Innovation and export in SMEs: The role of relationship banking

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Abstract

This paper aims to detect the role of relationship lending in explaining Small and Medium Entreprises's (SME) innovation activity, its probability to export (i.e. the *extensive margin*) and its share of exports on total sales conditional on exporting (i.e. the *intensive margin*). We propose an original measure of informational tightness: the ratio of firm's debt with its main bank to firm's total assets. We justify the adoption of this proxy on both theroretical and empirical grounds. Our results show that the strength of the bank-firm relation has a positive impact on both on the SME's export margins. Moreover we can decompose this positive effect into a direct and an indirect one that passes through the SME's increased propensity to introduce a product innovation.

JEL Classification: F10, G20, G21, O30.

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1. Introduction

Internationalization is one of the main channels through which firms' growth materializes. Nonetheless, even in its weaker form –export – internationalization is a challenging choice for firms, especially in the case of small and medium enterprises (henceforth SMEs).

In fact, the decision to export requires the firm to identify appropriate foreign markets, tailor its products to fit local tastes and conform to the country's regulations (Bugamelli and Infante, 2003). These represent sunk costs, which differ according to the type of product and the features of the targeted foreign market (Helpman et. al, 2008; Chaney, 2005).

In addition, a large body of empirical literature emphasizes a strong (positive) link between firms' international business and innovation activities[1]. Indeed, R&D or innovation results are likely to influence a firm's decisions to enter and expand in foreign markets[2], but the direction of causality also runs in the opposite direction: experience in international markets can foster firm's R&D effort and innovation capacity[3].

Finally, expansion beyond national borders implies greater information asymmetries between the firm and its lenders, possibly raising credit rationing issues (De Bonis et. al, 2010). Indeed, on the one hand, firms selling abroad show increasing financial needs, because of internationalization sunk costs and eventually higher investments in innovation. On the other hand, obtaining external financing becomes more difficult, because firms assets and business become more opaque to potential financiers, due to an increase of intangible capital to tangible capital, which furthermore takes place abroad, possibly in a distant and risky context for the domestic lender. Hence, one can argue that a strong relationship of exporting firms with their lenders (*informational tightness*) may

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[1] One of the first contributions on the positive relation between exports and innovation is Hirsch and Bijaoui (1985).

[2] Among the most recent papers, Cassiman and Golovko (2011) show that product innovation has a positive impact on the decision to enter a foreign market for a sample of Spanish SMEs.

[3] A recent study on the UK Community Innovation Survey (Harris and Moffat, 2011) finds that R&D, innovation and the decision to sell abroad are indeed intercorrelated, once one considers the contemporaneous link among them.

mitigate the more severe information asymmetries due to internationalization (Berger and Udell, 1995)[4].

This paper focuses on bank financing and aims to detect the role of relationship lending in explaining contemporaneously firm's innovation activity, its probability to export (i.e. the *extensive margin*) and its share of exports on total sales conditional on exporting (i.e. the *intensive margin*).

To address this issue we use detailed information on a large sample of Italian SMEs during the period 2004-2009, mainly by employing the 10th UniCredit Corporate Survey on manufacturing firms (UCS) and the 1st survey on European Firms in a Global Economy (EFIGE). These surveys provide detailed information on firms' innovation and export activites and proxies for the informational ties with their lenders. Italy is a good setting for our analysis because banks represent the main source of external finance (Beck et al., 2008) and SMEs represent a particularly large share of the overall firm population (Ayyagari et al., 2008)

The empirical literature provides evidence of the importance of informational tightness in affecting firm's innovation. On the contrary, the evidence on firm's export is mixed. This paper provides an alternative measure of informational tightness that points out the importance of the strength of the relationship with the main bank for firm's propensity to both innovate and export, by taking into account at the same time firm's access to external finance. Our indicator is the ratio of firm's debt with its main bank to firm's total assets. As far as we know, no study has used such a measure before as a proxy for informational tightness in the bank-firm relation. We argue that this indicator may provide a better measure of the intensity of relationship lending compared to the traditional ones (e.g. the duration).

According to our empirical analysis, the strength of the bank-firm relation has a positive impact both on the decision to export and on the intensity of exports. Hence, informational tightness indeed can help the firm suffering from credit constraints when it decides to expand abroad.

Moreover, we find that our measure of informational tightness significantly affects the probability that the firm introduces product innovation, in line with the results of Herrera and Minetti (2007), and that product innovation has a positive effect on either the extensive and the intensive margin of export.

[4] Indeed, Petersen and Rajan (1994) find evidence that a long-term relationship with the main bank increases credit availability. So, the presence of such a relationship may make the intensity of rationing less severe if the firm faces credit restrictions.

The paper is organized as follows. Section 2 summarizes the most relevant empirical literature. Section 3 discusses the econometric approach that links innovation, export and bank-firm relationship. Section 4 describes the data and the main variables used for the analysis. Section 5 discusses the most important econometric results and Section 6 concludes.

2. Related literature

Our paper builds upon three different streams of literature. The first one focuses on the relationship between financing constraints, the role of relationship banking and innovation. A number of papers have recently shown the negative effect of credit rationing on R&D investment (Aghion et al 2012, Mancusi and Vezzulli 2012) and innovation (Savignac 2008). As argued in Herrera and Minetti (2007), banks have sound incentives and ability to collect information on borrowers due to their concentrated nature and their emphasis on relationship lending. These authors show that informational tightness – measured by the duration of the credit relationship between the firm and its main bank – has a positive effect on the probability of the firm to innovate, the effect being more significant for product than for process innovation. By contrast, Benfratello et al. (2008) show that banking development (branch density) affects the probability of process innovation, particularly for small firms in high-tech sectors. For product innovation the evidence is much weaker and not robust.

The second stream of literature focuses on the relationship between financing constraints, the role of relationship banking and firms' international activities (most often export). Manova (2010) recently shows that financing constraints associated with high sunk costs are large for export and above and beyond those on domestic production. Minetti and Zhu (2011) provide evidence that limited access to liquidity has a negative impact on a firm's export. They also find that the duration of the relationship with the main bank does not seem to affect the firm's extensive margin, once one treats informational tightness as endogenous and instruments it. De Bonis et. al (2010) find that a longer relationship length with the main bank fosters Italian firms' foreign direct investment (FDI) and, weakly, production off-shoring abroad. By contrast, other than for smaller-sized companies, they detect no impact on firms' propensity to export.

The third and final stream of relevant literature focuses on the circular link between innovation and exporting. The idea is that innovation fosters firm's productivity and therefore promotes export. Learning by exporting, in turn, feeds back into innovation. In

most cases, empirical contributions focus on one of the two sides of the innovation-export relationship. Cassiman and Golovko (2011) show that product innovation has a positive impact on the decision to enter a foreign market, while Bratti and Felice (2012) study the relationship between innovation and export generated through "learning by exporting" effects. It is also worth mentioning the works of Costantini and Melitz (2007) and Vanbeveren and Vandenbussche (2010), which study how firms may self-select into innovation in anticipation of their entry into export markets. Finally, Harris and Moffat (2011) study how R&D, innovation and the decision to sell abroad are intercorrelated, once the contemporaneous link among them is taken into account.

3. Econometric model

Our econometric approach extends the models of Herrera and Minetti (2007) and Minetti and Zhu (2011) by trying to disentangle the indirect benefits of relationship banking on SMEs export exerted through the promotion of product innovation and the direct effect on firm exporting decision (extensive margin) and export share (intensive margin). Our econometric strategy involves the following models:

2.1 Model 1: firm's innovation equation.

As a first step we study the determinants of firm's innovation output focusing on product innovation (*innoprod*). Since our dependent variable of interest is binary (see Section 3.2), our main econometric model of reference is a probit specified as follows:

$$\Pr(innoprod_i = 1) = \Pr(\beta_0 + \beta_1 rel\_bank_i + \beta_2 X_i + \varepsilon_{1i} > 0) \qquad (1)$$

where *rel_bank* is a measure of the strength of the credit relationship between firm *i* and its main lending bank (see Section 3.2), X is a vector of common exogenous variables (see Section 3.4), ε is the unobservable normally distributed error component, β_0, β_1 and β_2 are the unknown structural parameters to be estimated.

2.2 Model 2: firm's export equations

In the final step of our analysis we study the determinants of firm's probability of exporting (extensive margin) and export intensity (intensive margin). For this purpose we follow quite closely the econometric approach of Minetti and Zhu (2011): let π_i^*

represent the difference between the firm *i* operating profits when exporting a given percentage of sales (quota_export*) and its operating profits when not exporting:

$$\pi_i^* = R(quota\_export_i^*) - C(quota\_export_i^*) - K \qquad (2)$$

where *R* and *C* are, respectively, the expected revenues and variable costs (both depends on the relative quantity exported, *quota_export*) and K represents the fixed cost of entering a foreign market (possibly including the cost for developing a new innovative product).

Given this setting, we observe an exporting firm when $\pi_i^*>0$ for some levels of quota_export*>0 and the expected percentage of sales exported will be the one which maximizes (2). When the optimal level of exported sales exceeds the productive capacity of firm *i,* we shall observe quota_export*=100.

In our econometric specification we assume the optimal percentage of exported sales to depend mainly on a set of firm's specific characteristics X (size, productivity, availability of internal liquidity, etc.), its propensity to innovate and the strength of credit relationship with the main bank:

$$quota\_export_i^* = \gamma_0 + \gamma_1 main\_bank\_loans\_ratio_i + \gamma_2 innoprod_i + \gamma_3 X_i + v_i \qquad (3)$$

where again γ_0, γ_1, γ_2 and γ_3 are the structural parameters to be estimated and *v* is an unobservable error component assumed to be normally distributed and encompassing all the latent factors affecting the firm's optimal exporting quota.

We then model the firm's exporting decision using a probit specification:

$$\begin{aligned}&\Pr(export_i = 1) = \Pr(quota\_export_i^* > 0) = \\ &\Pr(\gamma_0 + \gamma_1 main\_bank\_loans\_ratio_i + \gamma_2 innoprod_i + \gamma_3 X_i + v_i > 0) = \\ &\Phi(\gamma_0 + \gamma_1 main\_bank\_loans\_ratio_i + \gamma_2 innoprod_i + \gamma_3 X_i + v_i) \qquad (4)\end{aligned}$$

and the observed percentage of exported sales using a tobit specification:

$$quota\_export_i = \max(0,\ quota\_export_i^*) \qquad (5)$$

where Φ is a standard normal CDF.

Since *rel_bank* and *innoprod* are considered endogenous in equation (3) we will rely on instrumental variable estimation for both models (4) and (5) using the set of instruments described in Section 3.4.

4. Data and variables

4.1 Data sources

Our main data sources are the 10th UniCredit Corporate Survey (henceforth UCS) on manufacturing firms (formerly known as Capitalia-Mediocredito Centrale Survey) carried out in 2007 and the 1st survey on European Firms in a Global Economy (EFIGE) carried out in 2010. These two surveys gather data concerning, respectively, the 2004-2006 period and the 2007-2009 period, for a sample of 5,137 and 3019 Italian manufacturing enterprises. The sampling design for the firms with less than 500 employees has been drawn using a stratification procedure based on firm's size, sector and geographic localization. The surveys collect very detailed information about each firm, such as its ownership and managerial structure, human capital, investment and innovation efforts, internationalization, market strategies, financial management and relationships with banks. These information has been integrated with firm's balance sheet data for using the AIDA (Analisi Informatizzata Delle Aziende) database developed and maintained by Bureau van Dijk. Additional information on innovation at NUTS2 (Region) and NUTS3 (Province) levels has been collected using data from the ISTAT (Italian National Statistics Office) national survey on innovation activities, the KITES-PATSTAT database on Patent statistics (maintained by the KITES Research Center of the Bocconi University), the Statistical Bullettin of the Bank of Italy (SBBI) and the book "Struttura funzionale e territoriale del sistema bancario italiano 1936-1974" (SFT) of the Bank of Italy.

Since the focus of our paper is on SMEs, we dropped from the analysis enterprises with more than 250 employees, thus getting a subsample of 7,560 SMEs. Finally, after cleaning observations with missing data and trimming out the outliers, we ended with a final dataset of 4,334 SMEs.

4.2 Main dependent and explanatory variables

Our main variable of interest is the degree of strength of the relationship between the firm and its main bank (*rel_bank*), which is proxied by the share of firm's total assets that

are financed through the main bank. This indicator can be computed by the following formula:

$$rel\_bank_i = quota\_bank \times \frac{bank\_debts}{total\_assets} \times 100$$

where *quota_bank* is the share of the firm's total bank debts (*bank_debts*) financed through the main bank and total_assets are the firm's total assets. In order to simplify the parameter interpretation in our regressions we will use the standardized version (*rel_bank_std*) of the original variable *rel_bank*.

The existing teoretical literature argues that this ratio is a good proxy for firm-bank informational tightness (Smith, 1987; Diamond, 1984), especially for SMEs (Petersen and Rajan, 1994). However, to the best of our knowledge, it has never been used in the empirical literature as a proxy for relationship banking[5]. By contrast, there is mixed evidence on the significance of other indicators that have been extensively used, such as the duration of the firm-bank relationship (Elsas, 2005), when studying the nexus between bank-firm ties and firm's performance in terms of innovation, export and growth (Herrera and Minetti, 2007; Gambini and Zazzaro, 2008; De Bonis et al., 2010; Minetti and Zhu, 2011).

We believe that our indicator *rel_bank* is a better proxy for the strength of relationship banking since it is closely related to the concept of "bank debt concentration" (Berger and Udell, 1995), which has been argued to be an effective strategy, pursued especially by SMEs, in order to overcome information asymmetries[6].

On the one hand, since bank debt financing usually involves an accurate ex-ante screening, a high bank debt concentration can be used by the firm as a signal of "low risk profile" in order to attract other investors (Smith, 1987). On the other hand, a higher bank debt concentration may translate in larger economies of scale in information production for the main lending bank, which can put more effort in monitoring activities in order to prevent moral hazard problems (Diamond, 1984).

[5] The raw unweighted measure of debt concentration with the main bank (quota_bank) has been adopted in previous empirical studies (see for instance Gambini and Zazzaro, 2008)

[6] A principal component analysis supporting our belief that *rel_bank* can be considered as a good proxy for the concept of "relationship banking" is summarized in the Appendix.

This role of the banks is consistent with the theory of "trade off", which suggests that generally in less liquid markets, banks have greater corporate involvement, although not necessarily through equity holdings (Bolton and Von Thadden, 1998). Dispersed debt holders face the same free-rider problem as dispersed equity holders when it comes to monitoring management, whereas concentrated debt ensures that the debt holder will find it worthwhile to better monitor the firm and the information produced from this monitoring effort allows him to block an inefficient move by the managers of the firm (Kroszenr and Straham, 2001).

Many empirical works support these hypotheses, showing that bank debt concentration tend to be associated with a larger amount of overall credit availability (Petersen and Rajan, 1994; Ghosh, 2006). Moreover bank "control" of firm's assets is important in explaining differences in accounting performance measures of returns on investments (Krivogorosky et al., 2009), consistently with the "one-creditor model" concerning the firm-bank relationship by Von Thadden (1995).

The other key variable involved in our analysis is a dummy variable related to the firm's innovation activity as reported in the UCS and EFIGE surveys: *innoprod*. The dummy variable is equal to 1 if the firm declared to have introduced at least one innovative product[7] during the period of reference of each survey.

Finally, concerning the firm's exporting activities, our key variables are *export*, i.e. a dummy variable which equals to 1 if the firm declared to have sold at least part of its products abroad during the last year of the survey's reference period, and *quota_export* which is the self-reported firm's percentage of total sales which can be attributed to exports.

4.3 Instrumental variables

Our indicator of relationship banking can be potentially endogenous, leading to inconsistent estimates of the structural parameters in equations (2) and (4), since they can be jointly determined with the firm's innovation and export strategies and also because of potential omitted variable bias. To test the exogeneity of our relationship banking

[7] The definition product innovation provided by the survey's questionnaire is "… the introduction of a good which is either new or significantly improved with respect to its fundamental characteristics; the innovation should be new to your firm, not necessarily to the market…". In order to drop very marginal innovations we coded the dummy variable *innoprod* as equal to 0 if the average percentage of firm's turnover from innovative products sales was less than 10%.

regressor and to get consistent estimates in case of endogeneity, we rely on instrumental variable (IV) methods using the same set of instruments (Z) proposed by Guiso et al. (2003, 2004) and Herrera and Minetti (2007), which aim to identify exogenous shocks on the local supply of banking services that are unlikely to affect directly firm's innovation and export decisions.

The set of potential instrumental variables include:

- *nbranches_p*: the number of bank branches per 1000 inhabitants in 1936 in the province where the firm is located;
- *new_branch_inc*: the average number of new branches created by incumbent banks per 1000 inhabitants computed over the period 1991-2004 in the province where the firm is located.

The choice of this set of instruments is justified by the fact that in 1936 the local supply of banking services was strictly regulated by the Italian central government, which constrained each credit institution to open new branches only in the local geographical area of competence. This regulation had variable degree of tightness, depending on the local number of saving banks and cooperative banks, and affected the level of local banking supply and competition until the deregulation in the late 1980s. Thus, the local degree of tightness of this regulation is reflected by both the bank's market structure in 1936 and the degree to which the following deregulation impacted on the local supply of new branches. However it is difficult to predict the way our instruments could affect the strength of credit relationships. In fact, "… less tightly regulated provinces allegedly experienced a greater inflow of branches until the second half of the 1980s but also a lower one in the adjustment period following the deregulation…"[8].

In order to deal also with the potential endogeneity problem of *innoprod* in the export equation (4), we use an additional instrumental variable when estimating models (5) and (6). This instrumental variable (*bcit_ITA*) is computed using patent citations data coming from the KITES-PATSTAT database and it is defined as the total number of backward citations (excluding self citations) per 1000 inhabitants from the patents filed at the European Patent Office EPO from 1990 until 2004 (considering the priority filing date) by applicants located in the same province (defined using the Eurostat NUTS3 codes)

[8] Herrera and Minetti (2007). See also Guiso et al. (2003, 2004) for a more detailed discussion on the selected instrumental variables.

and active in the same economic sector of the firm[9]. In order to avoid considering knowledge flows directly coming from abroad (which can potentially arise because and be related to export activities) we consider only backward citations to national patents (i.e.: patents filed by Italian applicants). This patent citation count is then normalized by the NUTS3 province population in 2004.

We believe that these variables are likely to affect the firm's innovation propensity as proxies of the amount of localized knowledge spillovers coming from other Italian innovators, but unlikely to be directly related with the firm's contemporaneous export strategies.

4.4 Control variables

Our set of control variables include several firm's individual characteristics that are likely to affect the strength of the banking relationship, the firm's innovation propensity and its export strategy. Most of these control variables are taken from the recent existing literature (Herrera and Minetti, 2007; De Bonis et al., 2010; Minetti and Zhu, 2011) and include a set of firm's financial variables computed in years 2004 and 2007 (i.e. the starting year of the UCS and EFIGE survey reference periods):

- *ltot_assets:* logarithm of total assets (in Euro);
- *debts:* Total debts/Total Assets;
- *cash_flow:* Cash Flow / Total Assets;

The logarithm of total assets is a proxy for firm's size. As in Minetti and Zhu (2011) we adopt firm's liquidity (*cash_flow*) and firm's leverage (*debts*) to proxy the probability of credit constraints.

We also use the following set of additional firm level characteristics as control variables plus a set of dummy variables for each ATECO-NACE 2 digits level macro sector:

- *age:* logarithm of years since firm's foundation;
- *young:* dummy variable which equals to 1 if the firm has been founded after 1998;
- *group:* dummy variable which equals to 1 if the firm belongs to a group;
- *north_east:* dummy variable which equals to 1 if the firm is located in the North-East Italian macro region;

[9] The concordance of each citing patent with the firm NACE 2 digit sector has been performed using the OST-INPI methodology (see Schmoch 2008).

- *centre:* dummy variable which equals to 1 if the firm is located in the Centre Italian macro region;
- *south:* dummy variable which equals to 1 if the firm is located in the South Italian macro region;

Table 1: Variables description

Variable	Description	Source
rel_bank	Percentage of firm's main bank loans on Total Assets	AIDA-UCS-EFIGE
rel_bank_std	Standardized version ov *rel_bank*	
innoprod	Dummy = 1 if the firm introduced an innovative product	
export	Dummy = 1 if the exported	UCS-EFIGE
quota_export	Percentage of firm's export over Total Sales	
ltot_assets	Logarithm of Total Assets	
debts	Total Debts on Total Assets	AIDA
cash_flow	Cash Flow on Total Assets	
age	Logarithm of form's age in years	
young	Dummy = 1 if the firm is less than 10 years old	
group	Dummy = 1 if the firm belongs to a group	UCS-EFIGE
intcomp	Dummy = 1 if the firm has international competitors	
north_east	Dummy = 1 if the firm is located in the North-East	
centre	Dummy = 1 if the firm is located in the Centre	
south	Dummy = 1 if the firm is located in the South	
vvat_popres	Value added (in millions of Euro per 1000 inhabitants) in 2004 at the province (NUTS3) level	ISTAT
branch_04	Average number of bank branches per 1000 inhabitants in the period 1991-2004 at the province (NUTS3) level	
HHI	Average Herfindhal Hirschman Index of bank deposits concentration during the period 1991-2004, at the province (NUTS3) level	SBBI
nbranches_p	Number of bank branches per 1000 inhabitants in 1936, at the province (NUTS3) level	SFT
new_branch_inc	Average number of new branches created by incumbent banks per 1000 inhabitants in 1991-2004, at the province (NUTS3) level	SBBI
bcit_ITA	Number of backward patent citations (excluding self citations) per 1000 inhabitants from citing patents filed during the period 1990-2004 by applicants from the same province (NUTS3) and industry (NACE 2 digits) and citing other national patents.	KITES-PATSTAT

The logarithm of age (*age*) allows to control for firm's experience, which can be considered as an important predictor for firm's performance and probability of default. Moreover, young firms (*young*) tend to face additional problems because of their informational opaqueness. Being part of a group (*group*) can benefit the firm through mutual financial assistance, knowledge spillovers and distribution network cost sharing.

The dummies for the geographical macro-areas are included in order to control for different levels of economic and infrastructure development and distances to various foreign target markets (EU, North East Europe, South East Europe, North Africa, etc.). In order to better control for the local level of economic and banking development, we also used the following variables:

- *vvat_popres*: the value added (millions of Euros) per 1000 inhabitants of the province where the firm is located in 2004;
- *branch_04*: the average number of bank branches per 1000 inhabitants of the province where the firm is located computed during the period 1991-2004.
- *HHI:* the average Herfindhal Hirschman index of bank deposits concentration of the province where the firm is located computed during the period 1991-2004.

Table 1 summarizes all the variables involved in the analysis and Table 2 provides the main descriptive statistics.

Table 2: Main descriptive statistics (N=4341)

Variable	Mean	St. Dev	Min	Max
rel_bank	9.204	14.282	0	100
rel_bank_std	-0.002	1.002	-0.648	6.366
innoprod	0.661	0.473	0	1
export	0.655	0.475	0	1
quota_export	24.712	29.202	0	100
ltot_assets	12.657	3.631	3.040	19.102
debts	0.679	0.225	0.006	6.292
cash_flow	0.056	0.060	-0.250	0.304
age	3.148	0.718	0	5.553
young	0.113	0.317	0	1
group	0.155	0.362	0	1
north_east	0.294	0.456	0	1
centre	0.185	0.389	0	1
south	0.125	0.330	0	1
vvat_popres	24.292	4.867	11.242	33.388
branch_04	0.524	0.127	0.210	0.976
HHI	0.099	0.048	0.036	0.425
nbranches_p	0.208	0.079	0.037	0.618
new_branch_inc	0.021	0.009	0.002	0.045
bcit_ITA	0.070	0.148	0	1.020

5. Results

In this section we present and discuss the estimation results of our econometric models introduced in Section 2.1.

5.1 Determinants of innovation

In this sub-section we report and discuss the estimation results of the innovation equation (1).

Table 3: Determinants of innovation

VARIABLES	Coefficients *innoprod*	Marginal Effects (AMEs) *innoprod*
rel_bank_std	0.0869***	0.0308***
	(0.0289)	(0.0102)
ltot_assets	0.0434**	0.0154**
	(0.0201)	(0.0071)
debts	0.0379	0.0134
	(0.107)	(0.038)
cash_flow	-0.347	-0.123
	(0.377)	(0.133)
age	-0.0013	-0.0005
	(0.0411)	(0.0146)
young	0.0561	0.0197
	(0.0889)	(0.0308)
group	-0.0686	-0.0246
	(0.0603)	(0.0218)
vvat_popres	0.0118	0.0042
	(0.0075)	(0.0027)
branch_04	-0.228	-0.0809
	(0.241)	(0.0855)
HHI	0.0984	0.0349
	(0.497)	(0.176)
bcit_ITA	0.608**	0.215**
	(0.255)	(0.0902)
Constant	0.528	
	(0.332)	
Observations	4,341	4,341

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Dummies for years 2004-2006 and NUTS1 macro-area included

We previously tested the exogeneity of our indicator *rel_bank_std* by estimating equation (1) with Two-Stage Instrumental Variable (2SLS) methods using the set of instrumental variables described in section 3.3 (namely *nbranches_p* and *new_branch_inc*). The relevancy

of the selected instrumental variables is confirmed by the rejection of both the F-statistic and the Kleibergen-Paap statistic. The Hansen J test statistic confirmed the validity of our chosen set of instruments, whereas both the Hausman and the C-statistic tests did not rejected the exogeneity of the *rel_bank_std* indicator in both equations[10]. We thus decided, in order to get more efficient estimates, to treat our measures *rel_bank_std* as exogenous and to estimate equation (1) with heteroskedastic Maximum Likelihood Probit method. Table 3 reports the estimated coefficients and the Average Marginal Effects (AMEs) along with their standard errors (in parenthesis).

Our indicator *rel_bank_std* has a positive and statistically significant impact on product innovation propensity. The estimated average marginal effects in terms of increased predicted probability of introducing an innovative product is about +3.08% for one point increase of *rel_bank_std* (i.e.: one point standard deviation increase of the original variable *rel_bank*). In line with Herrera and Minetti (2007) we find a significant and economically sizeable effect of the strength of relationship lending on product innovation.

Concerning the other determinants of innovation, we find that larger firms tend to be more innovative and that firms located in provinces with high intensity of knowledge flows from other italian innovators (*bcit_ITA)* increases the propensity to innovate.

5.2 Determinants of exporting

In this last sub-section we report the estimation results of the export equation models (4) and (5). Table 4 shows the regression estimates for the extensive margin of exports.

In column (1) we estimated a GMM-IV Linear Probability Model (LMP). The instrumental variables used for *rel_bank_std* are the same of the previuos section (i.e. *nbranches_p* and *new_branch_inc*), whereas for *innoprod* we used our proxy for localized domestic knoledge spillovers computed using backward patent citations (*bcit_ITA*). The Hansen J test statistic confirmed the validity of our chosen set of instruments and both the Hausman and the C-statistic tests rejected the exogeneity of *rel_bank_std* and *innoprod*, which are thus treated as endogenous

[10] In particular when estimating equations (2a) and (2b) as separated 2SLS linear probability models the resulting Hansen J statistics are 0.256 (p-val 0.613) and 0.909 (p-val 0.340), the Kleibergen-Paap LM under-identification statistics are 6.224 (p-val 0.0441) and 6.768 (p-val 0.0339), the C endogeneity test are 2.456 (p-val 0.1171) and are 1.862 (p-val 0.1724), respectively.

In column (4) we also show the estimates using the efficient Full Information Maximum Likelihood (FIML) estimation technique proposed by Amemiya (1978) and improved by Newey (1987) along with the associated fist-step estimates in columns (2) and (3).
Both *rel_bank_std* and *innoprod* are statistically significant in the firm's export decision equation.

Table 4: Determinants of the export decision equation

	(1)	(2)	(3)	(4)
Estimation method	GMM-IV LPM	FIML-IV Probit	FIML-IV Probit	FIML-IV Probit
VARIABLES	*Export*	*rel_bank_std*	*innoprod*	*export*
innoprod	1.541*			1.749***
	(0.805)			(0.0877)
rel_bank_std	0.556			0.626***
	(0.526)			(0.0352)
ltot_assets	0.137	-0.0533***	0.0155*	0.0932***
	(0.0937)	(0.0197)	(0.0093)	(0.0058)
debts	-0.487	0.754**	0.0236	-0.531**
	(0.414)	(0.317)	(0.150)	(0.222)
cash_flow	0.834	-0.307	-0.135	0.141
	(0.715)	(0.572)	(0.398)	(0.922)
age	0.0137	0.0067	0.0006	0.0278
	(0.0478)	(0.0268)	(0.0140)	(0.0353)
young	-0.0315	-0.0043	0.0211	-0.0259
	(0.0672)	(0.0672)	(0.0356)	(0.0876)
group	0.0602	-0.0959***	-0.0260	0.112**
	(0.0438)	(0.0321)	(0.0230)	(0.0553)
vvat_popres	-0.0049	-0.0026	0.0051	-0.006
	(0.0066)	(0.00558)	(0.0032)	(0.0074)
branch_04	4.413	-42.79	19.94	0.413
	(25.39)	(27.22)	(12.90)	(25.39)
HHI	-0.0998	0.614	-0.0497	-0.217
	(0.392)	(0.395)	(0.210)	(0.530)
new_branch_inc		-0.0824	0.171***	
		(0.125)	(0.0634)	
new_branch_ent		0.0043**	-0.0021**	
		(0.0019)	(0.0008)	
bcit_ITA		3.262	0.182	
		(2.358)	(0.913)	
Constant	-1.451	0.406	0.632***	-2.023***
	(1.177)	(0.414)	(0.200)	(0.291)
Observations	4,334	4,334	4,334	4,334

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Dummies for years 2004-2006 and NUTS1 macro-area included

The estimated marginal effects for the efficient FIML IV Probit model are 0.2474 for *rel_bank_std* and 0.6130 for *innoprod*. That is, a unit increase of *rel_bank_std* increases the

predicted probability of exporting (extensive margin) by about 24.74%, whereas the introduction of a new innovative product increases the predicted probability of exporting by about 61%.

Table 5: Determinants of the intensity of export

	(1)	(2)	(3)
Estimation method	FIML-IV Tobit	FIML-IV Tobit	FIML-IV Tobit
VARIABLES	*rel_bank_std*	*innoprod*	*quota_export*
innoprod			252.5***
			(4.699)
rel_bank_std			64.10***
			(2.914)
ltot_assets	-0.0518***	0.0164***	7.917***
	(0.0116)	(0.0054)	(1.743)
debts	0.754***	0.0204	-57.68***
	(0.104)	(0.0335)	(10.85)
cash_flow	-0.354	-0.150	19.82
	(0.235)	(0.118)	(37.71)
age	0.0128	0.0003	1.359
	(0.0243)	(0.0119)	(3.693)
young	0.0029	0.0197	-3.612
	(0.0632)	(0.0334)	(9.477)
group	-0.105***	-0.0206	13.90**
	(0.0313)	(0.0225)	(6.311)
vvat_popres	-0.0021	0.0053**	-1.321*
	(0.0048)	(0.0024)	(0.742)
branch_04	-54.40**	15.81	905.9
	(26.21)	(15.75)	(3,880)
HHI	0.745**	-0.0202	-31.37
	(0.334)	(0.196)	(54.52)
new_branch_inc	0.0055**	-0.0017**	
	(0.0023)	(0.0007)	
new_branch_ent	2.566	-0.263	
	(1.913)	(0.573)	
bcit_ITA	-0.0216	0.187***	
	(0.116)	(0.0365)	
Constant	0.343	0.622***	-237.7***
	(0.224)	(0.105)	(32.44)
Observations	4,269	4,269	4,269

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Dummies for years 2004-2006 and NUTS1 macro-area included

We finally analyze the determinants of the intensive margin of exports, measured by the percentage of total revenues from exported sales (*quota_export*).

Since this dependent variable is bounded by construction between 0 and 100, we estimate equation (5) with a a Full Information Maximum Likelihood (FIML-IV) Tobit

model (Amemiya, 1979; Newey, 1987). The estimated coefficents and standard errors are reported in Table 5 column (3) along with the first-step estimates in columns (1) and (2).

In this final model we used the same set of endogenous regressors, exogenous variables and instruments as in the previous Probit IV model. Concerning the intensive margin, the estimated marginal effects are 2.98 for *rel_bank_std* and 11.74 for *innoprod*. These findings confirm, as in the previous IV-Probit model, that the magnitude of the estimated marginal effect of *rel_bank_std* on firm's export is smaller than the one of *innoprod*, but still not negligible.

In order to study more in details the marginal effect of *rel_bank_std* and *innoprod* on both the extensive and the intensive margins of exports we can compute the decomposition proposed by McDonald and Moffit (1980) which can be written as:

$$\frac{\partial E(\text{quota\_export}^* \mid x)}{\partial x} = \frac{\partial \Pr(\text{quota\_export}^* > 0 \mid x)}{\partial x} E(\text{quota\_export}^* \mid \text{quota\_export}^* > 0, x) + \\ + \Pr(\text{quota\_export}^* > 0 \mid x) \frac{\partial E(\text{quota\_export}^* \mid \text{quota\_export}^* > 0, x)}{\partial x} \qquad (7)$$

where the first component is the expected percentage increase of *quota_export* due to the positive marginal effect of x on the probability of exporting for domestic firms, whereas the second component is the expected percentage increase of *quota_export* due to the positive marginal effect of x on the export intensity for already exporting firms.

Given that the estimated conditional probability of exporting Pr(*quota_export**>0|x) is about 0.5447 and the estimated conditional export intensity E(*quota_export**>0| *quota_export**>0,x) is about 48.31, the two addends of the Mc-Donald and Moffit decomposition for *rel_bank_std* are: 9.39 + 1.66, whereas for *innoprod* they are: 31.73 + 6.39.

Thus, for the already exporting firm a one unit increase in *rel_bank_std* has an estimated impact of about +1.66% on the intensive margin, whereas the introduction of a new innovative product affects export intensity by about +6.39%.

We can now disentangle the estimated effect of an increase in the strength of the banking relationship into the direct impact on the probability and intensity of exporting

and the indirect impact that pass through the increased propensity to introduce an innovative product.

For the export decision (extensive margin) the estimated direct effect of an unit increase in *rel_bank_std* is 0.247 in term of increased probability of exporting, whereas the estimated indirect effect is: 0.613*0.0308=0.019 (where 0.0308 is the estimated AME of *rel_bank_std* in the product innovation equation reported in Section 4.1).

Concerning the percentage of export on total sales (intensive margin) the estimated direct effect of an unit increase in *rel_bank_std* is +2.98% whereas the estimated indirect effect is: 11.74 *0.031=0.36%. Thus the estimated direct effect of *rel_bank_std* on firm's exports seems to be larger than the indirect one when considering both the extensive and the intensive margins.

In conclusion, informational tightness seems to boost SMEs innovation output. In addition, the strength of the firm-bank informational ties seems to have non negligible direct benefit on both the export participation and export intensity, an effect which is independent from the innovation activity of the SMEs.

6. Conclusions

The present analysis explores the contemporaneous link between innovation and export and the role of relationship lending, adding new insights on the impact of the strength of credit ties between banks and small and medium enterprises (SMEs) when a firm faces both the choice to innovate and to export.

We extend and improve the analysis of Minetti and Zhu (2011) in several directions.

First, we disentangle the indirect benefits of relationship banking on SMEs export exerted through the promotion of product and the direct effect on firm's exporting decision (extensive margin) and share of export on total sales (intensive margin).

Second, in order to address this issue, we consider a measure of informational tightness, the firm's amount of credit with the main bank divided by its total asset, which takes into account both firm's access to liquidity and the strength of the relationship with the main bank.

Our empirical analysis shows that a tight relationship with the main bank plays a significant role in explaining firm's decisions not only on innovation but also on export.

In addition, we find that two effects are at work: one direct, positive effect of informational tightness on export, and one indirect effect, passing through product innovation.

We expect that our findings will be helpful for both investors and policy makers to better understand the relevance of firm-bank relationship as an important driving force for the growth and internationalization of SMEs, with a particular emphasis on the innovation step which plays a crucial role in the exporting decision and which is also the most problematic one in term of market imperfections for external financing.

Our results suggest that the bank is more than a pure liquidity provider: it can also help in mitigating the credit constraints that a firm could eventually face once it decides to expand abroad.

Further research could investigate more deeply the role of the bank in promoting firm's internationalization. In fact, the bank could offer export-related services, such as reliable and broad information on foreign markets, support in the contact with institutions and authorities abroad, advice on investment strategies beyond the national borders. In short, the bank can act as an "export consultant", drawing up alongside the firm in the choice of the product / market strategy, easing the targeting of suitable foreign commercial and industrial partners, attesting the mutual reliability of the parties[11].

[11] Two examples of the export-consultant role of the bank are the UniCredit initiatives named "East Gate Export" and "WinEast". Both initiatives aim to support SMEs in their exporting activity towards Central Eastern Europe (CEE) countries and offer the opportunity to benefit from the wide presence of the bank's subsidiaries and branches in these foreign markets. With East Gate Export, firms can easily meet qualified interlocutors – either UniCredit staff operating in the target markets and external experts in international tax and legal issues – and get deep information on several features related to some CEE countries (economy, legal and tax environments, commercial strategies, institutional facilities available in Italy for export, credit support that the bank can provide). East Gate Export has had a growing participation over time, a signal that smaller firms appreciate the export-consultant role of the bank as a useful device to reduce the significant fixed sunk cost of expanding abroad. WinEast further extends the East Gate Export initiative: it allows a small number of firms of a specific sector to get in contact with a selected group of foreign buyers in B2B meetings. In addition, as in the East Gate Export meetings, firms can collect various information on the target foreign markets, thanks to the presence of the UniCredit staff operating abroad and external advisors. See Frazzoni and Vezzulli (2011) for a case study on the WinEast initiative of UniCredit.

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Appendix

In this section we perform a principal component analysis in order to check if our variable *rel_bank* can be considered as a good proxy for the concept of "relationship banking". First of all we have to define what we precisely mean with "relationship banking". Boot (2000) defines relationship banking as the provision of financial services by a financial intermediary that:

i. invests in obtaining customer-specific information, often proprietary in nature; and

ii. evaluates the profitability of these investments through multiple interactions with the same customer over time and/or across products.

We also adopt this definition which centers around two critical dimensions: proprietary information and multiple interactions. We can retrive some information on the importance ot these factor that characterize the firm-bank relationship by focusing on a sub sample of about 1000 firms who responded to some specific questions inclued in the UCS survey. The questionnaire ask the firm to state the importance (using a likert scale that ranges from 1=very important to 4 = not important) of the following factors affeting the choice of the main bank:

1) The bank knows well the firm's main business;
2) The bank knows some of the firm's managers or owners;
3) The bank knows well the firm's industry;
4) The bank knows the firm's local economy;
5) The bank knows the firm's market conditions;
6) High frequency of meetings or other contacts between the firm and the bank's local branch manager.
7) The bank takes quick decisions;
8) The bank provides multiple services;
9) The bank provides a wide international network;
10) The bank provides efficients internet-based services;
11) The bank provides sable credit lines;
12) The cost of the bank loans and services are affordable;
13) The bank's loan conditions are simple and clear;
14) The bank is well strategically located.

We then have defined 14 dummy variables (dum1-dum14), one for each question, codified with 1 when it was rated as as "1=very important" by the firm and 0 otherwise. By performing a Principal Component Analisys on this set of 14 dummies we extracted and rotated (using Varimax method) the first two common factors (Factor1 and Factor2) that account for the 54.72% of the overall variance and show the following factor scores:

Table A1: Factor scores estimation

Variable	Factor1	Factor2	Uniqueness
dum1		0.7163	0.4713
dum2		0.7879	0.3755
dum3		0.7296	0.3843
dum4		0.7031	0.4515
dum5		0.6125	0.4798
dum6		0.4640	0.6081
dum7	0.6678		0.4916
dum8	0.7875		0.3486
dum9	0.6710		0.4932
dum10	0.6488		0.5235
dum11	0.7338		0.4424
dum12	0.7794		0.3612
dum13	0.7493		0.4203
dum14	0.6529		0.4884

(blanks represent abs(loading)<.45)

Table A1 suggests that Factor1 identifies characteristics of the firm-bank relationship based on questions 7-14, whereas the second one identifies characteristics that are more related with the set of the first 6 questions which are very close to the adopted definition of "relationship banking" (i.e.: importance of customer-specific information and multiple interactions with the same customer over time).

We then analyze the degree of correlation between Factor2 and our proxy variable (*rel_bank*) along with other two alternative proxies widely used in the literature of relationship banking: the duration of the relationship (number of years) with the main bank (nyears_bank) and the numer of bank relationships the firm maintains (n_banks). We found that *rel_bank* shows the strongest degree of pairwise correlation with Factor2 (0.1009) followed by *nyears_bank* (0.0268) and by *n_banks* (0.0422).