domain, while $Inno\_NTech_i$ takes value 1 if the focal firm has introduced an organisational or/and a marketing innovation only, in the absence of technological ones.[11]

We finally move to a more fine grained analysis of innovation typologies and substitute the previous two dummies - $Inno\_Tech_i$ and $Inno\_NTech_i$ - with as many as 15 dummies, through which we univocally distribute our sample firms among the 15 possible disjoint innovation profiles. These profiles can be obtained by combining the four basic typologies, and contrast them with the benchmark case of a full non-innovative profile, that is of no innovation at all, of any kind. The first four profiles refer to what we called "single innovators" and are accounted by four dummies that

[11] Strictly speaking, the former could be more than 'simply' technological innovators, it they have also introduced organizational or/and marketing innovations, but they distinguish from the latter for a technological imprinting that is exclusive to them.

take value 1, if the firm has introduced a certain innovation typology among the four in an *exclusive manner*, and 0 otherwise: $Inno\_Pd_i$, $Inno\_Pc_i$, $Inno\_Org_i$, and $Inno\_Mk_i$.[12] We have then the full technological and full non-technological innovative profiles, captured by a dummy that takes value 1, if the firm has introduced both product and process innovations, $Inno\_Pd\_Pc_i$, or both organizational and marketing innovations, $Inno\_Org\_Mk_i$, respectively, and 0 otherwise. Finally, we consider as many as 9 types of "complex innovators", for which we build up the following variables: 4 twofold dummies, $Inno\_Pd\_Mk_i$, $Inno\_Pd\_Org_i$, $Inno\_Pc\_Mk_i$, $Inno\_Pc\_Org_i$, taking value 1 if one of the two technological variants (product and process innovation) combines with one of the two non-technological variants (organisational and marketing innovation), and 0 otherwise; 4 threefold dummies, $Inno\_Pd\_Pc\_Org_i$, $Inno\_Pd\_Pc\_Mk_i$, $Inno\_Pd\_Org\_Mk_i$, $Inno\_Pc\_Org\_Mk_i$, taking value 1 if one of the two couples of technological (product and process innovation) and non-technological (organisational and marketing innovation) variants combine with one of the two non-technological (organisational or marketing innovation) and technological (product or process innovation) variant, respectively (and 0 otherwise); and 1 fourfold dummy, $Inno\_Pd\_Pc\_Org\_Mk_i$, taking value 1 if the firm has introduced all the four typologies of innovation and 0 otherwise.

Still with respect to innovation, in a robustness check of our results, we build up two additional sets of variables. A first set is intended to capture the extent to which what we expect to be the role of '*complexity*' in innovating, descending from combining innovation typologies of different kinds, is more inherently due to the '*intensity*' of innovation activities, as it could be simply reflected by the number of innovation typologies. In order to do that, we consider as focal regressors to disaggregate

[12] The four typologies of innovation are identified by question Q1 of the SAFE, which asks whether the respondent firm has undertaken, in the previous 12 months: "(1) a new or significantly improved product or service to the market; (2) a new or significantly improved production process or method; (3) a new organization of management; (4) a new way of selling your goods or services." Let us remember that, among the 0s of the correspondent single innovator dummies, we could find both non-innovative firms and firms that have combined the focal innovator typology with some other.

the sample of innovative SMEs and contrast to non-innovative ones, four dummies that tell us whether the focal firm has introduced one ($Inno1_i$), two ($Inno2_i$) , three ($Inno3_i$), or four ($Inno4_i$) types of innovation of any kind, that is, irrespectively from the nature of the typologies that are combined.[13] The second innovation variable for which we run a robustness check is a simple ordinal variable, which for each and every firm i counts the number of innovation typologies that it has introduced: $InnoCount_i$ (= 0, 1, 2, 3 and 4). In addition to providing us with further insights about the role of innovation intensity vs. complexity, this last variable enables us to test whether its role in external financing could be non-linear, by simply considering its squared term.

As an additional added value with respect to the extant literature, we also look at the motivations of SMEs' credit demand by building up a four-item categorical version of the dependent variable $Credit\_Demand\_Mot_i$ (y), which codes the following SMEs' outcomes with respect to bank loan applications over the past 6 months (question Q7A_a of the SAFE): (1) applied (y_1); (2) did not apply because of fear to be rejected (y_2); (3) did not apply because of sufficient internal funds (y_3); (4) did not apply for other reasons (y_4).

In front of a qualitative dependent variable, with more than two discrete, non-naturally ordered outcomes, we thus re-run Equation (1) with a multinomial logit regression. In particular, using the outcome of an occurred credit application as a baseline (y_1), we investigate whether the innovative status of firms affects the chance they refrain from applying because of: a "discouraged borrower" effect (y_2); already available sufficient internal funds (y_3), as from the pecking order theory; or other residual reasons (y_4).[14] Descriptive statistics of these variables are reported in Table 1.

Commentato [1]: INTEGRATE AND AMEND WITH THE NEW VARIABLES

[13] Of course, the last dummy corresponds to that we have termed $Inno\_Pd\_Pc\_Org\_Mk_i$.

[14] As for the latter outcome, it is a residual one which includes all the motivations to refrain from applying to bank loans, other than the cases 2-3. Although SAFE does not provide information on this outcome, we could infer that it might also refer to the use of informal finance (i.e., family, friends, and networks).

3.1.2 Credit supply

Coming to the supply of credit that SMEs eventually receive (or not), we investigate it by using two dependent variables. First of all, we define a dummy, $Credit\_Constraint_i$, which takes value 1 if the focal firm has ended out credit constrained, and 0 otherwise (question Q7B_a of the SAFE): either because it was refused its loan application by the bank, or because it refused it itself, as too costly.[15] Secondly, we originally investigate the role of innovation and innovation typologies/combinations in accounting for the amounts in which financial rationing could occur by using a categorical dependent variable, $Credit\_Received\_Amnt_i\ (y)$, referring to the cases in which the applicant firms: (1) received the demanded credit only partially (y_2); (2) received it integrally (y_3); versus the (3) benchmark case of being credit constrained (y_1). In order to build this categorical variable, we used the information provided in question Q7B_a of SAFE.

Symmetrically to what we have done on the demand side, also for the supply side we start by estimating the following model:

$$P(Credit\_Constraint_i = 1|X_i, Z_i) = \Lambda(\beta_i X_i + \delta Z_i) \qquad (2)$$

where X_i and Z_i are vectors that capture the same set of explanatory variables and of firm-specific control variables as in Eq.(1), respectively.

Like in the case of credit demand, let us notice that the supply of credit we refer to is not necessarily linked to the realization of an innovation project by the focal firm, but rather to the bank credit that innovative vs. non-innovative firms have received in response to their generic financial needs.

[15] In both cases, the credit supply at stake does not unfold and the firm remains credit constrained.

As the only firms reporting the credit obtained (or not) by banks are those having demanded for it, a problem of selection bias can of course emerge. In order to deal with such a selection bias from credit demand, we estimate a probit model with sample selection. In the selection equation, $Credit\_Demand_i$ is estimated against the set of regressors and controls of Eq(1), including those referring to the firms' innovation status. These variables are then jointly used in the output equation as explanatory variables of $Credit\_Constraint_i$, with the exception of an exclusion restriction. In particular, we follow Mina et al. (2013) in using information about the independent status of the firm as a restriction variable. In doing so, we assume that a firm belonging to a group can possibly access finance from its parent company and/or group partners, and thus be less prone to demand for a bank loan. Conversely, there is no reason to believe that being independent should affect the chance of having the credit demand turned down or accepted by banks.

A similar procedure to account for sample selection is adopted to estimate $Credit\_Received\_Amnt_i$. In particular, setting the credit constraint outcome (y_1) as baseline, we run a multinomial probit with selection bias and look at the role of innovation in affecting the extent to which SMEs manage to overcome their eventual credit constraint, by getting their loan request at least partially (y_2) if not even totally accepted (y_3).

The descriptive statistics of the variables employed in analysis are reported in Table 1. The correlation matrix displaying pairwise correlations are instead available in the Appendix (Table A.1).

Table 1 – Descriptive statistics

Commentato [2]: UPDATE

	obs.	mean	st. dev.	min.	max
Credit_Demand	15020	0.335	0.472	0	1
Credit_Demand_Mot:	15020	2.452	1.141	1	4
Applied (y1)	15020	0.335	0.472	0	1
Did not applied for fear of rejection (y2)	15020	0.069	0.254	0	1
Did not applied for sufficient internal funds (y3)	15020	0.408	0.491	0	1
Did not applied for other reasons (y4)	15020	0.192	0.394	0	1
Credit_Constraint	4115	0.082	0.274	0	1
Credit_Received_Amnt:	4115	1.700	0.613	1	3
Loans rejected or refused (y1)	4115	0.082	0.274	0	1
Loans application partially received (y2)	4115	0.779	0.415	0	1
Loans application fully received (y3)	4115	0.139	0.346	0	1
Inno	12389	0.625	0.484	0	1
Inno_Pd	12389	0.072	0.258	0	1
Inno_Pc	12389	0.045	0.206	0	1
Inno_Org	12389	0.093	0.290	0	1
Inno_Mk	12389	0.040	0.197	0	1
Inno_Pd_Pc	12389	0.055	0.229	0	1
Inno_Org_Mk	12389	0.047	0.211	0	1
Inno_Pd_Mk	12389	0.033	0.179	0	1
Inno_Pd_Org	12389	0.031	0.174	0	1
Inno_Pc_Mk	12389	0.008	0.089	0	1
Inno_Pc_Org	12389	0.030	0.171	0	1
Inno_Pd_Pc_Org	12389	0.040	0.196	0	1
Inno_Pd_Pc_Mk	12389	0.029	0.167	0	1
Inno_Pd_Org_Mk	12389	0.028	0.164	0	1
Inno_Pc_Org_Mk	12389	0.020	0.139	0	1
Inno_Pd_Pc_Org_Mk	12389	0.055	0.228	0	1
Profit_change	15020	2.018	0.796	1	3
Leverage_down	15020	1.896	0.686	1	3
Public_finance	15020	1.911	0.543	1	3
Single/family_owner	15020	0.852	0.355	0	1
Independent	15020	0.901	0.298	0	1
Age	15020	3.816	0.518	1	4
Size	15020	1.953	0.808	1	3
Export	14950	1.889	1.059	1	4
Exper_ growth	15020	2.198	0.712	1	3
Expect_growth	12325	2.720	0.713	1	4
Industry	15020	0.301	0.459	0	1
Construction	15020	0.103	0.304	0	1
Trade	15020	0.247	0.431	0	1

Our elaboration of SAFE data using the waves from the 11th to 21st.
Credit_Demand_Mot is a categorical variable that codes (from 1 to 4) the occurrence of a bank loan application by SMEs and the motivations for their refraining from it over the past 6 months: y_1, y_2, y_3, y_4.
Credit_Received_Amnt is a categorical variable that codes (from 1 to 3) the experience of a loan refusal by the applicant SMEs and the extent to which the loan has been accepted: y_1, y_2, y_3.

Before turning to the results, it is important to stress that, while using lagged values of our focal innovation variables could remove some potential for reverse causality, it does not completely eliminate other possible sources of endogeneity, like unobserved characteristics of firms that, out of those we have already controlled for, can cause both credit demand/supply and innovation, without the latter being causally linked to the former. R&D investments, for example, could both contribute to firms' innovation and lead firms to seek finance, but to expand into new markets as a result of a successful innovation. In the presence of such an econometric issue, our results should be read in terms of correlations and associations and only possibly hint to causal relationships.

4. Results

4.1. Credit demand

4.1.1. Logit model

Starting with the analysis of the SMEs' demand for bank credit, Table 2 presents the Average Marginal Effects (AME) of the regressors for the logit model of Eq.(1), accounting for firm *i* seeking bank credit in three specifications[16]: the first (Column 2.a) considers the innovative status of the sample firms in generic terms; the second (Column 2.b) distinguish innovative firms from non-innovative ones by considering the technological vs. non-technological nature of their innovation; the third (Column 2.c) distinguishes the 15 innovative profiles we have isolated with the respect to the benchmark case of non-innovative firms.

Commentato [3]: AMEND

[16] Coefficients are available from the authors upon request.

Before focusing on these innovation variables, let us notice that, in all the specifications[17], the majority of the other predictors of credit demand and of the controls turn out significant and with the expected sign. An improvement of SMEs' profits (*Profit_change*) correlates negatively with their probability to seek external finance, consistently with a pecking-order kind of argument (see Section 2). Still according to financial arguments, when liabilities with respect to assets get smaller (*Leverage_down*), and the leverage decreases, the probability that SMEs apply for a bank loan also decreases. Finally, having received public financial support and guarantees (*Public_finance*) is associated with SMEs being more reluctant to seek external credit, possibly because of its attenuating their financial needs. As expected, single owned and/or family businesses correlate with a higher probability to demand credit, and the same holds true for independent firms, not relying on business-group financing. The propensity to resort to bank credit grows with the SMEs' size and, although slightly significant, with their export internationalization, consistently with previous evidence (Mina et al., 2013), while older rather than younger SMEs are apparently more credit seeking. SMEs that perceive themselves in a current or prospected growth phase do also appear more probable to seek bank credit, possibly in order to pursue their potential growth perspectives. As for the sector dummies, results show that belonging to industry or trade, compared to services (the control group), correlate with a higher probability to demand for bank loans.

Commentato [4]: CHECK WHETHER THIS IS ACTUALLY SO

Coming to our focal regressors, Specification (2.a) shows that generic innovative SMEs, on average, have a nearly 5% (0.46) higher probability to apply for a bank loan than non-innovative ones. This result is highly significant and contrasts previous inconclusive evidence about innovation and credit demand by SMEs in the UK and the US (Mina et al., 2013) and in Denmark (Hain and Christensen,

[17] As the innovation variables of the three specifications actually provide the same kind of info for the sample firms, though in a different (compact and disaggregated, respectively) format, the marginal effects of the controls are as expected coincident or so.

2019). With respect to a wider set of countries, an innovative status seems to aggravate the external financial needs of European SMEs across the board. This suggests to policy makers an additional issue to that of integrating and/or supplementing the insufficiency/lack of internal resources that SMEs can reveal in innovating, about which we will report later.

Table 2 - Seeking bank credit

Logit model (lagged regressors, *t-1*): Average Marginal Effects

	(2.a)	(2.b)
Inno	0.046***	
	(0.010)	
Inno_Pd		0.030
		(0.018)
Inno_Pc		0.030
		(0.023)
Inno_Or		0.011
		(0.017)
Inno_Mk		0.060***
		(0.023)
Inno_Pd_Pc		0.060***
		(0.020)
Inno_Pd_Or		0.076***
		(0.026)
Inno_Pd_Mk		0.020
		(0.027)
Inno_Pc_Or		0.090***
		(0.026)
Inno_Pc_Mk		0.032
		(0.048)
Inno_Or_Mk		0.009
		(0.022)
Inno_Pd_Pc_Or		0.065***
		(0.023)
Inno_Pd_Pc_Mk		0.053**
		(0.026)
Inno_Pd_Or_Mk		0.075***
		(0.026)
Inno_Pc_Or_Mk		0.091***
		(0.031)
Inno_Pd_Pc_Or_Mk		0.090***
		(0.020)
Profit_change	-0.013**	-0.013**
	(0.006)	(0.006)
Leverage_down	-0.092***	-0.092***
	(0.010)	(0.010)
Public_finance	-0.016*	-0.016*
	(0.009)	(0.009)
Single/family_owner	0.042***	0.042***
	(0.015)	(0.015)
Independent	0.068***	0.067***

Commentato [5]: AMEND

	(0.019)	(0.019)
Age	0.024**	0.024**
	(0.009)	(0.009)
Size	0.106***	0.107***
	(0.007)	(0.007)
Export	0.009*	0.008
	(0.005)	(0.005)
Exper_growth	0.031***	0.030***
	(0.007)	(0.007)
Expect_ growth	0.017**	0.015**
	(0.007)	(0.007)
Industry	0.041***	0.040***
	(0.013)	(0.013)
Construction	0.027	0.029*
	(0.017)	(0.017)
Trade	0.038***	0.040***
	(0.013)	(0.013)
Wave	-0.006***	-0.005***
	(0.002)	(0.002)
Observations	15,020	15,020
Chi-squared	665.0	665.0
P value	0.0	0.0
Log-likelihood	-8761	-8761
Pseudo R^2	0.78	0.78

The table shows the AMEs obtained from the logit model of Eq.(1), whose dependent variable is the dummy *Credit_Demand*$_i$, taking value 1 if SMEs demand credit, and zero otherwise. Standard errors are in parentheses.
Significance levels: *** p<0.01, ** p<0.05, * p<0.1
Goodness of fit measures refer to the Logit model (with coefficients).

Moving to Column (2.b), the higher propensity of credit demand shown by generic innovative SMEs finds novel interesting qualifications when their specific innovative profile is considered. To start with, the fact that firms' innovations have or not a technological base does make a difference. Indeed, it is only in front of technological innovations (of some kind) (*Inno_Tech*) that the demand for credit increases with respect to that of non-innovative firms. Conversely, when firms innovate in other domains than those related to new product development and new process design (*Inno_NTech*), somehow in a 'soft' way (organisational or/and marketing), their credit demand does not change with respect to the benchmark.

Additional nuances emerge from Model (2.c), when we look at the specific innovation profiles that are hidden behind the previous two innovation variables. At the outset, let us notice that only one of the four single-innovator profiles reveals a significantly positive coefficient, and that the same occurs for just four out of the six double innovator profiles. The propensity to demand bank credit is significantly higher (than the benchmark) for all of the threefold innovative profiles that we considered and for that of the full-spectrum, or "super-complex" innovators. Once polled together, these results suggest that the external financial needs of SMEs increase also and above all with the extent of their involvement in the different domains of the innovative process. Indeed, with the exception of (single) marketing innovators, innovating in one domain only does not make the difference in terms of requested external financing. The case of marketing innovators is singular, and could be explained by the fact that SMEs typically lack of formal marketing departments and of the internal resources these could make available to the development of new marketing practices. Combining, or simply adding,[18] two types of innovation apparently exacerbates the firms' financial needs, but not in general. A significantly marginal effect is only revealed by full-technological innovators (*Inno_Pd_Pc*) and by technological innovators that integrate one of the relative typologies (product and process innovation) with an organizational kind of innovation on the non-technological side (*Inno_Pd_Org* and *Inno_Pc_Org*). Quite interestingly, on the first (twofold) step of the innovation complexity ladder, the introduction of technological (product or process) changes appears necessary to activate a significant and positive correlation with credit demand, and as much as necessary for that to happen is the concomitant occurrence of a novel organizational change. Considering that technological innovations are typically coupled with organizational ones by firms

[18] Unfortunately, we are incapable to know whether more kinds of innovations have been actually combined on purpose, or whether they have simply occurred in the same period, but dis-jointly.

that pursue a structural/systemic kind of change,[19] this result suggests that, as expected, the demand for bank credit is higher for SMEs that innovate in a "transformative" way. On the higher steps (threefold and fourfold) of the innovation complexity ladder, however, the extra-need (with respect to the benchmark) of external finance gets general: for example, by regarding also full non-technological innovators that innovate in one or the other of the technological domains. Finally, in further confirming our argument about the importance of the firms' extent of innovation typologies, the full-innovator profile (*Inno_Pd_Pc_Org_Mk*) shows one of the highest marginal effect: when SMEs show this "super-complex" innovative profile, their propensity of demanding bank credit increases of as many as 9 percentage points with respect to non-innovative SMEs.

4.1.2. Multinomial logit model

Further insights about the SMEs' credit demand emerge by looking at the results of the Multinomial Logit (ML) estimation of Eq.(1) with respect to the relative motivations. Using the case of applying (y_1) as a benchmark case for *Credit_Demand_Mot*$_i$ (*y*), Table 3 shows the Average Marginal Effects (AME) that a dichotomic change in our focal innovation predictors has on the different motivations for not applying that SAFE enables us to consider:[20] fear of rejection (y_2); available internal funds (y_3); other reasons (y_4), reported in Columns 3.a, 3.b and 3.c, respectively.

Starting with Panel A, which considers the innovative status of the focal firms in generic terms (*Inno*), let us notice that such a status of innovator, does not significantly correlate with the probability of

[19] The case of systemic, architectural innovations, which combine innovations in the way product and organizational modules are combined, represents an example of that (Colfer and Baldwin, 2016).

[20] The AME on the benchmark case of applying are available from the authors upon request and, net of small differences due to rounding and adopted the algorithms, they are of course consistent with results of Table 2. In interpreting the AME of Table 3, it should be recalled that they are calculated by retaining the probability weighted average of all the coefficients in Eq. (1) (see (15.19) in Cameron and Trivedi, 2005).

being a discouraged borrower for fear of rejection, compared to the non-innovator status (Column 3.a). Contrasting previous evidence about the greater financial discouragement shown by innovators at the regional level for the UK (Lee and Brown, 2016), this effect does not seem to emerge across the wide set of countries that we consider. The substantial absence of a discouraged borrower effect among innovative firms is confirmed by the estimates of Panel B, where we have started unpacking the innovative status of SMEs into a technological and a non-technological one: both the two variables (*Inno_Tech* and *Inno_NTech*) are in fact not significant in column 3.a. A similar result emerges by considering the 15 innovative probiles of Panel C. While full (and exclusive) non-technological innovators (combining organizational and marketing innovations only) show a significantly higher chance to refrain from applying because of a rejection fear – possibly because of the complex outcome of such an intangible innovative profile at the banks' eyes – the AME is quite low (about 2.1%), and in the case of a fourfold type of innovators the AME (of about 1,5%) is only significant at 10% level.

All in all, with the few exceptions we have reported above, it seems like that none of the different innovative profiles that SMEs can experience are correlated with the perceived risk to be rejected: a suggestion that we will have to verify looking at credit supply in the next Section.

Before moving to that, let us notice that Panel A of Table 3 shows that it is the availability of internal resources (Column 3.b), that, in driving the decision to refrain from demanding credit, matters more for innovative than non-innovative firms. More precisely, being a generic innovator reduces of nearly 6% (5.6% with respect to non-innovators) the chance that SMEs refrain from demanding credit because they have internal finance available. In other words, in the case of innovative SMEs, the arguable substitution effect that internally available resources could have on the demand of external credit appears to work to a lower extent. This is an interesting result that confirms and

further specifies our previous results about the higher financial needs of innovative SMEs (Table 2). In the same respect, column 3.b of Panel B reveals that the availability of internal resources correlates with refraining from demanding credit both for technological and non-technological innovators, but with an interesting specification: consistently with Table 2, the substitution effect entailed by the pecking order theory works more for the former than for the latter, as the relative status reduces credit demand of 4.7 and 6.2%, respectively.

Table 3 – Not seeking bank credit by motivation: Multinomial logit (lagged regressors, *t-1*): Average Marginal Effects

Commentato [6]: update and insert an intermediate panel where to plug Inno_Tech and Inno_NTech

	Panel A		
	(3.a) Fear of rejection (y_2)	(3.b) Available internal funds (y_3)	(3.c) Other reasons (y_4)
Inno	0.005	-0.057***	0.003
	(0.004)	(0.010)	(0.008)
Profit_change	-0.019***	0.051***	-0.016***
	(0.003)	(0.007)	(0.005)
Leverage_down	-0.014***	0.116***	-0.007
	(0.005)	(0.011)	(0.008)
Public_finance	-0.047***	0.066***	0.006
	(0.004)	(0.009)	(0.007)
Single/family_owner	0.007	-0.063***	0.014
	(0.007)	(0.016)	(0.012)
Independent	-0.001	-0.032*	-0.041***
	(0.008)	(0.019)	(0.014)
Age	-0.010***	0.001	-0.011
	(0.003)	(0.010)	(0.007)
Size	-0.017***	-0.032***	-0.051***
	(0.003)	(0.007)	(0.005)
Export	-0.003	-0.001	-0.005
	(0.002)	(0.006)	(0.004)
Exper_growth	-0.001	-0.003	-0.023***
	(0.003)	(0.008)	(0.006)
Expect_ growth	0.002	-0.004	-0.011**
	(0.003)	(0.007)	(0.005)
Industry	0.014**	-0.034**	-0.026***
	(0.005)	(0.014)	(0.010)
Construction	0.017***	-0.025	-0.024*

	(0.007)	(0.019)	(0.013)
Trade	-0.001	-0.002	-0.039***
	(0.005)	(0.014)	(0.010)
Wave	-0.004***	0.012***	-0.001
	(0.001)	(0.002)	(0.001)
		Panel C	
	(3.a)	(3.b)	(3.c)
	Fear of rejection (y_2)	Available internal funds (y_3)	Other reasons (y_4)
Inno_Pd	-0.000	-0.017	-0.015
	(0.008)	(0.020)	(0.015)
Inno_Pc	-0.006	-0.020	-0.003
	(0.012)	(0.025)	(0.019)
Inno_Or	0.009	-0.052***	0.029**
	(0.007)	(0.018)	(0.013)
Inno_Mk	-0.013	-0.038	-0.000
	(0.010)	(0.024)	(0.018)
Inno_Pd_Pc	-0.011	-0.047**	-0.010
	(0.010)	(0.022)	(0.017)
Inno_Pd_Or	0.007	-0.079***	-0.013
	(0.011)	(0.030)	(0.023)
Inno_Pd_Mk	0.010	-0.033	0.004
	(0.010)	(0.028)	(0.021)
Inno_Pc_Or	0.006	-0.080***	-0.022
	(0.012)	(0.029)	(0.023)
Inno_Pc_Mk	-0.021	-0.103**	0.088***
	(0.023)	(0.050)	(0.033)
Inno_Or_Mk	0.021***	-0.047**	0.002
	(0.008)	(0.023)	(0.017)
Inno_Pd_Pc_Or	0.007	-0.048*	-0.030
	(0.010)	(0.026)	(0.021)
Inno_Pd_Pc_Mk	0.017	-0.079***	0.002
	(0.010)	(0.029)	(0.021)
Inno_Pd_Or_Mk	-0.006	-0.075***	0.011
	(0.011)	(0.029)	(0.021)
Inno_Pc_Or_Mk	0.010	-0.107***	0.000
	(0.013)	(0.036)	(0.027)
Inno_Pd_Pc_Or_Mk	0.015*	-0.139***	0.023
	(0.008)	(0.023)	(0.016)
Observations	15,020	15,020	15,020
Log-likelihood	-16,834	-16,834	-16,834
Pseudo R^2	0.80	0.80	0.80

The table displays the AMEs obtained from the two specifications of the multinomial model of Eq.(1) in Panel A and B, respectively.
The dependent variable, *Credit_Demand_Mot*$_i$ (y), is a categorical one that codes the following SMEs' outcomes with respect to bank loans over the past 6 months: (y_1) applied; (y_2) did not apply because of fear to be rejected; (y_3) did not apply because of sufficient internal funds; (y_4) did not apply for other reasons . Applied (y_1) is used as a benchmark.

The AMEs for the controls are not reported in Panel B, because they are the same of those displayed in Panel A. Standard errors in parentheses.
Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Looking at Panel C, Table 3 reveals that the reduced extent to which internal finance could be thought to substitute external one is nearly common to all the innovation typologies we have observed. Indeed, the only cases in which being an innovator does not correlate with the resort to external credit because of internal funds (with respect to non-innovators), is represented by single innovators – with the notable exception of organizational ones – and by SMEs that integrate product innovations with innovations in the most functionally proximate domain (marketing innovation).[21] Once more confirming and specifying the results of Table 2, it is the extent to which firms resort to innovation that might emerge decisive in increasing their financial needs, to the point of making internal funds not enough to refrain from asking external funds. It is a wide, rather than restricted, innovation involvement that possibly makes SMEs' financial needs increase so much to render the substitution between internal and external finance "stickier". As a further confirmation of this result, let us notice that the negative AME on the decision to not apply because of available internal funds is among the highest for the threefold innovative profiles and definitively the highest for the full, fourfold innovators. With respect to them, the chance that available internal funds could discourage an external credit application reduces of as much as 14 (13.8) percentage points (with respect to non-innovators), confirming the highest financial need we detected for them in Table 2.

In concluding, let us notice that, it is only in Panel C that other reasons than being discouraged and having internal resources, correlate positively with the decision to not demand credit, and that this occurs for single organizational innovators (*Inno_Or*) and for process and marketing innovators (*Inno_Pr_Mk*) (Column 3.c). While further research and more detailed data are required to

[21] In spite of the negative sign, the coefficient is hardly significant also for the three-fold innovators marked by *Inno_Pd_Pc_Or*.

understand what makes the two profiles above refrain from applying for other reasons than that, the interplay between internal and external resources to which the pecking order theory refers is actually the most relevant motivation that lead innovative SMEs to apply (or not apply) for external credit.

The fact that innovative SMEs demand more credit than non-innovative ones, and that they refrain from doing it because of internally available resources they possibly prefer to invest in innovation, is the first bunch of results that our model suggests about the relationship between innovation and credit demand. A possibly more important result is however the specificity of these outcomes, which crucially depend on the kind of innovations that SMEs introduce and/or combine. Indeed, while previous results seem to hold more, if not even exclusively, for firms that combine more types of innovation (e.g. three rather than two), different exceptions suggest that the complexity of pursuing specific innovative domains and/or combining certain kinds of them, account for our results in addition to and possibly more than their simple intensity. As we will see, this is a result that our robustness checks seem to confirm and that recommends more attention to the heterogeneous financial needs that SMEs need to face to pursue different innovative profiles.

4.2. Credit supply

4.2.1. Heckit model

Moving to the supply of credit that SMEs eventually receive from banks, as we said, its analysis is carried out by estimating Eq. (2) with a probit model with sample selection *à la* Heckman (*Heckit*), whose first ladder uses Eq. (1). As we also said, available data allow us to capture credit supply by looking at the complement situation of firms facing a financial constraint, as they were refused their loan application or did refuse it themselves as too costly (*Credit_Constraint*).

Table 4 illustrates the AMEs of the expected determinants of this credit constraint, by integrating the regressors used in Eq.(1) with the usual three kinds of innovative profile: generic (Column 4.a), technological vs. non-technological (Column 4.b) and specific, among the 15 we have identified (Column 4.c) with respect to the benchmark case of fully non-innovative firms. Like in the analysis of credit demand, in order to reduce potential endogeneity problems, our focal variables are lagged of one period. [22]

Before moving to the innovation variables, the results about the controls deserve some comments. As expected, SMEs that have experienced an increase in profit, and thus presumably appear "healthy" to the lenders, are less probable to (declare to) have been credit constrained, while their leverage does not affect this outcome. Receiving public support does also correlate negatively with the SMEs' probability of ending out with no external credit, suggesting a possible certification/signaling effect of government subsidies on the SMEs access to bank finance (Li et al., 2019). Consistently with previous studies (Mina et al., 2013; Acharya and Xu, 2017; Petersen and Rajan 1994; Berger and Udell 1995; Mina et al. 2013, Andrieu et al., 2018), larger SMEs are less likely to be credit constrained, while their age does not seem to play a role in the same respect. Overall, these results are generally consistent with those of the extant literature. Exceptions could be due to the fact that, unlike other studies, our own focuses only on bank credit rather than on external financing. For example, across the 11 countries we have considered, the sensitivity of banks to firms' age appears less than that generally revealed by other kinds of external financiers (e.g. VC or business angels).

[22] Results for the first stage are available in the Appendix (Table A.2)

Table 4 – Being credit constrained:
Heckit model, output equation (lagged regressors, *t-1*): Average Marginal Effects

Commentato [7]: amend and insert column 4.b with the intermediate model

	(4.a)	(4.b)
Inno	0.014***	
	(0.004)	
Inno_Pd		0.005
		(0.007)
Inno_Pc		0.003
		(0.009)
Inno_Or		0.015**
		(0.006)
Inno_Mk		0.013*
		(0.007)
Inno_Pd_Pc		0.012
		(0.007)
Inno_Pd_Or		0.006
		(0.009)
Inno_Pd_Mk		-0.006
		(0.011)
Inno_Pc_Or		0.011
		(0.009)
Inno_Pc_Mk		0.024*
		(0.013)
Inno_Or_Mk		-0.001
		(0.008)
Inno_Pd_Pc_Or		0.006
		(0.008)
Inno_Pd_Pc_Mk		0.011
		(0.009)
Inno_Pd_Or_Mk		0.032***
		(0.008)
Inno_Pc_Or_Mk		0.026***
		(0.010)
Inno_Pd_Pc_Or_Mk		0.031***
		(0.006)
Profit_change	-0.008***	-0.007***
	(0.003)	(0.002)
Leverage_down	0.003	0.002
	(0.004)	(0.004)
Public_finance	-0.029***	-0.026***
	(0.006)	(0.004)
Single/family_owner	0.005	0.004
	(0.005)	(0.005)
Age	-0.003	-0.002
	(0.003)	(0.003)
Size	-0.008**	-0.006**
	(0.004)	(0.003)
Export	0.002	0.002
	(0.002)	(0.002)
Exper_growth	-0.003	-0.002
	(0.003)	(0.002)

Expect_ growth	0.002	0.001
	(0.002)	(0.002)
Industry	-0.003	-0.001
	(0.005)	(0.004)
Construction	0.011*	0.010*
	(0.006)	(0.005)
Trade	-0.000	0.001
	(0.004)	(0.004)
wave	-0.002***	-0.002***
	(0.001)	(0.001)
Observations selection eq.	12,178	12,178
Observations output eq.	4,115	4,115
Wald test	145.0	183.9
P value	0.00	0.00
Langrage test	279.2	317.1
P value	0.00	0.00
Log-likelihood	-8268	-8237
Rho (indipendent models)	0.77	0.84
LR test of indep. eqns.	2.53	4.36
P value	0.11	0.04

The table reports the AMEs calculated from the output equation of the Heckit model (Eq.2), with the dependent dummy variable $Credit\_Constraint_i$, taking value 1 if the firm is financially constrained and zero otherwise. The exclusion restriction variable – i.e. the independent status of the firm – is omitted. The estimated coefficients for the first stage of the Heckit model are reported in Table A.2 in Appendix. Standard errors in parentheses.
Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Coming to the innovation variables, the first specification (Column 4.a) of Table 4 shows that innovative SMEs, of any kind, are significantly more likely to be credit constrained than non-innovative ones. When a large set of countries is considered, like that of our sample, the mixed kind of evidence that emerges from comparing individual ones becomes more clear-cut: having introduced any type of innovation is associated with a higher probability of SMEs being credit constrained, though of no more than 1.5%. Quite interestingly, the detected constraint appears to be exclusively due to the presence of a technological dimension in SMEs' innovation, as Inno_Tech only is fully significant (Column 4.b), with an AME similar to the generic one (1.6%).

Mimicking what emerged from the credit demand side, also the AMEs on credit supply get larger when the specific innovation profiles of the demanding firm are considered and, once more, the

largest AME are of the most extensive of these profiles (Column 4.c). Differently from credit demand, however, the innovative extent that makes SMEs credit constrained is wider than that making them more demanding of external credit. While, as we said, a combination of two (selected) innovation typologies is required to increase the financial needs of SMEs with respect to their non-innovative counterparts (see Table 2), for them to be also financially constrained the number of innovation typologies is higher. Indeed, such a case requires the pool of at least three kinds of innovation typologies to emerge, and still of a certain kind; namely with a non-technological bias (*Inno_Pd_Or_Mk* and *Inno_Pc_Or_Mk*). Furthermore, the highest marginal effect on the occurrence of a credit constraint is exerted by what we called full innovators, combining all of the innovation typologies of our spectrum.[23] For these "super complex" innovators, the probability of getting constrained in fact increases by 3.2 percentage points with respect to non-innovators.

All in all, it seems that the extent to which SMEs involve in innovation (typologies) affect their credit demand more "promptly", along the innovation profile ladder, than their credit supply. In brief, extending the spectrum of innovation typologies has a more pervasive effect on credit demand than on credit supply, and once more the elements of the spectrum appears to matter, as we will confirm in our robustness checks. From the reverse side of the coin, not only "a little innovation is a good thing'' in financial terms (see Section 2), but "a single (kind of) innovation" appears good also in order not to be credit constrained.

[23] The only exception is represented by the case of single organizational and marketing innovators, but with a significance and an AME that are both low.

4.2.2. Heckman Multinomial model

Coming to the extent to which innovative firms can get credit constrained, Table 5 shows the AMEs of its determinants by estimating Eq.(2) with a Heckman Multinomial Probit, in which the benchmark case (credit constraint, y_1) is contrasted with the cases of a partial (y_2) or full acceptance of the loans application (y_3) , reported in Columns 5.a and 5.b, respectively.[24] Like in the previous cases, in order to reduce potential endogeneity, all the relevant explanatory variables are lagged at time *t-1*.[25]

Table 5 – Credit received by amount:
Heckman Multinomial Probit, output equation (lagged regressors, *t-1*): Average Marginal Effects

Panel A

	Partially received (y_2)	Fully received (y_3)
Inno	0.016**	-0.031**
	(0.008)	(0.014)
Profit_change	-0.011**	0.020**
	(0.005)	(0.010)
Leverage_down	-0.020	0.017*
	(0.015)	(0.010)
Public_finance	-0.033**	0.065**
	(0.013)	(0.028)
Single/family_owner	0.018	-0.023*

Commentato [8]: AMEND AND INSERT PANEL B WITH TECHNOLOGICAL AND NON-TECHNOLOGICAL INNOVATORS

[24] AMEs for the benchmark case of being credit constrained are consistent with those of the Heckit inTable 4 and available from the authors upon request. While the SAFE survey would allow us to distinguish a moderate (less than 75% of the request) and an intense (more than 75%) kind of partial acceptance, we have opted to collapse the two into a unique category as ...

[25] We should bear in mind that, in the multinomial probit with sample selection, the marginal effect of a predictor in the observed sample is made of two components: a direct effect, due to the coefficient in the outcome equation, and the indirect one, linked with the selection process. The size of these two effects depend on the particular setting, but the magnitude, sign, and statistical significance of the marginal effect might all be different from those of the estimate coefficient in the outcome equation and this point "appears frequently to be overlooked in empirical studies" (Greene, 2012, p. 875).

	(0.012)	(0.013)
Age	-0.004	0.008
	(0.006)	(0.007)
Size	0.013	-0.003
	(0.012)	(0.005)
Export	0.005	-0.007*
	(0.003)	(0.004)
Exper_growth	0.005	-0.005
	(0.005)	(0.005)
Expect_ growth	0.001	-0.003
	(0.003)	(0.004)
Industry	0.005	-0.002
	(0.008)	(0.008)
Construction	0.005	-0.018
	(0.009)	(0.013)
Trade	0.017	-0.017*
	(0.012)	(0.010)
wave	-0.003**	0.006**
	(0.002)	(0.003)
Log-likelihood	-10247.2	
Wald test	1155.0	
P value	0.00	

Panel C

	(5.a) Partially received (y2)	(5.b) Fully received (y3)
Inno_Pd	0.013	-0.021
	(0.020)	(0.026)
Inno_Pc	-0.021	0.021
	(0.032)	(0.037)
Inno_Or	0.030	-0.080***
	(0.026)	(0.028)
Inno_Mk	0.006	-0.035
	(0.026)	(0.033)
Inno_Pd_Pc	0.035	-0.062**
	(0.023)	(0.029)
Inno_Pd_Or	0.041	-0.038
	(0.028)	(0.038)
Inno_Pd_Mk	0.047	-0.033
	(0.037)	(0.042)
Inno_Pc_Or	0.013	-0.024
	(0.028)	(0.037)
Inno_Pc_Mk	0.042	-0.107
	(0.055)	(0.069)
Inno_Or_Mk	0.052	-0.053

	(0.033)	(0.034)
Inno_Pd_Pc_Or	0.029	-0.045
	(0.026)	(0.032)
Inno_Pd_Pc_Mk	-0.014	-0.003
	(0.034)	(0.039)
Inno_Pd_Or_Mk	0.009	-0.098**
	(0.037)	(0.040)
Inno_Pc_Or_Mk	0.019	-0.082*
	(0.035)	(0.043)
Log-likelihood	-10218.6	
Wald test	1245.2	
P value	0.00	

The table reports the AMEs obtained from the two specifications of the output equation of the Heckit model (Eq.2), in Panel A and B, respectively. The dependent variable, $Credit\_Received\_Amnt_i$ (y), is a categorical one that codes the following cases: (1) not received the requested financing, either because the loans were rejected or refused (y_1); (2) received the requested financing only partially (y_2); (3) received the requested financing completely (y_3). (1) is used as benchmark case. The AMEs for the controls are not reported in Panel B, because they are the same of those displayed in Panel A.
Standard errors are in parentheses.
Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Panel A (Table 5) shows that, unlike other SMEs' characteristics that could provide banks with positive signals about their financial reliability, and thus account for the larger probability of a full acceptance (with respect to a credit constraint) - like an increase in profit and a financial support from the public sector - being innovator has a coefficient with an opposite sign: the chance of getting fully financed reduce of more than 5%, confirming that a generic innovative status could be perceived as risky by the lenders (Column 5.b). On the other hand, the same generic status of innovator does not significantly correlate with the chance of being only partially financed (Column 5.a), suggesting an important specification of the extent to which innovative SMEs are financially constrained. Our results are consistent with a situation in which, in front of innovative firms, banks are more selective in the decision of full lending. However, an innovative status does not appear to reduce (and to increase either) the banks' perception that demanding firms are at least partially creditworthy. In brief, the same status apparently reduces, but does not cancel out the creditworthiness of demanding firms.

Commentato [9]: ALTHOUGH THE RESULT IS NOW NON SIGNIFICANT, AND NO MORE POSITIVE, WE DUE AN EXPLANATION, THAT HE DID NOT LIKE BEFORE, I HAVE TRIED TO CHANGE IT

When we move to the results about technological and non-technological innovative profiles, Panel B (Table 5) shows that none of them significantly affect the probability of being partially financed with respect to the benchmark case of being constrained (Column 5.a), confirming what we got by looking at generic innovators. Consistent is also the significantly negative coefficient that *Inno_Tech* and *Inno_NTech* reveal with respect to the outcome of a full acceptance of the credit demanded (Column 5.b). Somehow surprisingly, however, it is the case of non-technological innovators that has a larger negative effect on the same outcome, possibly because the guaranteeing value of soft kinds of innovations like marketing and organisational ones could be perceived by banks a lower.

The previous picture is basically confirmed when we disentangle the 15 kinds of innovative profiles we have identified. Panel C of Table 5 shows that, for all ll these innovative profiles, the probability of getting partially financed does not decrease with respect to the benchmark, and it does not significantly increase either (Column 5.b). An interesting specification however emerges when we look at the probability of SMEs to be fully financed. Consistently with the main argument of this paper, it is the specific kind of introduced innovation that makes firms' innovativeness correlate with the outcome of a full credit supply. At first sight, and also consistently with what we found in terms of credit demand and supply above, it is the intensity of this innovativeness that seems to matter: super complex innovators (*Inno_Pd_Pc_Or_Mk*) show the highest marginal reduction of a full acceptance (-10%), and as higher is the reduction of complex non-technological innovators that integrate product innovations (*Inno_Pd_Or_Mk*). However, intensity is not the only relevant issue, as a significantly negative correlation with the outcome at stake emerges also with respect to fully technological innovators (*Inno_Pd_Pc*) and to single organisational ones (*Inno_Or*).

In conclusion, and corroborating what we have found on the credit demand side, it is both the extent to which SMEs involve in innovation and the specific spheres in which they do, that matter the most in accounting the measure in which their credit demand is accepted. This is an additional novel result of this paper, which suggests a new light under which the financial constraints of innovative SMEs should be considered in future analysis and in policy action.

4.3. Robustness checks and additional results

….

5. Conclusions

This paper provides new arguments and evidence about the link between innovation and external financing with respect to SMEs. As a first value added to the extant literature on the topic, we extend the standard distinction between innovative and non-innovative SMEs to the consideration of the profile the latter reveal in terms of the typologies of innovation they introduce and eventually combine: technological vs. non-technological, and of different kinds for each of these two macro-typologies. Drawing on innovation studies, we in fact argue and expect that such a profile could have a differential impact on the credit SMEs demand to and obtain from banks, respectively. As a second value added, we investigate whether innovative SMEs of different profiles behave differently from their non-innovative peers, not only in the extent to which they seek and obtain external finance, but also in the motivations and amounts of the respective choices. Last but not least, extending previous studies mainly carried out with respect to specific country datasets, we address the previous research questions with respect to a large sample of SMEs belonging to eleven countries of the EU15, observed over the period 2014-19.

The results that we have obtained are only partially supportive of existing knowledge about the relationship between finance and innovation and add to it a set of interesting specifications. Differently from previous country-specific studies (e.g. Mina et al., 2013; Hain and Christensen, 2019), we do find confirmation of the theoretical tenet according to which innovation exacerbates the search for credit demand by SMEs (Hall and Lerner, 2010). Furthermore, we qualify this tenet in at least two respects. Firstly, with respect to non-innovative ones, SMEs increase their credit demand also and above all with the extent of their involvement in different innovation typologies, being credit demand larger for complex innovators that combine more typologies of technological and non-technological innovations. Secondly, increasing the SMEs' involvement in different innovation typologies does also decrease the extent to which their internal funds reveal sufficient to make them refrain from asking external credit. Their innovative profiles instead do not affect the emergence of a discouraged borrower effect in credit demand. Both of these specifications suggest that an important dimension that makes SMEs more demand seeking, and that could thus make their internal financing insufficient, is their innovation involvement at the "extensive margin", as this could be captured by different kinds of innovation that SMEs introduce and possibly combine. This dimension has been relatively neglected in previous studies and should be instead carefully considered in refining our knowledge about how firms' innovation affects their finance and about how the latter could turn into a barrier. In this last respect, the same dimension reveals important for policy makers too, as they should insert in the informative set to map the aspects of the firms' innovative activities that are more probable to generate financial needs they could help to fill.

As far as the supply side of credit is concerned, consistently with literature predictions (Lee et al., 2007; Kerr and Nanda, 2015), but once more differently from some previous country-specific studies, our results show that getting involved in innovative activities boosts the probability that

SMEs end out financially constrained as they do not get the requested credit. On the other hand, we add to this evidence that, for the sake of getting financed, not only is "a little innovation good", but also "a simple" innovation is good. Indeed, the chance of getting financially constrained is once more the highest for complex innovators, engaging in risky combinations of technological and non-technological changes. While providing firms with an extremely important strategic recommendation, to address a potential trade-off between innovation complexity and financeability, policy-makers are asked to help innovative SMEs in attenuating the same trade-off. In particular, SMEs that engage in innovation to a wider extent should be in the radar of policy makers in their action of curing financial barriers to innovation. The same kind of strategic and policy implications descend from our results about the extent to which SMEs get financially constrained. Results about the amount of SMEs' credit demand that is financed seem to suggest that a generic innovative status makes banks more selective in the decision of full lending, but the chance of reducing their decision increases only with respect to few and mainly multiple innovative profiles.

In concluding, we acknowledge some limitations of our study, which the availability of further data could possibly help us to address. First of all, our understanding of the relationship between the innovation status and external finance for SMEs would benefit from the introduction of additional variables: in particular, of a quantitative and continuous nature with respect to the innovation outcomes, skills and competencies of the focal firms. Secondly, the analysis would be also enriched by considering data on R&D, patents and other intangible investments, whose lack we have tried to remedy by employing a broad set of controlling covariates aimed at capturing the firm's heterogeneity. Thirdly, results could be made more accurate by overcoming the absence of firm identifiers in the SAFE survey, through which it could be linked to other datasets, like balance-sheet

data, where detailed information about the firms' financing are available. Addressing these limitations goes beyond the scope of our study and can provide inputs for further research.

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Appendix

Table A.1 - Correlation matrix

	Inno	Pd	Pc	Or	Mk	Pd_Pc	Pd_Or	Pd_Mk	Pc_Or	Pc_Mk	Or_Mk	Pd_Pc_Or	Pd_Pc_Mk	Pd_Or_Mk	Pc_Or_Mk	Pd_Pc_Or_Mk	Profit_change	Leverage_down	Public_finance	Single/Family	Indipendent	Age	Size	export	Exper_growth
Inno	1																								
Pd	0.216	1																							
Pc	0.167	-0.060	1																						
Or	0.249	-0.089	-0.069	1																					
Mk	0.156	-0.056	-0.043	-0.064	1.																				
Pd_Pc	0.186	-0.067	-0.052	-0.077	-0.048	1																			
Pd_Or	0.139	-0.050	-0.038	-0.057	-0.036	-0.043	1																		
Pd_Mk	0.144	-0.052	-0.040	-0.060	-0.037	-0.045	-0.033	1																	
Pc_Or	0.139	-0.050	-0.039	-0.058	-0.036	-0.043	-0.032	-0.033	1																
Pc_Mk	0.071	-0.026	-0.020	-0.029	-0.018	-0.022	-0.016	-0.017	-0.017	1															
Or_Mk	0.174	-0.062	-0.048	-0.072	-0.045	-0.054	-0.040	-0.042	-0.040	-0.021	1														
Pd_Pc_Or	0.157	-0.056	-0.044	-0.065	-0.041	-0.049	-0.036	-0.038	-0.036	-0.019	-0.045	1													
Pd_Pc_Mk	0.133	-0.048	-0.037	-0.055	-0.034	-0.041	-0.031	-0.032	-0.031	-0.016	-0.038	-0.035	1												
Pd_Or_Mk	0.131	-0.047	-0.036	-0.054	-0.034	-0.041	-0.030	-0.031	-0.030	-0.016	-0.038	-0.034	-0.029	1											
Pc_Or_Mk	0.110	-0.039	-0.030	-0.045	-0.028	-0.034	-0.025	-0.026	-0.025	-0.013	-0.032	-0.029	-0.024	-0.024	1										
Pd_Pc_Or_Mk	0.187	-0.067	-0.052	-0.077	-0.048	-0.058	-0.043	-0.045	-0.043	-0.022	-0.054	-0.049	-0.041	-0.041	-0.034	1									
Profit_change	0.046	0.011	0.025	-0.007	-0.006	0.040	0.019	0.003	0.007	-0.005	-0.023	0.026	0.021	-0.011	-0.005	0.011	1								
Leverage_down	0.000	-0.012	-0.022	-0.004	-0.006	0.003	-0.023	0.001	0.014	-0.002	0.014	0.002	-0.009	0.016	0.013	0.023	-0.201	1							
Public_finance	-0.005	0.005	0.018	0.007	-0.022	0.030	-0.008	-0.010	-0.007	-0.007	-0.025	0.003	0.014	-0.028	0.016	-0.011	0.198	-0.090	1						
Single/Family	-0.028	-0.013	-0.022	-0.033	0.018	-0.031	-0.020	0.011	0.004	0.013	0.013	-0.001	0.009	-0.009	0.012	0.014	-0.035	-0.006	-0.023	1					
Independent	-0.039	-0.030	-0.026	-0.035	0.026	-0.045	-0.037	0.021	-0.030	-0.003	0.010	0.003	0.021	0.008	0.021	0.033	-0.034	0.006	-0.043	0.383	1				
Age	-0.051	0.006	0.003	-0.004	0.005	0.013	-0.005	-0.022	-0.005	-0.018	-0.009	-0.040	0.001	-0.012	-0.020	-0.037	-0.021	-0.015	0.006	-0.004	0.008	1			
Size	0.074	0.030	0.072	0.076	-0.040	0.059	0.009	-0.054	0.038	-0.006	-0.021	0.034	-0.014	-0.015	-0.009	-0.038	0.136	-0.020	0.090	-0.226	-0.228	0.130	1		
Export	0.136	0.090	0.027	-0.019	-0.052	0.101	0.037	0.014	0.018	-0.013	-0.031	0.089	0.018	0.007	0.011	0.011	0.051	-0.002	0.044	-0.081	-0.123	0.044	0.286	1	
Exper_growth	0.096	0.014	0.025	-0.012	-0.020	0.056	0.011	0.020	0.010	0.000	-0.028	0.043	0.050	0.021	0.015	0.038	0.467	-0.126	0.284	-0.018	-0.027	-0.024	0.098	0.075	1
Exp_ growth	0.154	0.017	-0.003	-0.030	-0.013	0.062	0.035	0.034	0.004	0.013	-0.001	0.068	0.051	0.056	0.012	0.096	0.274	-0.059	0.121	-0.028	-0.030	-0.077	0.066	0.096	0.365

For sake of readability the prefix inno has been omitted in all the case but for the generic innovator variable

Table A.2 - Coefficients for the first stage of the Heckit

	(1)	(2)	(1)	(2)
Inno	0.230***	0.098***		
Inno_Pd			0.087	0.103**
Inno_Pc			0.044	0.021
Inno_Or			0.245**	0.003
Inno_Mk			0.224*	0.138**
Inno_Pd_Pc			0.196	0.150***
Inno_Pd_Or			0.098	0.230***
Inno_Pd_Mk			-0.097	-0.031
Inno_Pc_Or			0.185	0.200***
Inno_Pc_Mk			0.403*	0.028
Inno_Or_Mk			-0.021	-0.031
Inno_Pd_Pc_Or			0.093	0.118*
Inno_Pd_Pc_Mk			0.187	0.129*
Inno_Pd_Or_Mk			0.544***	0.133*
Inno_Pc_Or_Mk			0.433***	0.210**
Inno_Pd_Pc_Or_Mk			0.523***	0.208***
Profit_change	-0.130***	-0.006	-0.122***	-0.006
Leverage_down	0.051	-0.259***	0.033	-0.261***
Public_finance	-0.467***	-0.020	-0.440***	-0.019
Single/Family_owner	0.082	0.108***	0.069	0.105***
Age	-0.052	0.085***	-0.041	0.085***
Size	-0.130***	0.276***	-0.106**	0.280***
Export	0.026	0.020	0.026	0.017
Exper_growth	-0.041	0.065***	-0.041	0.064***
Exp_growth	0.029	0.025	0.013	0.019
Industry	-0.042	0.108***	-0.019	0.104***
Construction	0.172*	0.059	0.170*	0.065
Trade	-0.006	0.091***	0.011	0.096***
wave	-0.036***	-0.012***	-0.033***	-0.011***
Indipendent		0.160***		0.157***
Constant	-0.316	-1.818***	-0.491	-1.802***
Observations	12,178	12,178	12,178	12,178
Country FE	YES	YES	YES	YES
LogLikelihood	-8268	-8268	-8237	-8237
Chi-2	145.0	145.0	183.9	183.9
Prob	0.00	0.00	0.00	0.00

Significance levels: *** p<0.01, ** p<0.05, * p<0.1