Economics Bulletin

Volume 38, Issue 4

Green investment strategies and bank-firm relationship: a firm-level analysis

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Abstract

This paper investigates the determinants of firm's green investment strategies in equipment for pollution control. It uses micro-data from a large survey of Italian manufacturing firms from 2001 to 2006. In particular, we test whether the length of the firm-bank relationship affects the firm's probability of investing in environmentally friendly equipment. Our findings show that a longer relationship with the main bank fosters firms' involvement in green investment strategies in order to reduce their environmental impact. Conversely, the presence of a multiple credit relationship could concretely hinder a firm's investments towards environmental innovations.

Citation: Pasquale Marcello Falcone, (2018) "Green investment strategies and bank-firm relationship: a firm-level analysis", *Economics Bulletin*, Volume 38, Issue 4, pages 2225-2239
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Submitted: April 30, 2018. **Published:** December 02, 2018.

1. Introduction

Achieving a sustainable economy depends on investing sufficient capital to finance the (possible) long-term transition of the real economy. It does this by focusing not only on a restricted number of sectors (i.e. renewables, eco-innovations, bio-products, etc.), but also by creating the basis for a sustainable financial system to finance and fuel this transition (Falcone *et al.* 2018a).

Even though significant developments have been recorded in the last decade in greening the economy, the amount of green investments still remains insufficient. The European Environment Agency (2014) estimates that the amount of financial investments needed to attain a low carbon economy ranges from US$300-400 billion per year up to 2020 for reducing gas emissions. Under European regulations, Italy agreed to reduce greenhouse gas emissions to 20%, with respect to 1990 levels, by 2020. In view of these needs, and due to their intermediary role in the economy, banks hold a unique position with regard to environmental goals. This is because they might address or drive the economy through a sustainable allocation of funds. The role played by finance and banking in boosting green investments in environmental innovations (EI) is perhaps even more relevant than for traditional innovations, even though the literature on EI adoptions has not taken into it account with adequate depth and breadth (Barbieri *et al*. 2016).

Our analysis tries to fill this gap by contributing to the sparse literature on the interactions between the financial system and firms' commitment on environmental goals. Specifically, the novelty of this paper is to test whether the length of the firm-bank relationship affects the firm's probability of investing in environmentally friendly equipment. It uses micro-data from a large survey of Italian manufacturing firms that matched information on firms and banks.

The rest of paper is organized as follows. Section 2 surveys the relevant literature. Section 3 describes our dataset, while Section 4 presents the empirical methodology. Section 5 reports estimation results, and Section 6 concludes.

2. Related literature

Linking the ecosystem change with economic opportunities and social wellbeing has always been a challenging work (Falcone and Imbert 2018; Cucchiella *et al.* 2017). While the relevance and impact of environmental protection in producing environmental benefits is widely known (Morone *et al.* 2019), discussions on the effects of environmental regulation on economic performance have been a topic of debate among scholars for several years (Falcone 2014). A commonly explored concern is up to what point endogenous and exogenous factors and circumstances influence the relationship between firms' environmental performance and their economic outcomes. In contrast to the *neoclassical wisdom*, according to which environmental aims and firm profitability are indeed incompatible, a new perspective, based on the assumption that strict environmental protection may work as "win-win" policies, provides an innovation opportunity for firms to gain long-term profitability and a competitive advantage (Porter and Van der Linde 1995). This new perspective has stimulated a wide debate on the conditions under which the Porter Hypothesis may emerge. A core part of the debate relies on the linkage between environmental regulations and innovation; this linkage is recognised as a key determinant that may lead to a positive effect on a firm's economic performance (Costantini and Mazzanti 2012; Lanoie *et al*. 2011).

2.1 Green investment determinants: firms' specific characteristics vs. external factors

Despite the richness of the theoretical and empirical contributions, the analysis of the relationship between environmental practices and a firm's economic performance should be improved to take the broad and diverse set of factors that affect the adoption of environmentally oriented investments into account (Antonietti and Marzucchi 2014). In particular, in contexts characterized by weak environmental regulatory frameworks, it is important to consider that green investments might also be induced within the economic system (endogenously), rather from regulatory institutions (Ghisetti and Quatraro 2013). Cucchiella et al. (2012) demonstrate the relevance of making a portfolio risk explicit, and, through an optimal generation portfolio, show as such risk can be mitigated by the diversification of investments in renewable energies. Literature on corporate social responsibility (CSR) provides helpful tips for the identification of endogenous drivers for firms to invest in green technologies. Specifically, Ambec and Lanoie (2008) theoretically study how environmental practices contribute to a firm's economic and financial performance. First, a better environmental performance due to green investment strategies can increase returns for firms by enabling: (i) a better access to "green" markets; and (ii) a product differentiation strategy based on firm environmental reputation.

Moreover, green investment strategies can lead to a decrease in the cost of materials and energy use (e.g. installation of PV), capital assets (e.g. by easing access to green or ethical mutual funds), and cost of labour (e.g. by enhancing loyalty and commitment).

Firm's' investments in equipment for pollution control have gathered increasing attention from policymakers and researchers. This led to a proliferation in the number of studies on the determinants of the introduction of environmentally friendly technologies, mainly at the microeconomic level. The empirical literature testing factors explaining a firm's choice to invest in environmental goals, has enlarged the analysis to the effects of environmental practices that do not necessarily require environmental regulation. In this context, Antonietti and Marzucchi (2014), focusing on the surveys of manufacturing firms conducted by Unicredit bank covering the period 2001-06, empirically study the relationship between investments in green tangible investments and firms' export performance, relying on a rich firm-level dataset on Italian manufacturing. They found that firms with higher productivity, induced among other factors by green investments linking environmental and increased revenue aims, attain a higher export performance. Haller and Murphy (2012) investigate the determinants of a firm's current environmental expenditure and their capital investment in equipment for pollution control in Irish manufacturing industries. The main determinants for the two types of expenditure are similar: larger, exporting and energy-intensive firms are more likely to invest in green technologies for pollution abatement. Jaraitė *et al*. (2012), investigate the determinants of environmental expenditures and investment in Swedish industrial firms. They found that larger, more profitable and more energy intensive firms are more likely to spend and invest in the environment. Aden *et al*. (1999), alongside firm-specific and regulatory factors, consider community characteristics and related pressures in describing investments in pollution abatement in Korean manufacturing plants. They find that plant specific factors are more relevant than regulation and community characteristics in explaining green investment strategies. Moreover, as emphasized by Heal (2008), there is growing evidence that firms respond to other external pressures (e.g. local/interest group pressures, customer demand and other social pressures) for voluntary over-compliance with environmental regulation by investing more in green equipment than is required.

Collins and Harris (2002) investigated whether foreign-owned firms have a higher probability of investing in pollution abatement than domestic firms in UK manufacturing industries. They did not find a univocal relationship, but one that depended on the country of origin of the firm. Later (2005), they analysed whether foreign-owned firms invested more than domestic firms

on pollution abatement in the UK chemical industry. Controlling for other firm characteristics, they find that the effects may go in either direction depending on the type of pollution abatement expenditure. Horbach (2008) found that improved "knowledge capital", induced among others by R&D and further education measures, triggers environmental innovation adoption. Moreover, environmentally innovative firms in the past are also more likely to invest in environmental innovations in the present. Given these specificities, Horbach *et al*. (2012) extend the analysis to consider "Market-pull factors" to explain EI, including turnover expectations, new demand for eco-products, past economic performance and customer benefits.

2.2. Green investments and finance

In this paper, instead, we investigate the impact of the firm-bank relationship on environmental investment strategies. To this end, we consider green investments not derived solely from external regulations or by other single specific determinants. In doing so, we focus on a broad and interrelated set of economic and financial factors; this might not only involve regulations and policy instruments, but also other firm characteristics and strategies.

Classical investment theories emphasized the key role of financial institutions as the optimal mechanism for flowing funds from investors to businesses when information asymmetries occur between them. The empirical literature that tests what hinders innovation adoption by firms has extended the analysis to the bank-firm relationship. A particular strand of literature on banks and innovation investigated the effect of banking development and its relationship to lending on the adoption of innovation by Italian manufacturing firms (Brancati 2015; Alessandrini *et al*. 2010; Benfratello *et al*. 2008). From these contributions, the importance of the relationship lending on the adoption of innovations clearly emerges.

In their seminal paper, Petersen and Rajan (1994) point out that the length of bank-firm relationships (i.e. number of years) positively affects the availability and cost of funds for the firm. The availability of financial resources is particularly important to trigger green investments (Falcone *et al.* 2017) and, thus, the adoption of environmental innovations giving rise to a transition towards sustainability (Falcone *et al.* 2018b). However, green investments are often hampered because potential investors struggle with imperfect information and thus, the financial sector tends to constrain credit in markets characterized by such failure (Stiglitz and Weiss 1981). Consequently, financiers show stricter lending policies for green investment with respect to cases where relevant information is easily available. In this context, Ghisetti *et al*. (2017), by focusing on SMEs and using a survey data at the EU level, investigate whether financial barriers affect the adoption of environmental innovations by firms. Their main result is that perceived financial barriers concretely hinder firm's investments towards environmental innovations.

However, still lacking to our knowledge, the impact of relationship lending on the firm's likelihood to invest in environmental innovations still remains uninvestigated.

3. Data and Variable Definitions

3.1. Data sources

Our empirical investigation rests on a single dataset that was built from two different sources: (i) the Survey on Manufacturing Firms (SMF) carried out by the Unicredit corporate bank; (ii) the AIDA-Bureau van Dijk database (AIDA-BvD). While the latter (AIDA-BvD) provides

balance sheet information, the former (SMF) covers different areas of interests and gives information on ownership structure, labour force, investments, R&D and innovation, export, bank-firm relationship, etc.

To extract our data, we combined the surveys (IX) carried out in 2004, concerning the period 2001-2003, and in 2007 (X) with reference to the period 2004-2006[1]. The two surveys provide information on representative samples of 4,289 and 5,137 Italian manufacturing firms respectively. The SMF considers the whole universe of firms with more than 500 employees, while firms with 11-500 employees were selected looking at the geographical area of location, firm size, and sector of economic activity (Pavitt classification).

After merging the two datasets, the pooling sample has information on 9,426 firms. Then, we excluded firms with missing values, or those with inconsistencies or negative values for some firm specific variables (i.e. value added, labour cost, etc.).

3.2. Dependent variable

Our dependent variable concerns the firm's green investment strategies in equipment for pollution control. Specifically, we employ the following qualitative question included in SMF:

> *"Which are the main objectives pursued by firm's investments in new machinery and equipment during the time-period 2001-2003 and 2004-2006?"*

Particularly, the X survey (2004-2006) asked firms to evaluate the importance of the investment strategies pursued by identifying the three most important objectives, in decreasing order, related to their investment decision among seven alternatives: (1) improving the quality of existing products; (2) increasing the production of existing products; (3) introducing new products; (4) lowering the environmental impact; (5) lowering the use of raw materials; (6) reducing the employment of labour inputs; and (7) others. We then define the dummy HIGHMED_GINV, equal to 1 if the firm recognize the 4th investment decision (i.e. lowering environmental impact) as one of the top two alternatives (e.g. medium-high importance), 0 otherwise. It is worth nothing that, different from the X survey, the previous one (2001-2003) asked the question in a slightly different way. Specifically, while the X survey forced the respondents to provide a hierarchy of investment strategies, the IX survey allowed them to indicate for each of the seven alternatives of investment the level of importance (i.e. high, medium and low), creating a potential overlapping issue among investment variables. However, as Table 1 shows, this does not seem to be a problem for our empirical investigation because the level of pairwise correlation is not of concern.

Table 1: Correlation among investment variables (IX Survey)

	1	2	3	4	5	6
Object						

[1] The main reasons for using this limited and dated time span is that, since we aim at investigating the determinants of firm's green investment strategies in equipment for pollution control, no data are available for a more recent-crisis period. In fact, the current literature (see among the others D'Aurizio *et al.* 2015 and Bolton *et al.* 2016), mainly concentrating on the last financial crisis and the mechanisms affecting the access to credit of businesses, does not consider green investments strategies.

1. Product quality improvement	1					
2. Increasing existing production	0.3005***	1				
3. Introduction of new products	0.2047***	0.1508***	1			
4. Lower environmental impact	0.1288***	0.1727***	0.1524***	1		
5. Less raw material	0.1915***	0.1442***	0.1608***	0.3050***	1	
6. Less employment	0.0710***	0.1643***	0.1154***	0.2208***	0.2156***	1
7. Other	- 0.2786***	- 0.2024***	- 0.1599***	- 0.2232***	- 0.2250***	- 0.1299***

Source: author's elaboration

In order to standardize the information concerning our dependent variable between the two surveys, selection work has been carried out. In particular, following Antonietti and Marzucchi (2014) we construct our HIGHMED_GINV dummy variable; this is equal to 1 if the firm assigns a high level of importance to the 4th investment decision (i.e. lowering environmental impact), and does the same with at most one of the other six objectives. The rationale behind our empirical strategy is given by the need to better capture the firm's attitude towards green investments, disregarding those "enlarged" investment choices (e.g. the case in which firms assign high importance to several investment objectives).

3.3. Potential determinants of firm's green investment strategies

Based on earlier empirical and theoretical contributions, we consider the length of the credit relationship between the firm and its main bank as a key explanatory variable. Those firms who missed reporting such information are not considered for our empirical investigation. Additionally, we focus also on another indicator of the bank-firm relationship, namely the number of banks involved in a credit relationship with the firm. Moreover, we take into account firm-specific control variables such as size (number of employees), age (number of the years from its foundation), labour productivity, and return on investment (ROI). We also control for the firm's attitude towards research and development activities, and some financial indicators such as leverage, membership of a credit consortium and the firm's credit rationing. Other control variables refer to the geographical location of firm to better capture regional peculiarities (i.e. south, north-east and north-west), and sector specific effects for technological characteristics of the firms. Table 2 below displays the whole set of considered variables with related description and source.

Table 2: Variables: description and source

Variables	Description	Source
Dependent variable		
Green investments	Dummy that takes the value 1 if the firm has declared to pay a medium-high attention towards investment strategies aimed at reduce the environmental impact of the firm activities; 0 otherwise	Capitalia Survey IX, X
Endogenous variables:		
Relationship length	Log of the number of years of the relationship between the firm and its main bank	Capitalia Survey IX, X
Instrumental variable		
Saving banks in 1936	Number of saving banks per 10,000 citizens in the region in 1936	Guiso *et al*. (2004)
Exogenous variables		
Credit rationed	Dummy that take the value 1 if the firms demanded more credit without obtaining it.	Capitalia Survey IX, X
Number of banks	Log of the number of banks with which the firm entertains credit relationships	Capitalia Survey IX, X
Incentives and tax relief	Dummy that take the value 1 if the firms received incentives and tax relief	Capitalia Survey IX

Labour productivity	Log of value added per worker	Aida and Capitalia Survey IX, X
Roi	Return on Investment	Aida
Roe	Return on Equity	Aida
Value added	Average of the firm's value added in the period 2001-2003	Aida
Age	Log of the number of years of firm from its foundation	Capitalia Survey IX, X
Employment	Log of the number of workers	Capitalia Survey IX, X
Firm size	Variable that take value 1 (11-20 workers); 2 (21-50); 3; (51-250); 4 (>250)	Capitalia Survey IX, X
Traditional sector	Dummy that takes the value 1 if the firm belongs to the traditional sector (Pavitt taxonomy); 0 otherwise	Capitalia Survey IX, X
Scale intensive sector	Dummy that takes the value 1 if the firm belongs to the scale intensive sector (Pavitt taxonomy); 0 otherwise	Capitalia Survey IX, X
ISO9000 certified	Dummy that takes the value 1 if the firm is ISO9000 certified; 0 otherwise	Capitalia Survey IX, X
Export	Dummy that takes the value 1 if the firm exported; 0 otherwise	Capitalia Survey IX, X
Consortium	Dummy that takes the value 1 if the firm belong to a consortium; 0 otherwise	Capitalia Survey IX, X
Group	Dummy that takes the value 1 if the firm belong to a group; 0 otherwise	Capitalia Survey IX, X
Research and Development	Dummy that takes the value 1 if the firm has incurreded expenditure on Research and development; 0 otherwise	Capitalia Survey IX, X
Science Based	Dummy that takes the value 1 if the firm belongs to the science based category (Pavitt taxonomy); 0 otherwise	Capitalia Survey IX, X
Located in an industrial district	Dummy that takes the value 1 if the firm is located in an industrial district; 0 otherwise	Capitalia Survey IX, X
South	Dummy that takes the value 1 if the firm is located in a region South of Rome, with Lazio excluded; 0 otherwise	Capitalia Survey IX
Northwest	Dummy that takes the value 1 if the firm is located in the regions Emilia Romagna, Veneto, Friuli, Trentino Alto Adige; 0 otherwise	Capitalia Survey IX, X
Northeast	Dummy that takes the value 1 if the firm is located in the regions Lombardia, Piemonte, Liguria, Valle d'aosta; 0 otherwise	Capitalia Survey IX, X
Leverage	Ratio of the financial debt to debt plus net capital	Aida

Source: author's elaboration

3.4. Descriptive statistics

Table 3 shows the descriptive statistics for the variables used in this analysis. Separately, the table also provides the summary statistics for the firms involved in green investment strategies.

Table 3: Descriptive statistics

		All observations					If highmed_ginv = 1				
Label	**Variable description**	**Obs.**	**1st percentile**	**99th percentile**	**Mean**	**S.D.**	**Obs.**	**1st percentile**	**99th percentile**	**Mean**	**S.D.**
high_med_ginv	Medium high attention towards green investments	8589	0	1	0.099	0.299	855	1	1	1	0
num_banks	Log of the number of banks involved in credit relation with the firm	8188	0	3.02	1.51	0.61	844	0	3.22	1.77	0.64
relat_lenght	Log of the number of years of relationship	7048	1.12	4.12	2.72	0.68	766	0	4.18	2.29	0.82
cred_ration	Firm credit rationed	7771	0	1	0.057	0.22	819	0	1	0.098	0.18
ReS	Research and Development	7984	0	1	0.61	0.48	855	0	1	0.59	0.49
Employment	Log of the number of workers	7441	2.34	7.26	3.52	1.08	795	2.88	7.24	4.11	0.92
Age	Log of the number of years from the firm's foundation	8334	1.33	5.58	3.18	0.64	834	1.46	5.58	3.68	0.74
Lab_prod	Log of the output per worker	8178	5.56	9.38	6.814	0.18	806	5.64	9.20	6.643	0.25
Consortium	Firm belong to a consortium	8549	0	1	0.042	0.11	852	0	1	0.06	0.17
Roi	Return on investment	8129	-8.26	38.40	11.31	7.58	799	-6.02	37.83	12.54	7.40
Leverage	Ratio of financial debt to financial debt plus net capital	8261	0.47	0.99	0.88	0.12	796	0.46	0.96	0.85	0.14
Ind_dist	Firm is located in an industrial district	8233	0	1	0.47	0.49	812	0	1	0.49	0.44
South	Firm is located in a region south of Rome (Lazio excluded)	8589	0	1	0.15	0.33	855	0	1	0.12	0.31
North-west	Firm is located in the regions Lombardia, Piemonte, Liguria, Valle d'aosta	8589	0	1	0.37	0.45	855	0	1	0.39	0.48
North-east	Firm is located in the regions Emilia Romagna, Veneto, Friuli, Trentino Alto Adige	8589	0	1	0.29	0.41	855	0	1	0.35	0.46
Trad_sect	Supplier-dominated (Pavitt)	8589	0	1	0.37	0.48	855	0	1	0.42	0.48
Hightech_sect	Science based sector (Pavitt)	8589	0	1	0.05	0.17	855	0	1	0.09	0.06
Scale_sect	Scale intensive sector (Pavitt)	8589	0	1	0.17	0.34	855	0	1	0.22	0.23

Source: author's elaboration

Looking at the whole sample, Table 3 reveals that, during the period of our investigation (2001-2006), on average, firms are in business for 24 years with a number of employees equal to 34[2]. More than 60% of firms are involved (directly or not) in R&D activities, and 5% of them belong to a science-based sector (Pavitt taxonomy); 29% are located in the more developed northeast of Italy. Of the total, only 4% adhere to a credit consortium, and around 6% of firms reported to be credit rationed (i.e. they demanded more credit without obtaining it). Regarding our key explanatory variable, the average length of the firm-bank credit relationship is 15 years and ranges from 3 years (1st percentile) to 62 (99th percentile), while the number of banks involved in a credit relationship with each firm is, on average, 5 and ranges from 1 to 20.

Looking at the right hand side of the above table, we can observe that about 10% of the firms identified green investment in equipment for pollution control as one of the most important investment strategies. It is evident, from the table above, that firms involved in environmental investments are bigger and older than the whole universe of firms, with an average of 61 employees and 39 years respectively. They are prevalently located in the northwest of the country (40%) and almost 10% of them stated that they were credit rationed. The sectorial allocation reveals that firms involved in supplier-dominated sectors (e.g. textile and agriculture) and scale intensive sectors (e.g. automotive sector), report a greater pursuit of environmental objectives in their investment strategies, respectively 48% and 23% on average. As to our key explanatory variables, data show that the average duration of the credit relationship between the main bank and firm decreases to 10 years, while the average number of banks with whom each firm has established a credit relationship increases to 6.

4. Empirical methodology

The question we address in this analysis is: does the length of a bank-firm relationship affect firms' attitude to invest in order to reduce their environmental impact?

To answer this question, we estimate a pooled probit model in which the probability that a firm i undertakes investment strategies aimed at lowering their environmental impact can be expressed as:

$$prob(y_i = 1) = \Phi(\alpha_1 x_1 + Z_1 \lambda_1 + \varepsilon_1 > 0) \qquad (1)$$

where Φ is the normal distribution function, y_i is a binary variable (that is equal to 1 if the firm undertakes environmental investments, 0 otherwise), x_1 is the length of the bank-firm credit relationship, Z_1 denotes a vector of controls, and ε_1 is the residual in the "green investment equation" (1).

The length of the firm-bank relationship represents our most relevant concern because it could be endogenous to the borrower's green investment choices. Basically, because of the relative newness of some environmental innovations, the classical financial sector often lacks adequate experience and information to efficiently appraise the technical and market performance of new green projects (Volz *et al*. 2015). In this vein, banks might be motivated to have a long relationship with a more profitable firm: accordingly, the increase of the probability to green invest could be interpreted as the cause rather than the effect of relationship lending. To deal with potential endogeneity of the regressors, we consider a set of firm specific controls including both economic and financial indicators (e.g. roi, leverage, etc.), and then some firm's

[2] For the variables expressed in logarithmic we took the antilog of the number reported in table.

qualitative characteristics (e.g. age, size, sector, etc.). Moreover, in order to check for possible endogeneity between dependent and independent variables, we employ the instrumental variable (IV) method. Therefore, we look for a variable that could affect the duration of the credit relationship between bank and firm, but does not influence the firm investment strategies; therefore, it is not correlated with the residual of the "green investment equation" (1).

As argued in Herrera and Minetti (2007), the length of the credit relationship could partially explain the strength of the relationship because of the presence of multi-credit relationships. Hence, a firm can borrow from other banks even if it has a privileged relationship with a particular bank. In this perspective, and following De Bonis *et al*. (2015), we check for a further robustness analysis accounting for the number of bank relationships a firm enjoys. We also present linear regression results.

5. Results

In Table 4 we report estimation results without accounting for endogeneity. Specifically, the first two columns list the value of the coefficients and standard errors for the probit model specification, while the other two columns present OLS estimated coefficients and standard errors. Geographical, industry and survey dummies are taken into account while estimating the models.

Table 4: Determinant of the firm's green investment strategies

Pr(highmed_ginv)	**OLS**		**Probit**	
	Coeff.	S.E.	Coeff.	S.E.
relat_lenght	.0715*	.0019	.0625*	.0321
cred_ration	- .2855***	.0002	- .3212**	.0004
ReS	.0923**	.0231	.0876***	.0228
Employment	.0002***	.0002	.0322*	.0212
Age	.0019***	.0031	.0218**	.0123
Lab_prod	0.3758*	.0245	0.4328**	.0449
Consortium	0.2123	.0002	0.1872*	.0009
Roi	.0425	.0412	.0216	.0543
Leverage	-.3675**	.0534	-.4123*	.0579
Ind_dist	.0324			
Geographical dummies	yes		yes	
Sectorial dummies	yes		yes	
Survey dummies	yes		yes	
R^2	0.09		0.02	
Observation	5732		5736	

Notes: Three, two and one star (*) means, respectively, a 99%, 95% and 90% level of significance. The dependent variable Pr(highmed_ginv) is a dummy variable, equal to 1 if the firm undertakes environmental investments, and 0 otherwise. All regressions include geographical, industry and survey dummies and a constant.

Source: own elaboration

In Table 4, regressions present the estimations for the determinants of the firm's green investment strategies. Our main interest is in the length of the firm–bank relationship. This variable is statistically significant at 10% of significance level for both model estimations. Therefore, the duration of the firm-bank relationship is associated with a higher probability of firms realizing green investments.

With regard to the firm-specific characteristics, as predictable, we found that bigger, older, more profitable and more innovative firms are more likely to invest in environmentally friendly equipment (the estimated coefficients of employment, labour productivity, age and R&D are positive and statistically significant), while credit constrained and indebted firms encounter more difficulties in pursuing green investment strategies.

As a further analysis we check for the presence of potential endogeneity issues. We account for the possible existence of endogeneity in the relationship between the choice of green investment strategies and the length of the firm–bank relationship. The idea is to find a variable which could influence the bank-firm relationship length but is not able to affect the choice of firms to green invest; therefore, is not correlated with the residuals of our equations. In particular, following Guiso *et al*. (2004), we take the regional banking structure in Italy in 1936 as a reliable exogenous factor since it is not correlated with the historical development of the Italian banking system (as it was due to regulation). In Table 5 we report the first stage regression for the length of the firm–bank relationship.

Table 5: Determinant of the relationship length

relat_lenght	**OLS**	
	Coeff.	S.E.
Saving banks	.0625**	.0321
Cred ration	- .3212*	.0019
ReS	.0536***	.0002
Employment	- .0022*	.0021
Age	.0218**	.0202
Lab prod	0.2328*	.0031
Consortium	0.1872*	.0245
Roi	.0216	.0002
Leverage	-.0415*	.0412
Geographical dummies	yes	
Sectorial dummies	yes	
Survey dummies	yes	
R^2	0.2566	
Observation	5087	
Wald test of excluded instruments, F-statistic	10.22**	

Notes: Three, two and one star (*) means, respectively, a 99%, 95% and 90% level of significance. The dependent variable relat_lenght is the Log of the number of years of relationship between firm and its main bank. All regressions include geographical, industry and survey dummies and F-statistic for the Wald test of excluded instrument.

Source: own elaboration

The null hypothesis of excluded instruments is rejected at 5% confidence level. The F-statistic exceeds the conventional critical values, therefore the identified instrument is relevant[3]. The presence of savings banks in the region in 1936 has a positive link with the length of the firm–bank relationship. The estimates obtained also suggest a strong and positive link between the R&D carried out by firm and the relationship length with its main bank. One possible interpretation of this finding is that a higher R&D increases the main bank's power and firm's switching costs. Thus, more R&D implies that firms have a lower incentive to change the main

[3] Staiger and Stock (1997: 557-586) proposed a «rule of thumb» when we have only one endogenous variable on the right-hand side of the equation. If the F-statistic is greater than ten, the instrument is strong.

bank. Table 6 presents the IV results, corresponding to our main estimation (i.e. *Pr(highmed_ginv))* instrumenting for our endogenous variable (i.e. *relat_lenght*).

Table 6. Determinant of the firm's green investment strategies: IV estimations				
Pr(highmed_ginv)	**IV**		**IV- Probit**	
	Coeff.	S.E.	Coeff.	S.E.
relat_lenght	.1722***	.0021	.1625***	.0128
cred_ration	- .1155***	.0004	- .1112**	.0009
ReS	.1322**	.0342	.1287***	.0173
Employment	.0021	.0005	.0654	.0279
Age	.0024***	.0032	.0412**	.0876
Lab_prod	0.3758	.0432	0.5328**	.0234
Consortium	0.2123***	.0023	0.1872*	.0008
Roi	.0428**	.0234	.0519**	.0278
Leverage	-.1674**	.0238	-.2124*	.0527
Geographical dummies	yes		yes	
Sectorial dummies	yes		yes	
Survey dummies	yes		yes	
Observation	5732		5736	
Wald test of excluded instruments, F-statistic	11.40**		10.23**	

Notes: Three, two and one star (*) means, respectively, a 99%, 95% and 90% level of significance. The dependent variable Pr(highmed_ginv) is a dummy variable, equal to 1 if the firm undertakes environmental investments, and 0 otherwise. All regressions include geographical, industry and survey dummies, F-statistic for the Wald test.

Source: own elaboration

The objective here is to demonstrate how results might change as we move from an OLS and Probit estimations to IV estimations. Although the sign of the coefficient of the main variable, (i.e. relationship length) does not change, the level of significance increase considerably, moving from 10% to 1%, when IV is employed for both model estimations. Moreover, the estimated coefficient increase to (0.1722) and, since we have instrumented for it, it represents now the causal effect. This result is consistent with the idea that long term relationship between banks and firms promotes a sense of trust among parties, which would have a positive effect on green investing. At a glance, with regard to firm-specific characteristics, the main determinants of green investment strategies are: credit constraints, age, R&D, return on investment, leverage and credit consortium. In particular, being part of a credit consortium has now a positive and significant relation with the probability for a firm to green invest. This is in line with the objects of the mutual guarantee consortia (MGC), a financial institution well developed in Italy, established to alleviate the difficulties that SMEs face when they ask for a bank loan.

In order to test whether the above-mentioned findings are heightened or attenuated by other relevant firm-specific characteristics, and following De Bonis *et al*. (2015), we check for the impact of the presence of multiple credit relationships. Indeed, a firm can borrow from different banks even if it could maintain a privileged relationship with a specific one. This entails that the duration of credit relationships could not fully capture the degree of informational closeness between the firm and its main bank. Table 5 confirms our previous findings on the impact of the credit relationship on the green investment strategies pursued by firms

Table 7: Determinant of the firm's green investment strategies		
Pr(highmed_ginv)	Probit	OLS

	Coeff.	S.E.	Coeff.	S.E.
relat_lenght	.0928*	.0023	.0967*	.0028
num_banks	-.0826**	.0012	.0754**	.0122
cred_ration	- .2215***	.0202	- .1112**	.2004
ReS	.0236*	.0235	.0367*	.0268
Employment	.0653	.0032	.0237*	.0421
Age	.0311**	.0123	.0226**	.0129
Lab_prod	0.0322	.0011	0.0265	.0021
Consortium	0.1150***	.0987	0.0641***	.0032
Roi	.0825*	.0412	.0212	.0544
Leverage	-.1834	.0855	-.1277	.0657
Ind_dist	-.0342*	.0012	-.0287	.0034
Geographical dummies	yes		yes	
Sectorial dummies	yes		yes	
Survey dummies	yes		yes	
R^2	0.09		0.07	
Observation	5453		5464	

Notes: Three, two and one star (*) means, respectively, a 99%, 95% and 90% level of significance. The dependent variable Pr(highmed_ginv) is a dummy variable equal to 1 if the firm undertakes environmental investments, and 0 otherwise. All regressions include geographical, industry and survey dummies and a constant.

Source: own elaboration

Specifically, the number of banks is statistically significant in the Probit estimations, and has a negative effect on green investments. One possible interpretation is that green investment is often hampered because potential investors struggle with imperfect information (Volz *et al*. 2015). As the number of financing banks increases, the information tightness between firm and banks, decreases. Therefore, the presence of a multiple credit relationship could concretely hinder a firm's investments towards environmental innovations.

4. Conclusions

Using data on Italian manufacturing firms, this study addressed the role of the duration of the credit relationship between the firm and its main bank in affecting the decision of the firm to invest in environmentally friendly equipment.

Estimation results show that the duration of the firm-bank relationship is associated with a higher probability of a firm's green investment strategies. Conversely, the presence of a multiple credit relationship could concretely hinder firm's investments towards environmental innovations. With regard to the firm-specific characteristics, bigger, older, more profitable and more innovative firms are more likely to invest in environmentally friendly equipment, while credit constrained and indebted firms encounter more difficulties in pursuing green investment strategies. Overall, these findings seem to endorse the idea concerning the importance of the relationship lending on the adoption of environmental innovations.

The main limitation of this paper rests on restricted and dated timeframe of available data. Indeed, it does not allow investigating whether the recent financial crisis, that heavily impacted the entire bank system and, because of the credit crunch, have affected the firm-bank relationship. Moreover, the cross-sectional and survey nature of our data does not permit generalizing our findings.

Further lines of research could aim at extending our investigation by focusing on more representative longitudinal data, which would better account for more recent exogenous shocks (e.g. financial crisis).

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