

# DOES BANK SIZE MATTER IN FINANCING SMALL BUSINESS INNOVATION?

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Using data at the bank-firm level for a large sample of small firms collected through the 8th UniCredit Survey conducted in 2011, we investigate the extent to which banks of different size reward more innovative firms, in terms of both access to lending and volume of credit granted. First we find that the status of innovative firm is associated with the possibility of being weakly credit-rationed, as perceived by surveyed firms, while we do not observe any evidence of banks following strong credit-rationing strategies. On the contrary, using instrumental variable techniques in order to manage the endogenous nature of innovation, we show that all types of banks reward firms' innovative activities. We also provide evidence that a large internationalized bank more strongly supports product innovation, whereas there is no substantial difference in the extent to which small and large banks provide credit to small firms undertaking process innovations.

*JEL Classification: G21, L25, O31.*

*Keywords: relationship banking, informed finance, innovative firms.*

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## 1. Introduction

According to the literature on relationship lending (see for example Stein, 2002), small and local banks have an advantage in providing credit to small enterprises thanks to their greater ability to overcome the opaqueness which is traditionally associated to these firms. In a similar vein, it is claimed that big and internationalized banks deserve scarce attention to the small business segment compared to the wide range of services they instead supply to large companies (Berger and Udell, 2002).

However, in some countries – such as Italy – small businesses have a great economic role, for example in terms of aggregate firm turnover achievement, creation of value added and aggregate number of employees (Ayyagari et al, 2007). From the overall banking system's perspective there is indeed increasing awareness of the importance of retail customers. For instance, using a cross-country analysis, de la Torre et al. (2010) show that banks, regardless of their own dimension and degree of internationalization, consider smaller companies as a relevant, expanding market segment.

Due to their intense dynamics, small firms might require tailored financial services, which often need to be provided on a larger scale compared to firms' dimension, especially when entrepreneurs engage in strategic and capital-intensive activities like technological innovation and creation of new products. Under these circumstances, it might be the case that such kind of assistance can be more efficiently provided by large banks rather than by small intermediaries (see de la Torre et al., 2010 for a detailed discussion on large banks' greater efficiency).

The role of banks in fostering firm innovation activity is analyzed, in particular, by Herrera and Minetti (2007), whose empirical investigation shows that informational tightness – measured by the duration of the credit relationship between an enterprise and its main bank – has a positive effect on the probability of engaging in innovation activity.

In this paper we provide further evidence regarding the importance of the small business segment for big banks. More in detail, using data at the bank-firm level for a large sample of small firms realizing at most 5 million annual turnover, we investigate the extent to which banks of different size reward more innovative firms, especially in terms of both access to lending and volume of credit granted.

Our analysis is divided in two parts. In the first part we examine the probability that a small innovative firm perceives itself as credit-rationed by the banking system considered as a whole.

The findings of this part of the study are somehow contrasting. On the one hand, if we consider a weak form of rationing – i.e. a situation such that firms declare they are facing financial constraints although not having asked for a loan – innovative firms seem to be credit-rationed. On the other hand, when inspecting a stronger form of rationing – i.e. firms which have actually been denied credit – we find that being an innovative firm is not associated to a statistically significant probability of being credit-rationed.

In the second part of the analysis, we focus on the growth rate of the credit granted to small innovative firms. In particular, we compare loans accorded by a large internationalized bank (i.e. UniCredit<sup>5</sup>) with those granted by the rest of the banking system to the same set of enterprises. This approach is intended to investigate whether different credit allowance strategies are adopted by large internationalized credit institutions, on the one hand, and by a system where the representative bank can be unquestionably considered both smaller and operating on a more restricted geographical dimension, on the other hand.

We show that although more innovative firms frequently perceive themselves as rationed, the banking system as a whole actually accords them more credit compared to non-innovators. Moreover, using estimation techniques aimed at correcting for the endogenous nature of innovation with respect to credit, it turns out that the large internationalized bank in our sample appears to finance innovation more generously than the rest of the system does. In particular, there is evidence that it tends to reward small enterprises realizing most of their turnover from innovative products and services. There is no substantial difference, instead, regarding the extent to which small and large banks finance process innovation.

The paper is organized as follows: section 1 introduces; section 2 provides a brief overview of the literature; section 3 describes the dataset used in the empirical analysis; section 4 describes the methodology and discusses the empirical evidence; section 5 concludes.

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<sup>5</sup> UniCredit is a major international financial institution with strong roots in 20 European countries and an overall international network present in 50 markets, with over 150,000 employees and about 9,200 branches. UniCredit benefits from a strong European identity, an extensive international presence and a broad customer base (<https://www.unicreditgroup.eu/en/banking-group/at-a-glance.html>).

## 2. Literature background

Credit rationing problems faced by innovative firms seeking for external financial resources have been extensively studied in the literature related to economics and finance (see for instance Hall and Lerner, 2010 for a review).

A common theoretical framework to these studies is that they mostly explain both unfavourable credit conditions and several forms of rationing imposed on innovative firms with the existence of information asymmetries between lenders and borrowers (Myers and Majluf, 1984).

First, entrepreneurs are reasonably better informed than lenders as to the likelihood of success of their innovative projects. However, they have scarce incentives to disclose information to investors, including banks, since firms' strategic plans may be eventually revealed to competitors (Carpenter and Petersen, 2002; Bhattacharya and Ritter, 1983). Such a phenomenon is even more severe for innovative firms, since the success of their projects mostly relies on secrecy (Cohen et al., 2000; Zaby, 2010). Therefore, in such a context, investors face difficulties in distinguishing good projects from bad ones (adverse selection), which make credit rationing a serious concern (Jaffee and Russell, 1976; Stiglitz and Weiss, 1981).

Second, moral hazard effects can also hamper the difficulties related to external financial provision for innovative projects that are typically considered to embed a substantial degree of risk. On the one hand, since banks prefer safer projects, entrepreneurs could ex-ante declare to be willing to undertake such projects rather than riskier ones. On the other hand, the lack of credible commitments may induce borrowers to change ex-post their behaviour in favour of riskier projects, because of their higher profitability in case of success.

Furthermore, the above theoretical arguments suggest that small innovative firms are likely to face even higher costs of external finance and a corresponding greater probability of being credit-rationed. In fact, small enterprises, whether they are innovative or not, are typically less transparent compared to larger firms. This point is supposed to hold more strongly when considering start-ups, which, being newly-established and small-sized firms, are normally endowed with less valuable collateral as a guarantee to their loan (see for example Hall, 2009).

Such theoretical predictions have been confirmed by empirical evidence suggesting that financial constraints are more severe for small-sized firms (see, among others, Beck and Demirguc-Kunt, 2006; Benfratello et al., 2008; Czarnitzki, 2006; Vos et al., 2007) and for innovative start-ups (see Brown et al., 2012 for a discussion).

However, it has been recently observed that banks are increasingly applying a variety of techniques to overcome information asymmetries, especially when borrowers do not have a long-term relationship with the bank itself. This phenomenon has been associated, in particular, to the development of Information and Communication Technologies, such as, for example, the possibility to set up internal credit scoring models, and the availability of external information on borrowers provided by credit bureaus (Jappelli and Pagano, 2006).

Even more noteworthy, banks can also offer a range of credit contracts in order to overcome adverse selection (Bester, 1985). Such contracts may differ in collateral requirements (Bester, 1985), size (Freixas and Laffont, 1990) or maturity (Flannery, 1986). Banks can also cope against moral hazard through repeated short-term lending (Bolton and Scharfstein, 1990).

It seems unquestionable, then, that large banks have an advantage in achieving and/or developing all these tools, since they are better equipped in terms of qualified staff and can also exploit scale economies. Such a view opposes to the well-established thesis that large and internationalized banks are generally not interested in serving small enterprises, whereas small banks can better satisfy small businesses' financial needs through relationship lending. Thus, it is interesting to investigate and compare these strategies by looking at whether large or small banks better "reward" small innovative firms.

Finally, it is worth noting that much of the existing literature on the topic has deeply investigated the causality mechanisms that go from relaxing firms' financial constraints to their increasing willingness to invest in innovative products or production techniques (see for example Herrera and Minetti, 2007). In this paper, instead, our approach is substantially reversed, since our aim is to seek whether having previously undertaken innovative projects turns into being rewarded by a bank with more favorable credit opportunities. This raises concerns of causality, which we manage through accurately considering the timing of events and using instrumental variables related to the average degree of difficulties that small enterprises (located in the same province and operating in the same industry of the firm under investigation) face when planning to undertake some innovation activities.

### 3. Data and variables

#### 3.1 Data sources

Our main data source is the 8th UniCredit Survey on Small and Medium Enterprises (henceforth USM) carried out in 2011. The survey has been conducted for the period 2009-2011 on a sample of 6,025 Italian small firms<sup>6</sup> (defined as those with at most 5 million euros of turnover per year) belonging to all sectors of the economy. The sample has been drawn using a stratification procedure based on firm's size, sector and geographic localization, and can be considered representative of the Italian population of small firms.

The survey collects very detailed qualitative and quantitative information about each firm, such as its ownership and legal structure, production features, innovation efforts, degree of internationalization, market strategies, financial management and relationships with banks. These elements have been integrated with both balance sheet data and a rating measure of the firm excerpt from the CEBI (Centrale dei Bilanci) database, which has been developed and maintained by the Cerved Group.

Additional details concerning firms' access to bank credit during the period 2008-2011 have been drawn from the Bank of Italy CR (Centrale dei Rischi) database. Using the UniCredit internal database we have also added details on firms' rating and the ATECO 3-digit code.

#### 3.2 Main dependent and explanatory variables

In order to investigate the credit reward that small innovative firms can obtain compared to non-innovative ones, we consider two different sets of financial measures. The first set includes credit rationing variables, while the second set comprises measures of firms' financial resources obtained from Italian banks.

Following the literature on the effects of financial constraints on firms' innovation activity (see for example Piga and Atzeni, 2007), we consider two measures of credit rationing, *weakly rationed* and *strongly rationed*, both based on the USM data. More in detail, *weakly rationed* is a dummy variable that equals 1 if the firm declares that in 2010 it would have liked to receive more credit at the interest rate previously agreed with its bank. We define it a weak measure of credit rationing. The variable *strongly rationed*, instead, equals 1 if the firm asked for more credit to the bank – at a previously agreed interest rate – but its request has been denied. We interpret this as a strong

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<sup>6</sup> All small businesses in the sample are UniCredit customers.

form of credit rationing. The definition of the two credit rationing variables leads to a subsample of 5,894 observations due to some missing responses in the USM survey data.

Table 1 summarizes information about the frequency with which small firms declare to be rationed, according to the type of rationing and firm's size<sup>7</sup>. Overall, smaller firms seem to be less rationed than firms with at least 10 employees. This finding holds whether one considers the weak or the strong form of credit rationing.

*Table 1. Descriptive statistics on weak and strong credit rationing by firms' size class*

employees	Freq.	weakly rationed		strongly rationed	
		Mean	Std. Dev.	Mean	Std. Dev.
1-9	5,144	0.399	0.490	0.163	0.369
10-19	393	0.438	0.497	0.206	0.405
20 or more	180	0.428	0.496	0.206	0.405
missing	177	0.418	0.495	0.175	0.381
<i>Total</i>	<i>5,894</i>	<i>0.403</i>	<i>0.491</i>	<i>0.167</i>	<i>0.373</i>

Another strand of the literature on financial constraints (see Khwaja et al. 2010, among others) suggests the adoption of a second set of dependent variables: the average of the annual growth rates of the credit obtained by a firm in years 2010 and 2011. In this case we distinguish between the overall banking system and a given large bank, i.e. UniCredit. More precisely, one variable, *credit growth rate system 09\_11*, concerns financial resources granted by all the Italian banks except UniCredit (henceforth, "the Banking System"). The other variable, *credit growth rate UniCredit 09\_11*, accounts for the amount of credit granted by UniCredit only<sup>8</sup>.

We found that for 1,239 observations of the USM survey we can compute the average growth rate of the credit granted by the Banking System, whereas in the case of the given large bank the corresponding number is slightly larger, 1,529. Further combining the above information, we obtain a sample of 1,174 small firms for which we can compute both the average annual growth rate of credit granted by the Banking System and the average annual growth rate of credit granted by UniCredit.

Table 2 provides some statistics on the average growth rate of the credit granted to the surveyed firms in the period 2009-2011, either by the Banking System or UniCredit, according to firm's size.

<sup>7</sup> Henceforth, the size is defined according to the number of employees declared by the firms.

<sup>8</sup> All these data are drawn from the Bank of Italy CR database.

Table 2. Descriptive statistics on average annual growth rates of the credit granted to the firms in years 2010 and 2011 by firms' size class

employees	Credit growth rate system 09_11			Credit growth rate UniCredit 09_11		
	Freq.	Mean	Std. Dev.	Freq.	Mean	Std. Dev.
1-9	820	0.007	0.788	1,069	-0.005	0.354
10-19	266	0.001	0.285	286	0.039	0.406
20 or more	109	0.035	0.539	116	0.018	0.344
missing	44	-0.103	0.446	58	-0.010	0.532
Total	1,239	0.004	0.679	1,529	0,005	0.372

The key independent variables involved in our analysis are related to firms' innovation activity, as reported in the USM survey. In particular, we construct a dummy variable, *product innovation*, which equals 1 if the respondent declared that the firm has achieved at least one third of its 2010 total turnover from products or services that are innovative either for the market or for the firm<sup>9</sup>. We adopt this specification in order to include only product innovations that are relevant and account for an important share of the firm's total sales.

We account also for firms' activity regarding process innovation through a dummy variable, *process innovation*, which takes value 1 if the respondent declared that the firm has introduced at least one (out of five listed in survey) innovative process in the same period.

Table 3 summarizes information about the frequency with which the small firms surveyed tend to innovate, according to the nature of the innovation. Some interesting stylized facts emerge. First, descriptive statistics show that, in general, process innovation is more frequent than product innovation<sup>10</sup>. Second, when product innovation is introduced, it accounts for a non-negligible share of the total turnover<sup>11</sup>. Third, taking into account firms' size, we observe that both product and process innovation increase as the firm's dimension becomes larger.

<sup>9</sup> We exclude products and services that respondents consider only marginally innovative.

<sup>10</sup> In order to detect that this evidence does not depend by the threshold chosen to define the product innovation (i.e. one third of the firm's turnover), we also consider a broader definition of product innovation, including interventions involving less than 33 per cent of the total turnover. The corresponding statistics, not reported, are similar to those shown in column 1 of Table 3.

<sup>11</sup> On average 35 per cent of the firms obtain at least 33 per cent of turnover from selling innovative products, with peaks of more than 40 per cent for larger enterprises (see column 1 of Table 3).

Table 3. Descriptive statistics on innovations by firms' size class

employees	Freq.	product innovation		process innovation	
		Mean	Std. Dev.	Mean	Std. Dev.
1-9	5,224	0.340	0.474	0.535	0.499
10-19	404	0.455	0.499	0.720	0.449
20 or more	185	0.416	0.494	0.724	0.448
missing	212	0.349	0.478	0.358	0.481
Total	6,025	0.350	0.477	0.547	0.498

### 3.3 Control variables

Our set of covariates includes firms' individual characteristics that are likely to affect access to bank financing. Most of these data are drawn from the USM survey.

First, we consider a dummy variable which equals 1 if the firm declared to be a limited company (*limited company*). Limited liability, in fact, should influence the amount of credit granted since, *ceteris paribus*, credit default would be more penalizing for the bank compared to a situation when liability is unlimited. In the latter case, in fact, banks can appropriate the owner's personal resources and this may ease credit allowance. Such variable looks also important to control for the owner's incentives to well perform (i.e., undertake efficient innovations in our specific framework) in order to avoid meeting losses with her own assets.

Second, we account for the importance of the geographical location of firms' activity by constructing two binary variables: the first one (labeled *local market*) takes the value of 1 if the firm declared that either the provincial or the regional markets are of "medium" or "high" importance; the second one (labeled *national market*) takes the value of 1 if the firm declared that the national market is of "medium" or "high" importance. A residual category is represented by firms whose main market is abroad.

Third, we introduce the logarithm of years since firm's foundation (*age*) in order to allow for the possibility that firm's maturity can substantially affect both the willingness to innovate and banks' capability to evaluate credit merit.

Fourth, we account for firms' dimension through the logarithm of the number of employees (*employees*). It is worth noting that, although in the econometric analysis we will not deal with dependent variables computed in absolute value (thus not requiring any scale measures among the regressors), controlling for firms' dimension is important since larger firms might obtain relatively more credit thanks to their greater bargaining power.

Fifth, *multibank* is a dummy variable which equals 1 if the firm has relationships with many banks. Bank awareness of such practice, in fact, could both imply different credit plan shaping and influence respondents' perception of being rationed.

Sixth, we consider measures of rating that banks assign to each firm. In particular, when focusing on credit rationing, we adopt measures provided by the CEBI for the year 2009. The set of *system rating* variables include four dummies (*system rating\_1* - *system rating\_4*) which are ranked on the basis of firms' risk. The higher the class, the higher the level of the risk associated to the firm (so that *system rating\_4* denotes very high risk level). The set of controls *system rating* is used to explain the volume of credit accorded by the Banking System, as well as the loans granted by UniCredit in order to allow coefficient comparison between the two models. In the case of the large bank, we also adopt a different measure, which is based on the rating applied by UniCredit itself to its customers (taken from the UniCredit internal database). This set of variables, *UniCredit rating*, is constructed following the same criterion that has been used to build *system rating*.

Next, we include some variables taking into account the credit granted by both the Banking System and the given large bank in 2008 (*credit growth rate system 08\_09*, *credit growth rate UniCredit 08\_09*, *credit system/total assets 08* and *credit UniCredit/total assets 08*).

Using data from the UniCredit internal database, we also construct a set of 14 dummy variables reflecting firms' different sectors of activity. Such controls, in particular, are aimed at gathering the degree of technological intensity of each firm's sector. We start from the ATECO-NACE 3 digit level codes and the related ISTAT definitions. We then adopt the Pavitt classification for the manufacturing sector and, in addition, following the ISTAT methodology, we classify service activities according to their technological content.

Finally, in order to take into account the firm's location, we introduce a set of 20 dummy variables, at NUTS2 (i.e. regional) level, using information on firms' location from the UniCredit internal database. Each variable equals 1 if the firm is located in a given region, and 0 otherwise<sup>12</sup>.

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<sup>12</sup> The literature emphasizes that the province level is the important dimension when considering the degree of financial markets development and, in general, when the bank-firm relationship matters. We performed our analysis using provincial dummies without obtaining substantially different outcome (results provided upon request). Moreover, since in the regressions several provincial dummies are dropped due to collinearity, here we limit the analysis to the NUTS2 levels.

### 3.4 Instrumental variables

Our set of instrumental variables is based on the average degree of difficulties that small firms (other than the focal one, but located in the same province and operating in the same industry) face when planning to undertake some innovation activities.

In particular, we build two instrumental variables using data from a question included in the USM survey and regarding the degree of importance assigned to several factors which may potentially hamper firms' engagement in innovation. The first hampering factor that we used is the degree of "difficulty to find partners cooperating in the innovation activity", whereas the second factor is related to the "presence of consolidated firms which dominate the market". We first defined two dummy variables (one for each of the hampering factors considered) that flag with 1 the firms that declared "high" or "medium" degrees of difficulties concerning these two factors. For each firm we then computed the peer-average values (of each dummy variable) by considering as peer-group of reference all the firms (excluding the focal one) located in the same province and operating in the same macro-industry. The purpose of the computation of peer-averages is to increase the degree of confidence about the exogeneity of our set of instruments by preserving at the same time an acceptable degree of relevancy<sup>13</sup>.

The first instrumental variable (labeled *hampering partners*) concerns the average level of difficulty, perceived by the peers, to find partners cooperating in the innovation activity. The impact of this variable on the propensity to innovate of the focal firm may be two-sided. On the one hand, it may have a negative spillover effect if also the focal firm strongly relies on external collaborations with the peers for its innovation activity. On the other hand, if the focal firm is capable to engage in innovation activities by using mainly its internal resources, then a positive spillover effect may arise since the difficulties experienced by the peers can generate a sort of "competitive advantage".

The second instrumental variable (labeled *hampering competitors*) is related to the presence of consolidated firms which dominate the market. In the same vein as above, this may either discourage the focal firm from introducing new products and processes (negative externality), or stimulate further competition through innovation (positive externality).

Table 4 summarizes all the variables involved in the analysis.

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<sup>13</sup> A similar methodology has been adopted by Laeven and Levine (2009) to instrument their bank's ownership structure variable.

Table 4. Description of the variables

Variable	Description	Source
<u>Dependent variables:</u>		
<i>weakly rationed</i>	Dummy = 1 if the firm declares that in 2010 it would like to have received more credit at the interest rate previously agreed with the bank	USM
<i>strongly rationed</i>	Dummy = 1 if the firm declares that in 2010 it would like to have received more credit at the interest rate previously agreed with the bank and it has asked for it without getting it	USM
<i>credit growth rate system 09_11</i>	Average of the annual growth rates in years 2010 and 2011 of the credit granted to the firm by Italian banks except UniCredit (i.e., "the Banking System")	CR
<i>credit growth rate UniCredit 09_11</i>	Average of the annual growth rates in years 2010 and 2011 of the credit granted to the firm by UniCredit	CR
<u>Independent variables:</u>		
<i>process innovation</i>	Dummy = 1 if the firm declared to have adopted at least one (out of 5 listed in the survey) innovative process in the previous 3 years	USM
<i>product innovation</i>	Dummy = 1 if the firm declared to gain at least the 33% of its total turnover in 2010 from products or services that are innovative for market or for the firm	USM
<u>Control variables:</u>		
<i>limited company</i>	Dummy = 1 if the firm declared it is a limited company	USM
<i>local market</i>	Dummy = 1 if the firm declared that the degree of importance of the local or regional market is "high" or "medium"	USM
<i>national market</i>	Dummy = 1 if the firm declared that the degree of importance of the national market is "high" or "medium"	USM
<i>age</i>	Logarithm of years since firm's foundation	USM
<i>employees</i>	Logarithm of the number of employees	USM
<i>multibank</i>	Dummy =1 if the firm declared that it has a relationship with more banks	USM
<i>system rating</i>	Rating classification of the firm for 2009, four classes	CEBI
<i>UniCredit rating</i>	Rating classification of the firm, four classes	UniCredit
<i>credit growth rate system 08_09</i>	Annual growth rate in 2009 of the credit granted to the firm by Italian banks except UniCredit (i.e., "the Banking System")	CR
<i>credit growth rate UniCredit 08_09</i>	Annual growth rate in 2009 of the credit granted to the firm by UniCredit	CR
<i>credit system/total assets 08</i>	Ratio of the credit granted to the firm by Italian banks except UniCredit (i.e., "the Banking System") in 2008 over the firm's total assets in 2008	CR, CEBI
<i>credit UniCredit/total assets 08</i>	Ratio of the credit granted to the firm by UniCredit in 2008 over the firm's total assets in 2008	CR, CEBI
<u>Instrumental variables:</u>		
<i>hampering partners</i>	Peer-average level of difficulty to perform innovation activity related to the lack partners cooperating in the innovation activity	USM
<i>hampering competitors</i>	Peer-average level of difficulty to perform innovation activity related to the presence of consolidated firms which dominate the market	USM

Table 5 provides the related descriptive statistics for the sample of 1,599 firms obtained after having dropped all the observations with missing values and having trimmed out the outliers which is used to estimate the credit rationing econometric model (see section 3.1).

Table 5. Main descriptive statistics

Variable ID	Variable name	N. obs.	Mean	Std.Dev.	Min	Max
	<u>Dependent variables:</u>					
1	<i>weakly rationed</i>	1,599	0.429	0.495	0	1
2	<i>strongly rationed</i>	1,599	0.186	0.389	0	1
3	<i>credit growth rate system 09_11</i>	1,225	0.007	0.682	-1	1.624
4	<i>credit growth rate UniCredit 09_11</i>	1,515	0.007	0.372	-1	4.279
	<u>Independent variables:</u>					
5	<i>process innovation</i>	1,599	0.647	0.478	0	1
6	<i>product innovation</i>	1,599	0.409	0.492	0	1
	<u>Control variables:</u>					
7	<i>system rating</i>	1,599	5.256	2.043	1	9
8	<i>UniCredit rating</i>	1,590	4.014	2.726	1	13
9	<i>limited company</i>	1,599	0.408	0.492	0	1
10	<i>local market</i>	1,599	0.506	0.500	0	1
11	<i>national market</i>	1,599	0.163	0.369	0	1
12	<i>age</i>	1,599	2.877	0.711	0	4.836
13	<i>employees</i>	1,599	1.658	0.875	0	4.595
14	<i>multibank</i>	1,599	0.772	0.420	0	1
15	<i>credit growth rate system 08_09</i>	969	0.237	1.090	-0.838	20
16	<i>credit growth rate UniCredit 08_09</i>	951	0.032	0.350	-1	3.339
17	<i>credit system/total assets 08</i>	971	0.688	0.558	0	7
18	<i>credit UniCredit/total assets 08</i>	971	0.289	0.344	0	7
	<u>Instrumental variables:</u>					
19	<i>hampering partners</i>	1599	0.534	0.195	0	1
20	<i>hampering competitors</i>	1599	0.592	0.190	0	1

Finally, Table 6 shows the cross-correlations of the main variables involved in the analysis. We can see that the strongest pairwise correlations are the ones linking the dummy variables for innovation (variables 5 and 6 in the table) and the two ratios of the credit granted to the total assets in 2008 (variables 17 and 18 in the table), as well as the ones relating the probability of being credit-rationed (variable 1 and 2 in the table) to the different rating classification applied to the firm by the Banking System and UniCredit (variable 7 and 8 in the table). Not surprisingly, the ratio of the credit granted by the Banking system over the total assets of the firm in 2008 (variable

17) is correlated to the rating measure (variable 7) and to the growth rate of the credit granted in 2009 (variable 15). In the case of the given large bank, the ratio of the credit granted over the total assets of the firm in 2008 is correlated to the firm's size (variable 18 and 13). The other variables show a negligible degree of correlation.

Table 6. Correlation matrix

Variable ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1																	
2	0.555	1																
3	0.007	-0.025	1															
4	-0.015	-0.033	0.017	1														
5	0.078	0.046	0.040	0.081	1													
6	0.066	0.043	0.120	0.007	0.327	1												
7	0.258	0.192	0.005	-0.005	-0.030	-0.049	1											
8	0.254	0.279	-0.019	-0.174	-0.002	0.024	0.352	1										
9	-0.027	-0.020	0.059	0.047	0.053	0.058	-0.118	0.016	1									
10	0.032	-0.035	0.009	0.005	0.004	0.039	-0.050	-0.018	0.010	1								
11	0.000	0.022	-0.053	0.024	0.009	0.001	0.032	0.006	0.092	-0.127	1							
12	-0.026	-0.011	0.021	-0.042	0.020	-0.018	-0.143	-0.109	-0.101	-0.010	0.009	1						
13	-0.033	-0.018	0.049	0.082	0.090	0.040	-0.060	-0.003	0.172	0.015	0.095	0.110	1					
14	0.060	0.043	0.128	-0.026	0.034	0.059	-0.038	-0.009	0.112	0.025	0.063	0.059	0.130	1				
15	0.039	-0.003	-0.019	0.021	-0.039	-0.054	0.018	0.045	-0.098	-0.016	-0.056	-0.091	-0.067	-0.154	1			
16	-0.014	-0.001	0.034	-0.013	0.040	0.018	-0.056	-0.071	0.022	-0.027	-0.038	-0.127	0.012	-0.016	0.168	1		
17	-0.015	0.000	-0.036	-0.067	-0.043	0.006	0.293	-0.015	-0.071	0.027	0.005	-0.005	-0.027	0.055	-0.235	-0.085	1	
18	-0.046	-0.033	0.017	-0.093	-0.037	0.036	0.177	-0.153	-0.102	0.005	-0.062	-0.024	-0.259	-0.040	-0.103	-0.160	0.571	1

### 3. Methodology and results

We perform the empirical analysis in two steps. In the first step we model the probability of being credit-rationed as a function of the firm's innovation effort undertaken in the previous three years and other firm's characteristics. We aim to detect whether there is a relation between a firm's perception of being credit-rationed and its innovation activity.

In the second step we study if the growth rate of bank loans accorded during the recent financial crisis period (2009-2011) is affected by firms' innovation strategies. The latter analysis is carried out on a restricted sample of enterprises for which information is available on the credit granted by both the Banking System and UniCredit in order to investigate whether on average the growth rate of the loans accorded to the firm changes when considering banks of different size.

#### 3.1 Probability of credit rationing

The general econometric model of reference for the first step of our analysis is the following:

$$\Pr(\text{rationed}_i = 1) = f(\beta_0 + \beta_1 \text{innovation}_i + \beta_2 \text{rating}_i + \text{control\_variables}_i + u_i) \quad (1)$$

In this model we alternatively consider the dummies *weakly rationed* and *strongly rationed* as dependent variables. Because of the high degree of bivariate correlation between product and process innovation previously reported, we estimate separate models for each individual measure describing firms' innovation activity, *process innovation* and *product innovation* (see Westhead and Storey, 1997; Freel, 2007). In all models we include the full set of controls described in the previous section, but *UniCredit rating* and the variables built on the credit granted in 2008 (*credit growth rate system 08\_09*, *credit growth rate UniCredit 08\_09*, *credit system/total assets 08* and *credit UniCredit/total assets 08*). In model (1) we relate firm's innovation strategies with the probability of being credit-rationed. Since it involves a set of dummy dependent variables (*weakly rationed* and *strongly rationed*), we adopt a Probit maximum likelihood estimation technique by assuming normally distributed error term ( $u_i$ ) with robust standard errors.

The estimated average marginal effects (reported in Table 7) suggest that, *ceteris paribus*, innovative firms perceive themselves as being more credit-rationed than non-innovative firms - see columns (1) and (2). This result apparently confirms the well-established finding that innovative firms face a significant higher probability of being credit-rationed than non-innovative ones (see for example Guiso, 1998; Alessandrini et al., 2009). However, this result might be

affected by the fact that innovators perceive their credit requirements as being not fully satisfied, although it may be that banks indeed release a great deal of financial support to their projects.

In more detail, the estimated marginal effect on the probability of being weakly credit-rationed is equal to +7.05% for firms that adopted a process innovation (column 2), whereas the effect is still positive but lower in magnitude (+5.25%) for firms that introduced a new innovative product which contributed for at least 33% to the firm's 2010 total turnover (column 1).

Concerning the sign and the magnitude of the other significant regressors, we find that the probability of being (weakly) credit-rationed increases with the firm's degree of risk, expressed by the more general rating measures (*system rating* dummies). Rationing is also higher when the firm has many banking relationships (*multibank*). Finally, as expected, the age of the firm is negatively correlated with the probability of being (weakly) credit-rationed. This result can be explained by the fact that young firm are traditionally considered more "opaque" than old-established ones.

Columns (3) and (4) show the estimation results of model (1) when considering strong credit rationing, i.e. when *strongly rationed* is the dependent variable. In this case we find no statistically significant correlations between our set of innovation dummy variables and the probability of being credit-rationed<sup>14</sup>.

Overall, these results suggest that being an innovative firm increases on average the reported need for banking loans. This may explain why, whether such firms received more credit than others or not, they perceive themselves as being more rationed (weak credit rationing). On the other hand, the same innovative status doesn't significantly affect the probability of being denied financial support by the bank when the firm effectively asked for it (strong credit rationing).

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<sup>14</sup> The mixed results when considering weak and strong forms of credit rationing are found in other strands of the literature. For instance, Minetti and Zhu (2011) analyze the effect of both weak and strong credit rationing on export for a sample of Italian manufacturing firms. They find a statistically significant impact of strong credit rationing on firms' exporting decision and foreign sales, but no significant effect of weak credit rationing.

Table 7. Probit regression: probability of being weakly and strongly credit-rationed

VARIABLES	(1) <i>weakly rationed</i>	(2) <i>weakly rationed</i>	(3) <i>strongly rationed</i>	(4) <i>strongly rationed</i>
<i>product innovation</i>	0.0525** (0.0263)		0.0127 (0.0191)	
<i>process innovation</i>		0.0705*** (0.0269)		0.0230 (0.0195)
<i>system rating_2</i>	0.177*** (0.0531)	0.173*** (0.0532)	0.124** (0.0529)	0.122** (0.0529)
<i>system rating_3</i>	0.272*** (0.0524)	0.269*** (0.0526)	0.207*** (0.0586)	0.205*** (0.0588)
<i>system rating_4</i>	0.347*** (0.0488)	0.345*** (0.0490)	0.276*** (0.0544)	0.274*** (0.0547)
<i>local market</i>	0.00258 (0.0259)	0.00480 (0.0259)	-0.0312 (0.0190)	-0.0304 (0.0189)
<i>national market</i>	0.00394 (0.0360)	0.00245 (0.0360)	0.0162 (0.0267)	0.0159 (0.0267)
<i>limited company</i>	-0.0390 (0.0275)	-0.0385 (0.0275)	-0.0139 (0.0199)	-0.0133 (0.0200)
<i>age</i>	-0.0314* (0.0186)	-0.0329* (0.0186)	-0.0197 (0.0140)	-0.0200 (0.0140)
<i>employees</i>	-0.00121 (0.0163)	-0.00486 (0.0164)	0.00609 (0.0122)	0.00473 (0.0123)
<i>multibank</i>	0.148***	0.148***	0.0903***	0.0897***
<i>Dummies for macro-industry</i>	yes	yes	yes	yes
<i>Dummies for regions</i>	yes	yes	yes	yes
Log pseudolikelihood	-1012.67	-1011.31	-703.97	-703.53
Observations	1,599	1,599	1,590	1,590
Pseudo R-squared	0.073	0.074	0.081	0.081

Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Note. In columns (3) and (4) 9 observations are dropped because there are no strongly-rated firms in the “financial services” sector

### 3. 2 Change in the amount of credit granted

In the previous paragraph we found that being an innovative small firm is positively associated with a higher need of bank lending, but it does not significantly increase the probability of being denied more credit once required. One possible explanation for this result is that banks do not systematically deny more credit to innovative firms. Rather, it seems reasonable to think that banks could have increased the amount of credit granted to innovators, given that the latter require more external finance and also have higher propensity to ask for more credit compared to non-innovators.

In order to shed light on this hypothesis, we analyze whether banks have actually increased or decreased the amount of credit granted to innovative firms, by studying separately the cases of a large internationalized bank (UniCredit) and the Banking System.

Our main econometric model of reference is now the following:

$$\begin{cases} \text{innovation}_i = \gamma_0 + \gamma_1 \text{instruments}_i + \gamma_2 \text{rating}_i + \gamma_3 \text{control\_variables}_i + v_i & (2a) \\ \text{credit growth rate}_i = \delta_0 + \delta_1 \text{innovation}_i + \delta_2 \text{rating}_i + \delta_3 \text{control\_variables}_i + \varepsilon_i & (2b) \end{cases}$$

In the second equation (2b) the dependent variable, *credit growth rate*, is the average annual growth rate (in years 2010 and 2011) of the credit granted to firm *i* by either the Banking System (*credit growth rate system 09\_11*) or by UniCredit (*credit growth rate UniCredit 09\_11*). Equation (2b) shares the same set of independent variables (*process innovation*, *product innovation*) and controls included in model (1). In an alternative version of this model, we regress the growth rate of credit accorded by UniCredit on the rating of firm *i* as computed by UniCredit itself, thus using the set of variables *UniCredit rating* instead of the dummies *system rating*.

In model (2) we also consider the ratio of the total credit granted to the firm in 2008 over its total assets in that year, from both the Banking system and the given large bank (*credit system/total assets 08* and *credit UniCredit/total assets 08*, respectively) and the growth rate of credit granted to the firm between 2008 and 2009 (*credit growth rate system 08\_09* for the Banking system, *credit growth rate UniCredit 08\_09* for the large bank). The first variable controls for the amount of credit already granted to the firm in 2008, whereas the second one accounts for the possible credit growth that the firm experienced in 2009.

We focus on the sub-sample of firms for which it was possible to compare both the average annual growth rate of the credit granted by the Banking System and by UniCredit (1,174 observations). This has been done in order to avoid any potential bias which may stem from the estimation of the two models using different samples.

Since our endogenous independent variable is binary (*innovation*), model (2) is estimated using Maximum Likelihood (ML) Treatment techniques (Maddala, 1983) with robust standard errors.

To perform this analysis we use the set of instruments described in section 2.4.

Table 8 reports estimation results associated to model (2) when considering product innovation (*product innovation*). First, we consider the credit granted by the Banking System (excluding UniCredit) and use *system rating* as a measure of credit merit. The first column of Table 8 refers to

the estimation of equation (2a), while the second column refers to the estimation of equation (2b) in this case. Similarly, column (3) and (4) show the estimates of the same model, when considering the average growth rate of the credit granted by UniCredit. This specification allows us to compare the effect of firm's product innovation on the growth rate of the credit granted by the Banking system and the given large bank, respectively, because it keeps the same set of control variables. However, in the case of the credit granted by UniCredit one should account for the wider information it holds on its clients. Therefore, we estimate model (2) using the alternative measure of rating adopted by the bank (*UniCredit rating*), the ratio of total credit granted to the firm by UniCredit over total assets in 2008 (*credit UniCredit 2008/total assets*) and the growth rate of credit granted by the bank between 2008 and 2009 (*credit growth rate UniCredit 08\_09*). The output results are shown in columns (5) and (6).

The estimates reported in column (2) suggest that the average growth rate of the credit granted by the Banking System to firms which introduced new or technologically improved products (*product innovation*) has been 15.5% higher than for firms that have not undertaken such activities.

Even more relevant to our purposes, considering the large bank's lending (column (4)), we can notice that the estimated parameter for product innovation turns out to be three-times higher than in the case of the overall Banking System (column (2)), indicating that the former "rewards" product innovators considerably more than the latter.

As expected, the parameter associated to product innovation slightly decreases when replacing the set of dummies *system rating* with the dummies reflecting the large bank's own rating, *UniCredit rating*. This might indicate that information regarding the firm's innovation activity is embedded in the bank's process of credit evaluation, which influences the internal rating value assigned to its customers, although to a very small extent. In addition, comparing the parameter of product innovation in column (4) with that reported column in (6), both related to UniCredit financing, a difference of only 3 per cent emerges, suggesting that banks, and especially large ones, tend to "reward" their customers for their innovation activity, regardless of the rating model they adopt.

Table 8. Treatment regression: average of the annual growth rates of the credit granted to product innovators in years 2010 and 2011

VARIABLES	(1) <i>product innovation</i>	(2) <i>credit growth rate system 09_11</i>	(3) <i>product innovation</i>	(4) <i>credit growth rate UniCredit 09_11</i>	(5) <i>product innovation</i>	(6) <i>credit growth rate UniCredit 09_11</i>
<i>product innovation</i>		0.155*** (0.0598)		0.460*** (0.159)		0.430** (0.169)
<i>credit growth rate system 08_09</i>	-0.0506 (0.0418)	-0.00693 (0.0136)	-0.0405 (0.0355)	0.0143 (0.0118)		
<i>credit system 2008/total assets</i>	0.0176 (0.0945)	-0.0245 (0.0268)	0.0284 (0.0869)	-0.0212 (0.0271)		
<i>credit growth rate UniCredit 08_09</i>					0.154 (0.138)	-0.122** (0.0510)
<i>credit UniCredit 2008/total assets</i>					0.436** (0.197)	-0.267*** (0.0743)
<i>system rating_2</i>	0.104 (0.232)	0.0765 (0.0711)	0.135 (0.209)	0.0584 (0.0566)		
<i>system rating_3</i>	-0.0700 (0.232)	0.106 (0.0721)	-0.0992 (0.209)	0.0906 (0.0566)		
<i>system rating_4</i>	-0.0233 (0.235)	0.0952 (0.0772)	-0.0441 (0.211)	0.0282 (0.0537)		
<i>UniCredit rating_2</i>					0.120 (0.107)	-0.0437 (0.0417)
<i>UniCredit rating_3</i>					0.0485 (0.169)	-0.209*** (0.0492)
<i>UniCredit rating_4</i>					-0.152 (0.233)	-0.368*** (0.0610)
<i>local market</i>	0.0840 (0.0944)	-0.0166 (0.0359)	0.0819 (0.0917)	-0.00493 (0.0299)	0.134 (0.0922)	-0.0161 (0.0289)
<i>national market</i>	-0.0976 (0.123)	-0.0699* (0.0362)	-0.105 (0.119)	0.0445 (0.0383)	-0.0973 (0.122)	0.0351 (0.0380)
<i>limited company</i>	0.105 (0.0986)	0.0121 (0.0432)	0.0393 (0.101)	-0.00968 (0.0287)	0.0291 (0.106)	-0.0120 (0.0267)
<i>age</i>	-0.0479 (0.0772)	0.0221 (0.0322)	-0.0571 (0.0741)	-0.0111 (0.0275)	-0.0442 (0.0742)	-0.0381 (0.0253)
<i>employees</i>	0.0782 (0.0632)	0.0309 (0.0254)	0.0630 (0.0623)	0.0101 (0.0202)	0.0637 (0.0652)	-0.00249 (0.0209)
<i>multibank</i>	0.228 (0.173)	0.207*** (0.0765)	0.176 (0.162)	-0.0658 (0.0449)	0.229 (0.162)	-0.0846* (0.0439)
<i>hampering partners</i>	0.339**		0.268**		0.254**	

	(0.137)		(0.116)		(0.122)	
<i>hampering competitors</i>	-0.0959		-0.0338		-0.0195	
	(0.148)		(0.111)		(0.112)	
<i>Constant</i>	-5.265***	-0.668***	-5.139	-0.0749	-4.908	0.185
	(0.510)	(0.164)	(0.179)		(15.34)	(0.153)
<i>Dummies for macro-industry</i>	yes	yes	yes	yes	yes	yes
<i>Dummies for region</i>	yes	yes	yes	yes	yes	yes
<i>rho</i>	-0.0447		-0.676**		-0.663**	
	(0.0624)		(0.184)		(0.213)	
<i>sigma</i>	0.501***		0.417***		0.393***	
	(0.073)		(0.070)		(0.071)	
Log-pseudolikelihood		-1052.483		-788.872		-735.496
Wald test of indep. eqns.		0.4742		0.0154		0.0365
chi2(1) P-val						
Kleibergen-Paap Wald rk statistic <sup>(a)</sup>	F(2,718) = 2.28		F(2,718) = 2.28		F(2,707) = 1.99	
Hansen J statistic <sup>(a)</sup>		0.2098		0.2896		0.3931
Chi-sq(1) P-val						
Observations	761	761	761	761	750	750

Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1  
<sup>(a)</sup> From two-stage linear regression

The situation is less polarized when considering the average of the annual growth rates of the credit granted to small businesses pursuing process improvements (*process innovation*). Table 9 on process innovation follows the same structure of Table 8. In this case we observe that all types of banks are likely to reward firms for undertaking process innovation, since the estimated parameters associated to *process innovation* in equation (2b) are always positive and significant. Moreover, as opposite to the case of product innovation, the average growth rate of credit granted by UniCredit to process innovators is approximately the same as the one estimated for the Banking System. Next, it is interesting to note that the magnitude of the parameters is almost the same in the second columns of Tables 8 and 9, indicating that the Banking System is not likely to evaluate product and process innovation differently.

As for the Probit regressions of model (2a) (odd columns of each table), we observe a positive sign of the parameters associated to the instruments when the latter are significant. This suggests that positive externalities arising from the difficulties experienced by the peers (either partners or competitors) are stronger than the negative ones. Furthermore, both instruments are significant and jointly pass the weak instrument test at 20 per cent critical level in the regressions concerning process innovation (Table 9), whereas only the variable related to the presence of a partner to collaborate in the innovation activity is significant in the regression of product innovation (Table

8). This consequently lowers the weak instrument F statistics. The joint hypothesis of correct specification and validity of the instruments is instead never rejected according to the Hansen J statistic reported at the bottom of each table.

*Table 9. Treatment regression: average of the annual growth rates of the credit granted to process innovators in years 2010 and 2011*

VARIABLES	(1) <i>process innovation</i>	(2) <i>credit growth rate system 09_11</i>	(3) <i>process innovation</i>	(4) <i>credit growth rate UniCredit 09_11</i>	(5) <i>process innovation</i>	(6) <i>credit growth rate UniCredit 09_11</i>
<i>process innovation</i>		0.133** (0.0580)		0.111*** (0.0390)		0.0895** (0.0399)
<i>credit growth rate system 08_09</i>	-0.0407 (0.0378)	-0.00713 (0.0130)	-0.0403 (0.0385)	0.00979 (0.00930)		
<i>credit system 2008/total assets</i>	-0.129 (0.0932)	-0.0172 (0.0278)	-0.129 (0.0932)	-0.0124 (0.0234)		
<i>credit growth rate UniCredit 08_09</i>					0.172 (0.131)	-0.107** (0.0427)
<i>credit UniCredit 2008/total assets</i>					0.0420 (0.235)	-0.197*** (0.0602)
<i>system rating_2</i>	0.180 (0.238)	0.0759 (0.0697)	0.179 (0.239)	0.0709* (0.0420)		
<i>system rating_3</i>	0.160 (0.238)	0.0965 (0.0711)	0.156 (0.239)	0.0749* (0.0407)		
<i>system rating_4</i>	0.151 (0.241)	0.0882 (0.0764)	0.147 (0.241)	0.0196 (0.0385)		
<i>UniCredit rating_2</i>					0.212* (0.110)	-0.0258 (0.0333)
<i>UniCredit rating_3</i>					0.202 (0.194)	-0.201*** (0.0400)
<i>UniCredit rating_4</i>					-0.157 (0.242)	-0.375*** (0.0518)
<i>local market</i>	0.00578 (0.0970)	-0.0110 (0.0355)	0.00442 (0.0970)	0.00998 (0.0259)	0.0214 (0.0977)	0.00454 (0.0249)
<i>national market</i>	-0.0421 (0.124)	-0.0731** (0.0360)	-0.0433 (0.125)	0.0287 (0.0318)	0.00863 (0.127)	0.0238 (0.0317)
<i>limited company</i>	0.0214 (0.0999)	0.0162 (0.0431)	0.0217 (0.100)	0.00598 (0.0267)	0.00819 (0.0997)	0.00380 (0.0259)
<i>age</i>	0.00661	0.0192	0.00821	-0.0189	0.0131	-0.0435**

	(0.0790)	(0.0327)	(0.0798)	(0.0218)	(0.0811)	(0.0204)
<i>employees</i>	0.166**	0.0274	0.167**	0.0170	0.151**	0.00678
	(0.0669)	(0.0249)	(0.0670)	(0.0180)	(0.0698)	(0.0197)
<i>multibank</i>	0.0932	0.215***	0.0927	-0.0338	0.0951	-0.0517
	(0.168)	(0.0775)	(0.167)	(0.0338)	(0.167)	(0.0317)
<i>hampering partners</i>	0.306**		0.293**		0.305**	
	(0.136)		(0.134)		(0.136)	
<i>hampering competitors</i>	0.260*		0.255*		0.263*	
	(0.149)		(0.148)		(0.150)	
<i>Constant</i>	-5.706***	-0.664***	-5.708***	-0.126	-5.821***	0.122
	(0.514)	(0.174)	(0.516)	(0.172)	(0.459)	(0.146)
<i>Dummies for macro-industry</i>	yes	yes	yes	yes	yes	yes
<i>Dummies for region</i>	yes	yes	yes	yes	yes	yes
<i>rho</i>	-0.121**		-0.081		-0.0585	
	(0.053)		(0.049)		(0.0566)	
<i>sigma</i>	0.505***		0.357***		0.338***	
	(0.075)		(0.042)		(0.043)	
Log-pseudolikelihood		-1027.448		-765.966		-712.905
Wald test of indep. eqns.		0.0250		0.1060		0.3008
chi2(1) P-val						
Kleibergen-Paap Wald rk statistic <sup>(a)</sup>	F(2,718) = 4.98		F(2,718) = 4.98		F(2,707) = 5.20	
Hansen J statistic <sup>(a)</sup>		0.8528		0.6999		0.7620
Chi-sq(1) P-val						
Observations	761	761	761	761	750	750

Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

<sup>(a)</sup> From two-stage linear regression

Finally, OLS estimates parallel to the second-stage regression results in columns (2), (4) and (6) of Table 8 and 9 are reported in Tables 10 (product innovation) and 11 (process innovation). First, in general OLS tend to underestimate (compared with the ML Treatment regressions) all the parameters relative to innovation. Second, looking at the sign of the estimated coefficient rho in Tables 8 and 9, we observe that a negative type of endogeneity is at stake. In other words, some unmeasurable characteristics in the error term of equation (2b) are likely to be positively correlated with the likelihood to innovate, while contemporaneously decreasing credit allowance. This finding suggests that such factors could be related to some unobservable firms' characteristics, such as its propensity towards risk or collateral availability, which is something we cannot precisely measure. In fact, some types of firms, such as start-up enterprises, have high innovative potential (usually associated with a high degree of riskiness), while not being endowed with large collateral amount.

Table 10. OLS regression: average of the annual growth rates of the credit granted to product innovators in years 2010 and 2011

VARIABLES	(1) <i>credit growth rate system 09_11</i>	(3) <i>credit growth rate UniCredit 09_11</i>	(5) <i>credit growth rate UniCredit 09_11</i>
<i>product innovation</i>	0.119*** (0.0433)	0.0158 (0.0284)	0.0191 (0.0276)
<i>credit growth rate system 08_09</i>	-0.00745 (0.0138)	0.00831 (0.00980)	
<i>credit system 2008/total assets</i>	-0.0240 (0.0275)	-0.0162 (0.0238)	
<i>credit growth rate UniCredit 08_09</i>			-0.103** (0.0439)
<i>credit UniCredit 2008/total assets</i>			-0.197*** (0.0605)
<i>system rating_2</i>	0.0777 (0.0729)	0.0736* (0.0440)	
<i>system rating_3</i>	0.105 (0.0742)	0.0775* (0.0424)	
<i>system rating_4</i>	0.0947 (0.0792)	0.0219 (0.0408)	
<i>UniCredit rating_2</i>			-0.0204 (0.0335)
<i>UniCredit rating_3</i>			-0.195*** (0.0411)
<i>UniCredit rating_4</i>			-0.381*** (0.0535)
<i>local market</i>	-0.0155 (0.0363)	0.00935 (0.0267)	0.00407 (0.0256)
<i>national market</i>	-0.0713* (0.0375)	0.0273 (0.0326)	0.0241 (0.0323)
<i>limited company</i>	0.0135 (0.0442)	0.00705 (0.0278)	0.00424 (0.0271)
<i>age</i>	0.0216 (0.0334)	-0.0183 (0.0224)	-0.0428** (0.0210)
<i>employees</i>	0.0318 (0.0266)	0.0225 (0.0180)	0.0105 (0.0199)
<i>multibank</i>	0.209*** (0.0790)	-0.0305 (0.0361)	-0.0497 (0.0335)
<i>Constant</i>	-0.672*** (0.168)	-0.120 (0.175)	0.127 (0.148)
<i>Dummies for macro-industry</i>	yes	yes	yes
<i>Dummies for region</i>	yes	yes	yes

Observations	761	761	750
R-squared	0.075	0.049	0.104

Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 11. OLS regression: average of the annual growth rates of the credit granted to process innovators in years 2010 and 2011

VARIABLES	(1) <i>credit growth rate system 09_11</i>	(3) <i>credit growth rate UniCredit 09_11</i>	(5) <i>credit growth rate UniCredit 09_11</i>
<i>process innovation</i>	0.0345 (0.0377)	0.0646** (0.0275)	0.0573** (0.0273)
<i>credit growth rate system 08_09</i>	-0.00879 (0.0136)	0.00900 (0.00959)	
<i>credit system 2008/total assets</i>	-0.0214 (0.0275)	-0.0143 (0.0241)	
<i>credit growth rate UniCredit 08_09</i>			-0.105** (0.0441)
<i>credit UniCredit 2008/total assets</i>			-0.196*** (0.0612)
<i>system rating_2</i>	0.0806 (0.0725)	0.0731* (0.0434)	
<i>system rating_3</i>	0.101 (0.0736)	0.0768* (0.0419)	
<i>system rating_4</i>	0.0918 (0.0789)	0.0213 (0.0399)	
<i>UniCredit rating_2</i>			-0.0232 (0.0340)
<i>UniCredit rating_3</i>			-0.199*** (0.0413)
<i>UniCredit rating_4</i>			-0.377*** (0.0530)
<i>local market</i>	-0.0112 (0.0364)	0.00991 (0.0265)	0.00468 (0.0255)
<i>national market</i>	-0.0754** (0.0373)	0.0276 (0.0326)	0.0236 (0.0324)
<i>limited company</i>	0.0174 (0.0440)	0.00653 (0.0274)	0.00411 (0.0265)
<i>age</i>	0.0194 (0.0338)	-0.0188 (0.0224)	-0.0433** (0.0209)
<i>employees</i>	0.0330 (0.0268)	0.0197 (0.0182)	0.00844 (0.0199)
<i>multibank</i>	0.218***	-0.0323	-0.0507

	(0.0796)	(0.0351)	(0.0329)
<i>Constant</i>	-0.680***	-0.134	0.117
	(0.177)	(0.177)	(0.149)
<i>Dummies for macro-industry</i>	yes	yes	yes
<i>Dummies for region</i>	yes	yes	yes
Observations	761	761	750
R-squared	0.064	0.055	0.108

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Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

#### 4. Conclusions

In this paper we have investigated the possibility and the extent to which large banks reward more innovative small firms, with regard to both credit rationing indicators and the average growth rate of granted loans.

Our analysis has been performed using data from a large sample of small firms collected through the 8<sup>th</sup> UniCredit Survey, conducted in 2011 and referring to firms' activities carried out in the period 2008-2010. Survey data has been integrated using other sources of information, such as UniCredit customer files, and both the Italian Centrale dei Bilanci and Centrale dei Rischi databases.

In the first part of the analysis we have examined whether the status of innovative firm is associated with the possibility of being credit-rationed, as perceived by surveyed firms. We have found that small innovative enterprises are subject to a weak form of rationing, identified by respondents declaring they would have liked to receive more credit at the interest rate previously agreed with its bank.

Thus, preliminary evidence suggests, on the one hand, that innovative firms are discouraged from applying for loans, a result which would not be new to the literature. On the other hand, however, it might be that their innovative activity pushes the demand for financial resources above the extent to which banks are ready to supply, although the latter may have granted credit to these enterprises far more than they did for other firms.

It might occur, also, that the self-declared definition of innovative firm presents some shortcomings, since it is not necessarily consistent with the information gathered at the bank level. Therefore, employing self-reported data might raise concerns about firms overstating or understating both their innovations and actual financial needs.

As a matter of fact, we then consider a strong form of rationing involving an actual, unsatisfied, request of credit to a bank. Using this definition, our estimates do not provide significant evidence that more innovative firms are being denied credit.

Still, however, one aspect that may drive our findings is not completely ruled out. It might be the case, indeed, that a substantial amount of resources is needed by those firms which are particularly active in their innovation activities, or intend to undertake large-scale and costly projects. However, it is possible that banks refrain to fully finance such initiatives due to diversification strategies, thus privileging a plethora of small-scale loans financing minor

innovations over granting support to one big project. In other words, the probability that a firm gets fully financed is decreasing in the scale of its project conditional on the project's expected return.

Such possible drawbacks led us to consider, in the second part of the analysis, the rate of growth of the credit granted as a measure of bank reward to more innovative small firms. In this context, we further compare loans accorded by a given large internationalized bank (UniCredit, which is representative of Italian large internationalized banks) with the amount of credit granted by the rest of the Italian banking system (whereby the representative bank is definitely smaller).

Using instrumental variable techniques in order to address endogeneity issues, we have shown that all types of bank reward firms' innovative activities, intended as both product creation and process improvement.

We have also found that the large internationalized bank more frequently provides financial support to product innovation, whereas the size of the credit institution does not seem to matter for the extent to which loans are accorded to small firms undertaking process innovations. Indeed, it may be easier for larger banks to appraise innovations, for example because they either take advantage of their technological competencies within their organizations or exploit better institutional cooperation (e.g. partnership with universities and research centers) when evaluating the credit merit of an innovative firm. Also, since innovations typically involve substantial amounts of financial resources, it might be the case that big banks succeed in providing credit for such projects, while still complying with their portfolio diversification strategies.

There is also some additional noteworthy evidence coming from the regression analysis. In fact, our results in terms of credit rationing still hold despite the fact that we control for each firm's degree of risk embedded in its rating. In particular, it is commonly argued, especially among practitioners, that previous firms' degrees of creditworthiness and affordability are the main (or even unique) element on which banks decide whether or not and to what extent loans are accorded. Although it is unquestionable from our results that credit allowance considerably depends upon the above-mentioned features, credible commitments to undertake innovative activities seem also accounted for by intermediaries.

In conclusion, according to our findings it emerges that the overall banking system is likely to provide more credit to innovative firms rather than to non-innovative ones. However, large banks also seem more willing to finance product innovations, since they may exploit useful tools for

selecting more creditworthy firms engaged in these activities. This, in turn, implies that an innovative firm seeking for external finance should carefully choose the type of bank it applies to.

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