Research in International Business and Finance 69 (2024) 102222

Contents lists available at ScienceDirect

Research in International Business and Finance

journal homepage: www.elsevier.com/locate/ribaf

Does gender matter in financing SMEs in green industry?

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ARTICLE INFO

JEL Classification codes:
F64
G21
G32
G34

Keywords:
Gender diversity
Green
SMEs
Bank credit
Cost of credit

ABSTRACT

This study explores gender differentiation in access to credit which penalizes Italian female-led green SMEs compared to male-led ones. We carry out a panel analysis with 184,425 observations, of which 5855 refer to green firms, observing how the percentage of women among directors and managers (PWDM) affects access to bank credit and its costs. Our results demonstrate that green SMEs show different levels of financial debt compared to non-green ones depending on the PWDM. Our paper contributes to the literature in three ways. First, we investigate whether women-led green SMEs show different demands for financial credit in terms of amounts borrowed and mix between long/short-term bank credit; second, whether this potentially different credit demand is associated with coherent or incoherent effects on the cost of credit; and third, whether the credit demand of women-led green SMEs depends on the PWDM in the company.

1. Introduction

Since the 2008 crisis, the demand for a new economic and sustainable recovery has been recognized as increasingly important, and European Union (EU) policy places great emphasis on green economic growth (European Commission, 2018, 2019). Promoting green innovation will have big impacts on many sectors (agriculture, transport, extractive industries, manufacturing, construction, services, etc.) and on all sorts of firms, particularly on Small and Medium-Sized Enterprises (SMEs).

Environmental, Social, and Governance (ESG) disclosure refers to the practice of companies disclosing information about their ESG practices to their stakeholders. While ESG disclosure is often associated with larger companies, it is becoming increasingly important for SMEs as well (Yu et al., 2020).

SMEs play a significant role in the global economy, and their environmental and social impacts can be substantial. Indeed, in 2021, 99.8% of all enterprises in the EU-27 non-financial business sector were SMEs and they generated more than 52% of value-added and about 64% of employment (European Commission, 2022a). To improve their reputation on the credit market and among stakeholders, like customers, investors, and employees, SMEs need to disclose their ESG practices.

Furthermore, SMEs are highly sensitive to external threats, such as climate change, and their credit risk is recognized to be higher than large and established firms (Alam et al., 2022b). In this context, although the presence of women among directors and officers of big firms seems to contribute to a company's ESG performance (Cathcart et al., 2020), women-led SMEs seem to have greater difficulties in accessing external financing sources than men-led ones (Basiglio et al., 2023), and this might delay and/or reduce the investments necessary for green growth.

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https://doi.org/10.1016/j.ribaf.2024.102222
Received 28 June 2023; Received in revised form 13 November 2023; Accepted 5 January 2024
Available online 11 January 2024

This paper aims to investigate the relationship between women-led green SMEs and access to finance and the link between the women-led green SMEs and the cost of credit. We first investigate whether financial credit requirements of women-led green SMEs are different from those of men-led ones in terms of amounts borrowed and combination of long/short-term bank credit. We then investigate whether this potentially different credit demand is associated with coherent or incoherent effects on the cost of credit; and third, whether it depends on the percentage of women among directors and managers (PWDM) in the company.

The study focuses on Italian manufacturing SMEs, for the following reasons: a) in Italy the shares of employment and value-added generated by SMEs are particularly high, 75.9% and 63.4% respectively,[1] compared to the EU average; b) manufacturing firms, having a greater concentration of tangible assets (with high liquidation value) are supposed to have a better access to debt financing (both trade and bank credit) or lower information asymmetries than non-manufacturing firms (Van Der Wijst and Thurik, 1993; Jordan et al., 1998; La Rocca et al., 2010); and c) manufacturing firms are also chosen because sectors such as agriculture, or industries not sufficiently clearly defined, such as services for example, may be specifically 'green'.

This paper makes a significant contribution to the existing literature. First, we examine the relationship between firm characteristics and ESG performance in the context of access to finance for SMEs (Cambrea et al., 2023; Khan, 2022; Kyaw et al., 2022; Naciti, 2019) by investigating the extent to which SME ESG performance affects their access to finance. The study thus sheds light on the importance of ESG considerations for SMEs in securing the funding they need to grow and operate sustainably. Secondly, our research contributes to the literature on access to finance (Constantinidis et al., 2006; Bellucci et al., 2010; Alesina et al., 2013; Andriamahery and Qamruzzaman, 2022; Hewa-Wellalage et al., 2022) by specifically examining the impact of female representation on access to finance for green SMEs, particularly long-term bank credit. We investigate whether the PWDM in these SMEs has a positive effect on their ability to secure financing for their sustainable initiatives. And since we find a curvilinear relationship (inverted *U*-shape) between Long-term bank credit and PWDM, our results are quite different from other more usual ones found in the literature and oriented to support the "too-much-of-a-good-thing" (TMGT) effect (Pierce and Aguinis, 2013)[2] as highlighted, moreover, in a recent study on board gender diversity on a firm's environmental performance in a sample of firms from the 2020 Fortune 1000 Index over the 2004–2020 period (Dang et al., 2023).

Our research findings indicate that the presence of gender differentiation in access to finance for green SMEs depends on the PWDM. We recommend that financial intermediaries incorporate "green" parameters into the creditworthiness evaluation of Italian SMEs, recognizing the crucial role that women play in companies' managerial decisions and the resulting impact on financial efficiency, economic performance, and asset quality. These findings highlight the need for a more gender-inclusive approach to financing and underscore the potential benefits of promoting gender diversity in SME leadership. Our research thus provides a closer understanding of the interplay between gender, sustainability, and access to finance for SMEs, which can inform policies and initiatives aimed at promoting more equitable and sustainable economic growth.

This paper presents valuable insights for regulators and policymakers regarding the crucial role of ESG considerations in securing financing for sustainable business initiatives in SMEs. It highlights the benefits of adopting ESG practices which can help SMEs better understand how to attract financing and achieve sustainable growth and assist lenders in assessing the potential risks and returns of financing sustainable businesses. It also draws attention to the gender gap in access to finance for sustainable businesses, highlighting the importance of promoting gender diversity in SME leadership. Our findings can inform policies and initiatives aimed at increasing access to finance for female-led green SMEs, promoting a more equitable and sustainable business landscape. Ultimately, this research contributes to a deeper understanding of how SMEs can pursue sustainable growth, and the critical role of regulators and policymakers in supporting them.

The rest of the paper is organized as follows. Section 2 discusses the literature review and hypothesis development. Section 3 describes our sample, variables, and methodology. Section 4 contains the empirical results. Section 5 presents further analysis and Section 6 discusses and concludes the paper.

2. Literature review and hypotheses development

Recent studies demonstrate that combating environmental degradation by fostering green investments in business is critical to protecting the environment by pursuing the goal of a new stable economic growth and is also significant in terms of reducing firm operational risk level (Bouslah et al., 2018; Godfrey et al., 2009, Muhammad et al., 2015, Farza et al., 2021), and facilitating access to financial markets (Jo and Na, 2012; Zeidan et al., 2015), and to bank credit (Bauer and Hann, 2010; Goss and Roberts, 2011; Magnanelli and Izzo, 2017; Sharfman and Fernando, 2008). These findings appear to hold for green SMEs. Green firms seem to have a lower probability of liquidity shortfall and bankruptcy, a higher level of reputation, which facilitates the improvement of innovation processes (Huang et al., 2020; Hong and Liskovich, 2015), and the ability to raise levels of trust among stakeholders including employees, suppliers, and clients (Lins et al., 2017, 2019). These findings are encouraging, but a wider area of literature shows that SMEs in fact have a higher probability of failure than bigger companies, particularly in case of external crises (Berger and Udell, 1998; Davidson and Gordon, 2016; Doern et al., 2019; Herbane, 2013, 2019; May and Lixl, 2019; Beck and Demirguc-Kunt, 2006; Juergensen et al., 2020) and this may have a negative impact on the ability to raise financial resources to finance the investments necessary for the energy transition. In the short period, the effects of green innovation can be uncertain, due to the difficulty of compliance with complex

[1] Source: European Commission (2022b).

[2] The TMGT effect occurs when a beneficial input variable reaches a maximum or minimum point beyond which the desired effect ceases to be positive and becomes null or even negative.

environmental regulations (Levi and Newton, 2016) or to the variability of energy prices (Abeberese, 2017), and SMEs may suffer a reduction in profitability which further downgrades their solvency profiles (Goss and Roberts, 2011). Much literature finds that the financial constraints of SMEs are higher for women-led than men-led SMEs, and the consequent greater difficulties in accessing finance are considered an obstacle to business investments and growth (Coleman et al., 2019). The literature on gender differentiation in access to credit for female SME owners is abundant, with a considerable number of studies examining the behaviour of banks and financial institutions in providing loans to male or female SME owners. However, the evidence in the literature on the existence of a gender bias in accessing credit is quite complex. Some studies, (Constantinidis et al., 2006; Bellucci et al., 2010; Alesina et al., 2013; Andriamahery and Qamruzzaman, 2022; Hewa-Wellalage et al., 2022), provide evidence of gender bias in the form of higher interest rates, difficulty in accessing funding from traditional channels and lower credit availability for women-owned SMEs. The evidence of a gender gap seems particularly clear during periods of financial uncertainty (Hewa-Wellalage et al., 2022; Cowling et al., 2020) due to the tendency of banks to adopt a more cautious approach towards allocating capital in uncertain times. There appear to be various reasons for this, and they seem to depend, first, on economic variables such as the industry, size, age and ownership structure of the company, second, on human variables relating to the preferences, values and perceptions of women entrepreneurs, and third on culture and social variables such as stereotypes and work-family conflicts).

Referring to economic variables, women appear to be more involved in the management of SMEs and micro-business in traditional low-growth industries (traditional services and retail) or with low-growth profile or higher risk. These factors could also explain the lower capital invested in start-ups and SMEs by women entrepreneurs compared to their male counterparts (Riding and Swift, 1990; Orhan, 2001; Coleman, 2002, Heidrik and Nicol, 2002, Verheul and Thurik, 2001, Treichel and Scoot, 2006, Alesina et al., 2013 on Italian SMEs, Pham and Talavera, 2018), the fact that women-owned companies tend to be smaller (Stefani and Vacca, 2015) and in more general terms the lower and different quality (in terms of mix between long-short term and bank/trade) of credit demand of women led SMEs than male-led ones (OECD 2000, Robb and Wolken, 2002). All these variables can also produce a vicious circle where the size, growth rates and risk profiles of the female-led SMEs might limit and delay the access to bank credit which, in turn, could end up delaying and limiting growth prospects of female-led SMEs.

Other studies (Wellalage and Locke, 2017 and Galli et al., 2020) have found no significant male-female discrimination in access to credit when controlling for firm characteristics. Therefore, lower levels of financial debt of women-led SMEs compared to those led by men could be explained by the importance of human variables such as the human capital (work experience, functional experience and education), the social capital (social and business relationships), the financial capital and the personal cognitions and objectives (Gatewood et al., 2003).

The counterproof is represented by the fact when educational level is included in the analysis as an indipendent variable, many of gender differences in access to credit tend to disappear (Coleman, 2000, 2002 and 2004). In this sense, some studies have demonstrated the relevance of these discriminating factors in the demand for credit by female-led SMEs and in particular attributable to lower levels of education, of financial, managerial and entrepreneurial competence (OECD, 2000, Robb and Wolken, 2002), and the lack of technical and managerial experience (Boden and Nucci, 2000). According to these theories, lower levels of financial debt of women-led SMEs compared to those led by men could be explained by a greater aversion to risk and by a greater scepticism of women on their ability to raise funds (Carter et al., 2015; Chaudhuri at al, 2018; Croson and Gneezy, 2009; Malmström et al., 2017; Ongena and Popov, 2016; Poczter and Shapsis, 2018; Roper and Scott, 2009; Treichel-Zimmerman and Scott, 2006), so that female firms could appear as discouraged borrowers (Freel et al., 2012; Kalnins and Williams, 2014; Kon and Storey, 2003; Moro et al., 2017).

Finally, further variables that can influence both the growth trend of the women-led businesses and the demand for financial debt are referable to culture and social variables which include gender-based stereotypes (Godwin et al., 2006), lack of opportunities and of infrastructural support, work-family conflicts (Panda and Dash, 2014, 2016).

Focusing on the literature on gender differences in access to credit for green SMEs, we observe that it is a relatively new field, with a limited number of studies conducted in recent years. However, a few studies have investigated the relationship between sustainable factors, firm performance, and access to credit, and some of these studies have also considered the role of gender. Some have shown that the presence of female directors positively affects ESG performance and corporate emission reduction (Cambrea et al., 2023; Kyaw et al., 2022). Additionally, diverse board composition is positively associated with sustainability performance (Naciti, 2019) and some studies (Cambrea et al., 2023) highlight the minimum number of female directors (three) to obtain better ESG performance. Other studies (Kyaw et al., 2022) underline that female board representation matters: firms with gender-diverse boards reduce the probability of environmental emission by 9% more than their industry peers and the effect of relaxing financial constraints on innovation (and green investments are part of innovation) seems to be significantly higher in women-led SMEs (Palomo et al., 2021). On one hand, these results seem to further confirm that gender diversity has a positive impact on the innovativeness of firms (Østergaard et al., 2011; Ritter-Hayashi et al., 2016; Bauweraerts et al., 2022; Alam et al., 2022a), but on the other hand, they suggest that gender bias persists because environmental assurances impact access to finance. This impact is sensitive to the gender composition of firm leadership with male-led firms being more likely to access loans than female-led firms (Zhang et al., 2022).

This study concentrates on Italian manufacturing SMEs. Because SMEs do not often have an ESG rating and because, moreover, there are significant divergences in the ESG ratings attributed to the same companies by the five most important rating agencies (Berg et al., 2019), we identify as “green” those SMEs belonging to industries characterized by a particularly high green component according to independent research (Politecnico di Milano and Camera di Commercio di Milano, 2012). Finally, in the light of our research objectives, we focus on women-led Italian SMEs on the basis of the percentage of women directors and managers (PWDM). Our research hypotheses are the following:

Hypothesis 1. *Women-led green SMEs show less demand for financial credit than average, and this demand decreases as the PWDM*

increases.

Hypothesis 2. *Women-led green SMEs pay credit costs that are higher than average, and credit costs increase as the PWDM increases.*

3. Research design

3.1. Sample

The main sources of data are the AIDA Bureau Van Dijk database (AIDA), containing all financial and governance data of Italian SMEs, and ISTAT, the Italian National Institute of Statistics, a public research organization, which is the main producer of official statistics in Italy. Our final sample includes all companies for which data are available for the period 2017–2021: it consists of 36,885 SMEs.

The SMEs included in our sample belong to an "industry in the strict sense". In the ATECO 2007 code, the classification of economic activity used by ISTAT, these are found in Sections B-E. Section B is "Extraction of minerals from quarries and mines", Section C is "Manufacturing activities", and Sections D and E are "Supply of electricity, gas, steam and air conditioning" and "Supply of water; sewer networks, activities of waste management and remediation". Following the study by the Politecnico di Milano and Camera di Commercio di Milano (2012), we selected industries that have an important green component, among those in the industry "in the strict sense", using the following ATECO 2007 codes: Collection, Reuse, Recycling of Waste (Codes 38.11.00, 38.12.00, 38.21.01, 38.21.09, 38.22.00, 38.31.10, 38.32.10, 38.32.20, 38.32.30 and 39.00.01), Efficiency of water systems (Code 36.00.00), Planning, Reclamation and of the territory (Code 30.00.09), Wastewater treatment (Code 37.00.00), Energy Storage (Code 27.20.00). We, thus, use a definition of green SMEs based on the firm industry (and not on some firm-specific characteristics). Table 1 shows the distribution of observations by type of sector of firms included in the sample (i.e., green and non-green).

3.2. Descriptive statistics and univariate analysis

Table 2 presents descriptive statistics for the total sample and the sub-samples of green and non-green SMEs. We also reported the t-test for the significance of the differences. Green SMEs are younger, and bigger, and show lower Short-term bank credit than non-green ones. Although green firms receive less Short-term (and substantially the same Long-term) bank credit than non-green ones, there are no significant differences in terms of Financial expenses. Moreover, green SMEs show higher Accounts payable, Accounts receivable, Fixed investments, ROA, and ROA volatility than non-green companies. Finally, the two groups do not show statistically significant differences for the variables Female and Equity/Total Assets. These results obviously also depend on the composition of the sample being investigated and, in particular, on the criterion adopted to identify green companies.

Tables 3 and 4 report the Pearson correlation matrix for the sub-sample of green and non-green SMEs, respectively. We note some interesting results. For green firms, the variable Female is negatively correlated with both Long-term and Short-term bank credit, and Financial expenses, while for non-green SMEs, Female is positively correlated with Short-term bank credit, although the coefficient is very low. For both green and non-green companies, older and bigger companies have more bank credit and pay less financial interest. A positive correlation exists between Age and Female, Size and Female and Size and Age but the coefficient is higher for green companies. For green firms, we find a higher negative correlation between Account payable and receivable and Long-term bank credit, and a higher negative correlation between Account payable and Short-term bank credit. Fixed investments increase as bank credit increases, but Fixed investments are negatively correlated with Female in the case of green SMEs and positively correlated in the case of non-green SMEs. The correlation between ROA and Female is negative for non-green firms and, to a greater extent, for green companies. The volatility of ROA reduces granting of bank credit, above all Short-term bank credit for green SMEs. Finally, the Equity-to-total assets ratio shows a negative correlation with Short-term bank credit, above all for green firms. Appendix A (Table A.1) reports the correlation matrix for the total sample.

3.3. Methodology

In our empirical analysis, we use a panel data approach. The equations include the following three dependent variables: "Long-term bank credit", i.e., debts due over 12 months, divided by total assets (Eq. 1); Short-term bank credit", i.e., the debt due within 12 months, divided by total assets (Eq. 2); "Financial expenses", i.e., financial interest on loans from companies to financial intermediaries and on bonds issued, divided by total assets (Eq. 3). As independent variables, we consider the dummy variable "Green" equal to 1 when a firm is green following the criteria defined in Section 3.1, and 0 otherwise; the variable "Female", which is the expression of PWDM of the SMEs considered; the impact of trade payables and receivables, in both cases divided by total assets; the amount of fixed

Table 1
Observations by type of sector.

Type of sector	No. of observations	% of total
Green	5855	3.17
Non-green	178,570	96.83
Total	**184,425**	**100**

Table 2
Descriptive statistics and difference in means.

	Full Sample		Green		Non-green		T-test Green vs. Non-green	
Variable	Mean	Std	Mean	Std	Mean	Std	Δ	t-test
Panel A: Dependent variables								
Long-term bank credit	0.077	0.119	0.079	0.002	0.077	0.0003	0.002	(0.917)
Short-term bank credit	0.080	0.112	0.065	0.0015	0.081	0.0003	-0.016***	(−9.078)
Financial expenses	0.007	0.019	0.007	0.0001	0.007	0.00005	-0.0004	(1.567)
Panel B: Variable of interest								
Female	0.037	0.136	0.035	0.002	0.038	0.0004	-0.003	(−1.418)
Panel C: SMEs specific variables								
Age	30	15.930	24.396	0.195	30.185	0.041	-5.789***	(−25.173)
Size	8.614	1.122	8.689	0.018	8.611	0.003	0.078***	(4.623)
Account payable	0.179	0.145	0.196	0.002	0.179	0.0004	0.018***	(7.976)
Account receivable	0.254	0.181	0.285	0.003	0.253	0.0005	0.032***	(11.467)
Fixed investments	0.310	0.205	0.378	0.003	0.308	0.0005	0.070***	(22.510)
ROA	0.055	0.118	0.058	0.002	0.054	0.0003	0.004***	(2.281)
σROA	0.053	0.074	0.061	0.0009	0.053	0.0002	0.007***	(7.0088)
Equity/Total Assets	0.300	8.942	0.320	0.003	0.299	0.024	0.021	(0.152)

The table reports the summary statics for the full sample, green and non-green SMEs. In the last column of the table, we perform t-tests on the equality of means. *, **, *** indicate 10%, 5% and 1% significance levels, respectively.

investments divided by total assets; Return on Asset (ROA) and "σROA" (i.e., ROA volatility); "Creditboom", i.e., the trend of bank loans granted to firms measured as a year-over-year percentage change. (Data are sourced from the Bank of Italy); and the dummy variables "North" and "South" equal to 1 when a firm is located in the North or in the South of Italy, respectively, and 0 otherwise. The main equations of the models are the following:

$$\text{Long-term bank credit}_{it} = \beta_0 + \beta_1 \text{Green}_i + \beta_2\, \text{Female}_{it} + \beta_3\, \text{Short-term bank credit}_{it} + \beta_4 \text{Trade credit}_{it} + \beta_5 \text{Account receivable}_{it} + \beta_6 \text{Fixed investments}_{it} + \beta_7 \text{ROA}_{it} + \beta_8 \sigma\text{ROA}_{it} + \beta_9 \text{North}_i + \beta_{10} \text{South}_i + \text{year dummies} + \mu_i + \varepsilon_i \quad \text{t(1)}$$

$$\text{Short-term bank credit}_{it} = \beta_0 + \beta_1 \text{Green}_i + \beta_2\, \text{Female}_{it} + \beta_3 \text{Trade credit}_{it} + \beta_4 \text{Account receivable}_{it} + \beta_5 \text{ROA}_{it} + \beta_6 \sigma\text{ROA}_{it} + \beta_7 \text{North}_i + \beta_8 \text{South}_i + \text{year dummies} + \mu_i + \varepsilon_{it} \quad (2)$$

$$\text{Financial expenses}_{it} = \beta_0 + \beta_1 \text{Green}_i + \beta_2\, \text{Female}_{it} + \beta_3 \text{Short-term bank credit}_{it} + \beta_4 \text{Long-term bank credit}_{it} + \beta_5 \sigma\text{ROA}_{it} + \beta_6 \text{Creditboom} + \beta_7 \text{North}_i + \beta_8 \text{South}_i + \text{year dummies} + \mu_i + \varepsilon_i \quad \text{t(3)}$$

where i is firm, and t is the time period; μ_i represents the firm-specific effects, and ε_{it} represents the measurement errors. We estimate Eqs. (1), (2) and (3) using estimators of fixed and random effects to take the individual effects into account (μ_i), with clustered standard errors at the firm level. The Hausman test is performed to ascertain whether the individual effects are fixed or random. If the null hypothesis is rejected, the correlation between the independent variables and the individual unobservable effects does not exist and the random effects model is considered a good estimator. The Hausman test results suggest that random effect models are appropriate for our dataset. However, the variable Green is time-invariant and the fixed-effects estimator does not allow to obtain coefficients of this kind of variables (i.e., time-invariant); we thus use the random effects estimator.

4. Results

4.1. Regression results on the overall sample

Table 5, in columns (1), (2), and (3), reports the results for the panel regression related to Equation 1 in which the dependent variable is the Long-term bank credit. Model 1 shows that green SMEs are more financially constrained than non-green SMEs when it comes to accessing Long-term bank credit. Our analysis also highlights a convex quadratic relationship between Long-term bank credit and the percentage of women among directors and managers (PWDM), as evidenced by the statistical significance of the coefficient on Female and the square of Female. Specifically, our findings indicate that an increase in PWDM is associated with a reduction in Long-term bank credit, but the relationship between Long-term debt and Female changes its sign for a certain PWDM, where the negative relationship becomes positive. Using the results of Model 1, we calculate the turning point of the relationship between Long-term bank credit and Female. Fig. 1 shows the estimated Long-term bank credit resulting from increasing the percentage of females in SMEs. It suggests a negative relationship between Long-term bank credit and the percentage of females up to a threshold of 41.9%, beyond which a positive relationship is observed. This threshold is relatively high considering that the average percentage of females as managers and directors in our sample of Italian SMEs was approximately 3.7% (see Table 2).

Moreover, Model 1 in Table 5 reveals that Long-term bank credit decreases when Accounts receivable, ROA, and especially Account payable, Short-term bank credit, and ROA volatility increase. These results offer valuable insights into the financial constraints faced by green SMEs and the impact of gender diversity on access to long-term bank credit. Policymakers, financial intermediaries, and other stakeholders can use this information to design and implement initiatives that promote more equitable and sustainable financing for

Table 3
Correlation matrix - Green SMEs.

	Long-term bank credit	Short-term bank credit	Financial expenses	Female	Age	Size	Account payable	Account receivable	Fixed investments	ROA	σROA	Equity/Total Assets
Long-term bank credit	1											
Short-term bank credit	0.001	1										
Financial expenses	0.145 *	0.278 *	1									
Female	-0.055 *	-0.029 *	-0.053 *	1								
Age	0.041 *	0.097 *	-0.029 *	0.089 *	1							
Size	0.058 *	0.032 *	-0.008	0.170 *	0.232 *	1						
Account payable	-0.333 *	-0.171 *	0.031 *	0.072 *	-0.083 *	0.144 *	1					
Account receivable	-0.236 *	0.022	0.014	0.024	-0.036 *	0.133 *	0.494 *	1				
Fixed investments	0.396 *	0.138 *	0.129 *	-0.052 *	0.065 *	0.121 *	-0.270 *	-0.474 *	1			
ROA	0.006	-0.085 *	-0.096 *	-0.047 *	0.001	0.069 *	-0.055 *	0.054 *	-0.130 *	1		
σROA	-0.081 *	-0.104 *	0.021	0.016	-0.153 *	-0.128 *	-0.014	-0.062 *	-0.032 *	-0.061 *	1	
Equity/Total Assets	-0.018	-0.173 *	-0.307 *	0.019	0.203 *	0.053 *	-0.345	-0.218 *	0.052 *	0.328 *	-0.048 *	1

The table reports the correlation matrix for the green SMEs. * indicates significance levels at 5%.

Table 4
Correlation matrix - Non-green SMEs.

	Long-term bank credit	Short-term bank credit	Financial expenses	Female	Age	Size	Account payable	Account receivable	Fixed investments	ROA	σROA	Equity/Total Assets
Long-term bank credit	1											
Short-term bank credit	-0.023 *	1										
Financial expenses	0.114 *	0.243 *	1									
Female	-0.016 *	0.008 *	-0.009 *	1								
Age	0.015 *	0.049 *	-0.031 *	0.049 *	1							
Size	0.027 *	0.030 *	-0.081 *	0.145 *	0.195*	1						
Account payable	-0.267 *	-0.117 *	0.001	0.019 *	-0.125*	0.115*	1					
Account receivable	-0.213 *	0.087 *	0.008 *	0.005	-0.066*	0.052*	0.498*	1				
Fixed investments	0.375 *	0.109 *	0.040 *	0.012 *	0.114*	0.062*	-0.264*	-0.383*	1			
ROA	-0.104 *	-0.179 *	-0.072 *	-0.023 *	-0.038*	0.039*	-0.009*	0.088*	-0.153*	1		
σROA	-0.095 *	-0.103 *	0.103 *	0.020 *	-0.103*	-0.113*	-0.027*	-0.056*	-0.091*	-0.102*	1	
Equity/Total Assets	-0.131 *	-0.279 *	-0.410 *	0.001	0.011*	0.052*	-0.003	0.003	0.011*	0.186*	-0.279*	1

The table reports the correlation matrix for the non-green SMEs. * indicates significance levels at 5%.

Table 5
Panel regression for the overall sample.

	Long-term bank credit			Short-term bank credit			Financial expenses		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Green	-0.018 ***	-0.017 ***	-0.017 ***	-0.041 ***	-0.040 ***	-0.040 ***	0.001 ***	0.001 ***	0.001 ***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.0003)	(0.0003)	(0.0003)
Female	-0.066 ***	-0.028 ***	-0.082 ***	0.033 **	0.008	0.024 **	-0.006 ***	-0.002 ***	0.0002
	(0.019)	(0.008)	(0.012)	(0.019)	(0.008)	(0.010)	(0.001)	(0.0004)	(0.0006)
$Female^2$	0.054 **			-0.037			0.006 ***		
	(0.026)			(0.026)			(0.001)		
Green*Female		-0.041	-0.036		-0.033	-0.031		-0.001	-0.001
		(0.046)	(0.045)		(0.046)	(0.046)		(0.002)	(0.002)
Short-term bank credit	-0.423 ***	-0.423 ***	-0.428 ***				0.015 ***	0.015 ***	0.015 ***
	(0.003)	(0.003)	(0.003)				(0.0002)	(0.0002)	(0.0002)
Long-term bank credit							0.007 ***	0.007 ***	0.007 ***
							(0.002)	(0.0002)	(0.0002)
Account payable	-0.601 ***	-0.601 ***	-0.606 ***	-0.294 ***	-0.293 ***	-0.290 ***			
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)			
Short-term bank credit *Female			0.125 ***						-0.008 ***
			(0.022)						(0.002)
Long-term bank credit *Female									-0.001
									(0.002)
Account payable*Female			0.139 ***			-0.079 **			
			(0.038)			(0.038)			
Account receivable	-0.014 ***	-0.014 ***	-0.014 ***	0.233 ***	0.233 ***	0.233 ***			
	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)			
Fixed investments	0.226 ***	0.226 ***	0.226 ***						
	(0.004)	(0.004)	(0.004)						
ROA	-0.208 ***	-0.208 ***	-0.208 ***	-0.129 ***	-0.129 ***	-0.129 ***			
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)			
σROA	-0.388 ***	-0.387 ***	-0.387 ***	-0.304 ***	-0.304 ***	-0.304 ***	0.005 ***	0.005 ***	0.005 ***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.001)	(0.001)	(0.001)
Creditboom							-0.038 ***	-0.038 ***	-0.038 ***
							(0.003)	(0.003)	(0.002)
North	-0.031 ***	-0.031 ***	-0.031 ***	-0.019 ***	-0.019 ***	-0.019 ***	-0.001 ***	-0.001 ***	-0.001 ***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.0001)	(0.0001)	(0.0001)
South	-0.010 **	-0.009 **	-0.009 **	-0.025 ***	-0.025 ***	-0.025 ***	0.001 ***	0.001 ***	0.001 ***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.0002)	(0.0002)	(0.0002)
Constant	0.398 ***	0.398 ***	0.399 ***	0.241 ***	0.241 ***	0.241 ***	0.002 ***	0.002 ***	0.002 ***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.0001)	(0.0001)	(0.0001)
Year dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
R^2	0.386	0.387	0.387	0.040	0.040	0.040	0.150	0.150	0.150

Table 5 presents the results for panel regression obtained through Eqs. (1), (2), and (3). In columns (1), (2), and (3) the dependent variable is Long-term bank credit; in columns (4), (5), and (6) the dependent variable is Short-term bank credit; in columns (7), (8), and (9) the dependent variable is Financial expenses. The standard errors are in parentheses. R^2 reported is within R^2. *, **, *** indicate the level of significance at 0.1, 0.05, and 0.01, respectively.

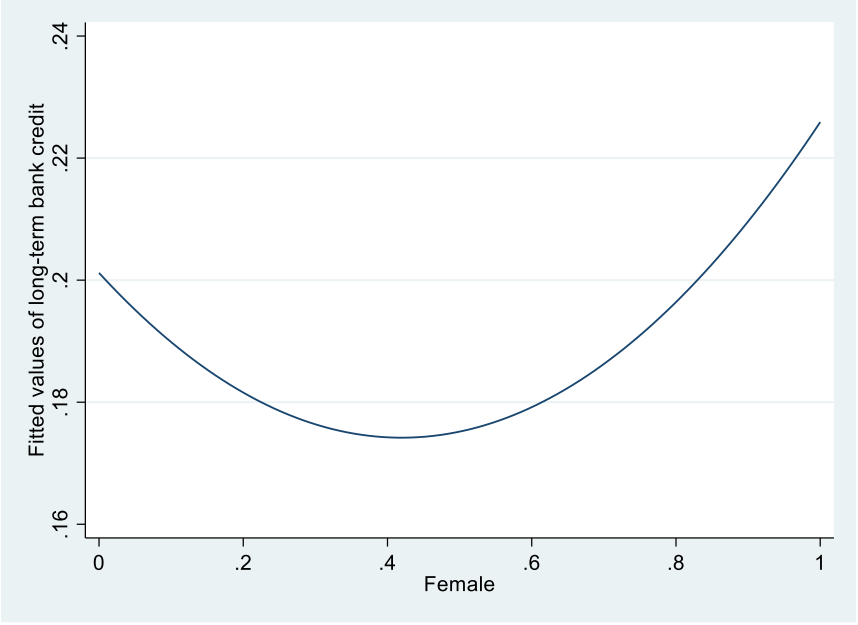

Fig. 1. Quadratic prediction of long-term bank credit using Female and Female.
Note: Fig. 1 is based on estimates of Table 5 Model 1 (column (1). It shows the change in the long-term bank credit for an increase in the percentage of Females.

SMEs.

In Model 2, we include the interaction term between Green and Female (Green*Female), but the results show that it is not statistically significant. This suggests that considering each variable separately is more informative than examining their interaction. The findings in Model 1 still hold true in Model 2.

In Model 3, we introduce two more interaction terms: Short-term bank credit and Female (Short-term bank credit*Female) and Account payable and Female (Account payable*Female). The coefficients for these interaction terms are positive and significant,

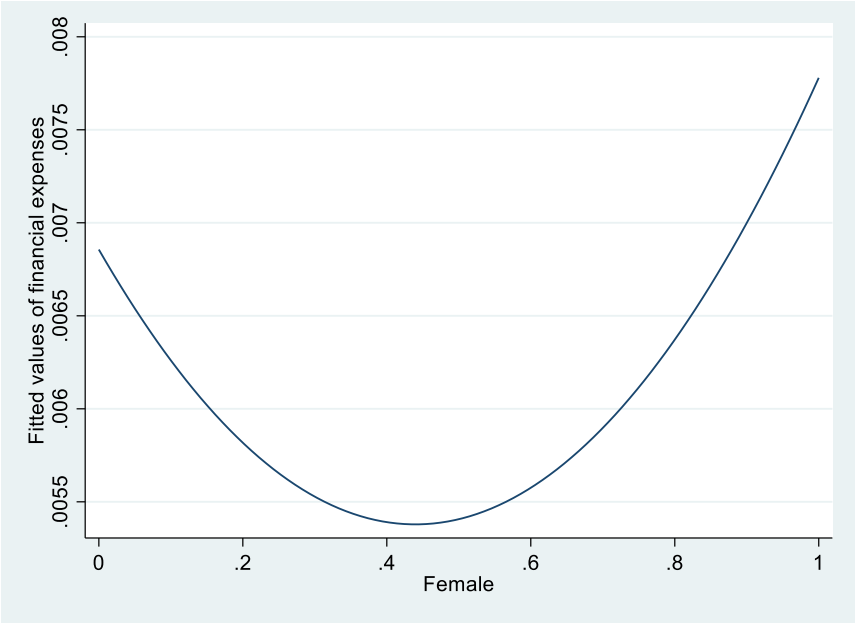

Fig. 2. Quadratic prediction of Financial expenses using Female and Female^2.
Note: Fig. 2 is based on estimates of Table 5 Model 1 (column (7). It shows the change in the financial expenses for an increase in the percentage of Females.

indicating that the PWDM can help mitigate the negative impact of short-term bank credit and trade credit on long-term bank credit. This means that as the percentage of women in leadership positions increases, the reduction in long-term bank debt is less severe when short-term bank credit and trade credit are higher. The results for the other variables are consistent with those of Models 1 and 2.

Overall, our findings suggest that the PWDM is an important factor in determining access to Long-term bank credit for green SMEs in Italy. Our study highlights the role of women in managerial decision-making and the importance of promoting gender diversity in leadership positions. Policymakers and financial institutions can use our results to develop initiatives that support sustainable and gender-inclusive SMEs. If, from one side the role of financial institutions is crucial to support green investments by SMEs and if, on the other side, the increase of PWDM in SMEs with low levels of PWDM (less than 41,9%) is associated to a reduction in long-term banking credit, investments in this green SMEs group might be postponed or not adequately examined. In this sense policymakers should take steps aimed at reducing the negative effects of the lack of human and social capital (through educational initiatives and the transfer of skills and experiences) and once this has been done with further measures aimed at strengthening financial capital or access to financing (in terms of subsidized credit) particularly for SMEs with a PWDM less than a "crucial" threshold (above identified at 41,9%).

Table 5, in columns (4), (5), and (6), presents the results of the panel regression for Eq. (2), where the dependent variable is the Short-term bank credit. In Model 1, we consider all the regressors of the analysis and find evidence of lower Short-term bank credit for green SMEs than non-green ones. However, unlike in the case of Long-term bank credit, there is no evidence of a quadratic relationship with the percentage of women among managers and directors. We also find that an increase in the PWDM leads to an increase in Short-term bank credit. Furthermore, Model 1 reveals that Short-term bank credit decreases when Account payable, ROA, and ROA volatility increase, but it increases when Account receivable increases.

In Model 2, we add the interaction between Green and Female (Green*Female), which is not statistically significant. This suggests that considering the two variables individually is more explanatory than their interaction. The other results remain similar to Model 1.

In Model 3, we introduce the interaction between Account payable and Female (Account payable*Female) and find a significant negative coefficient. This implies that an increase in the percentage of women among directors and managers does not improve the negative relationship between trade credit and short-term bank credit, given the same level of account payable. Other results remain

Table 6
Panel regression for green and non-green SMEs.

	Long-term bank credit		Short-term bank credit		Financial expenses	
	Green	Non-green	Green	Non-green	Green	Non-green
	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.115 * *	-0.082 * **	0.008	0.024 * *	-0.003	0.0003
	(0.069)	(0.012)	(0.059)	(0.011)	(0.002)	(0.001)
Short-term bank credit	-0.356 * **	-0.430 * **			0.013 * **	0.015 * **
	(0.020)	(0.003)			(0.001)	(0.0002)
Long-term bank credit					0.006 * **	0.008 * **
					(0.001)	(0.0002)
Account payable	-0.459 * **	-0.613 * **	-0.226 * **	-0.294 * **		
	(0.027)	(0.006)	(0.024)	(0.006)		
Short-term bank credit *Female	0.135	0.125 * **			-0.004	-0.008 * **
	(0.144)	(0.022)			(0.008)	(0.002)
Long-term bank credit*Female					0.006	-0.001
					(0.008)	(0.002)
Account payable*Female	0.133	0.141 * **	-0.183	-0.077 * *		
	(0.209)	(0.039)	(0.193)	(0.039)		
Account receivable	0.030	-0.016 * **	0.151 * **	0.236 * **		
	(0.023)	(0.005)	(0.019)	(0.004)		
Fixed investments	0.249 * **	0.224 * **				
	(0.022)	(0.004)				
ROA	-0.094 * **	-0.211 * **	-0.162 * **	-0.127 * **		
	(0.026)	(0.005)	(0.024)	(0.005)		
σROA	-0.290 * **	-0.392 * **	-0.217 * **	-0.307 * **	0.016 * **	0.005 * **
	(0.093)	(0.018)	(0.084)	(0.018)	(0.004)	(0.001)
Creditboom					-0.049 * **	-0.038 * **
					(0.010)	(0.003)
North	0.029 *	-0.033 * **	0.022	-0.020 * **	-0.0003	-0.001 * **
	(0.016)	(0.003)	(0.014)	(0.003)	(0.001)	(0.0001)
South	-0.021	-0.007 *	-0.041 * **	-0.023 * **	0.001	0.001 * **
	(0.017)	(0.004)	(0.015)	(0.004)	(0.001)	(0.0002)
Constant	0.274 * **	0.405 * **	0.192 * **	0.241 * **	0.002 * **	0.002 * **
	(0.021)	(0.004)	(0.015)	(0.003)	(0.0006)	(0.0002)
Year dummies	Included	Included	Included	Included	Included	Included
R^2	0.247	0.391	0.042	0.040	0.122	0.149

The table presents the results for panel regression divided by green and non-green SMEs. In columns (1), and (2) the dependent variable is Long-term bank credit; in columns (3), and (4) the dependent variable is Short-term bank credit, and in columns (5), and (6) the dependent variable is Financial expenses. The standard errors are in parentheses. R^2 reported is within R^2. *, **, *** indicate the level of significance at 0.1, 0.05, and 0.01, respectively.

consistent with Models 1 and 2.

Table 5, in columns (7), (8), and (9), reports the results for the panel regression related to Equation 3, where the dependent variable is Financial expenses. Model 1 shows that green SMEs have higher Financial expenses than non-green firms but, in general, the increase in the PWDM determines a reduction in Financial expenses. Furthermore, the analysis shows a quadratic relationship between the PWDM and the Financial expenses, indicating that there is a turning point in which the presence of a certain number of females in the SMEs may increase the Financial expenses. Specifically, by setting the first derivative of the function equal to 0, we identify the threshold beyond which the relationship between Financial expenses and Female becomes positive. Fig. 2 shows the estimated Financial expenses resulting from increasing the percentage of females in SMEs. It suggests a negative relationship between Financial expenses and the percentage of females up to a threshold of 43.9%, beyond which a positive relationship is observed. This threshold is relatively high considering the average percentage of females as managers and directors in our sample of Italian SMEs, which was approximately 3.7% (see Table 2). Model 1 (column 7) also reveals that Financial expenses obviously rise as Long-term and Short-term bank credit increase and when the ROA volatility increases. Financial expenses decrease as the Creditboom grows.

In Model 2 we add the interaction between Green and Female (Green*Female) that is not significant. This means that the consideration of the two variables individually is more explanatory than the interaction between them alone. Other results are similar to those of Model 1.

In Model 3, we add the interactions between Short-term bank credit and Female (Short-term bank credit*Female) and between Long-term bank credit and Female (Long-term bank credit*Female). In this case, we find a negative and significant coefficient for the first interactions: against the same level of short-term bank credit, the increase in the PWDM contributes to reducing financial expenses. Other results are similar to those of Models 1 and 2.

Regarding the geographical area of the companies, the relationship between North and Long-term bank credit is negative with a coefficient higher than that of South; the relationship between North and Short-term bank credit is negative with a coefficient lower than that of South; the relationship between North and South, on the one side, and Financial expenses, on the other side, is negative

Table 7
Panel regression by green sub-sectors – Model 3.

	Long-term bank credit			*Short-term bank credit*			*Financial expenses*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Female	-0.166 * *	0.426	-0.498	0.009	-0.193	-0.817	-0.002	-0.006	-0.007
	(0.071)	(0.366)	(1.015)	(0.061)	(0.191)	(0.935)	(0.003)	(0.007)	(0.013)
Short-term bank credit	-0.364 * **	-0.449 * **	-0.239 * **				0.014 * **	0.005 * *	0.010 * **
	(0.021)	(0.122)	(0.058)				(0.001)	(0.003)	(0.002)
Long-term bank credit							0.006 * **	0.006 * **	0.004 * *
							(0.001)	(0.001)	(0.002)
Account payable	-0.478 * **	-0.481 * **	-0.267 * **	-0.234 * **	-0.084 *	-0.235 * **			
	(0.030)	(0.071)	(0.083)	(0.028)	(0.047)	(0.077)			
Short-term bank credit	0.212	-3.694 * **	1.745				-0.004	-0.009	-0.041
*Female	(0.147)	(0.982)	(2.114)				(0.009)	(0.031)	(0.085)
Account payable*Female	0.270	-2.358	0.015	-0.214	1.960 * *	1.756			
	(0.215)	(1.652)	(3.048)	(0.201)	(0.922)	(2.861)			
Long-term bank							0.005	0.005	-0.053
credit*Female							(0.009)	(0.012)	(0.097)
Account receivable	0.026	0.238 * *	-0.026	0.177 * **	-0.054	0.004			
	(0.025)	(0.116)	(0.069)	(0.021)	(0.059)	(0.060)			
Fixed investments	0.258 * **	0.364 * **	0.142 * **						
	(0.024)	(0.120)	(0.069)						
ROA	-0.098 * **	-0.433 * *	0.052	-0.157 * **	0.069	-0.352 * **			
	(0.027)	(0.213)	(0.106)	(0.025)	(0.136)	(0.098)			
σROA	-0.439 ***	0.171	0.741	-0.269 * **	-0.119	-0.104	0.019 * **	0.009	-0.002
	(0.104)	(0.334)	(0.484)	(0.094)	(0.174)	(0.450)	(0.004)	(0.006)	(0.016)
Creditboom							-0.050 * **	-0.028 * *	-0.060 * **
							(0.012)	(0.011)	(0.015)
North	0.026	0.165	0.026	0.028 *	0.068	-0.054	-0.0001	-0.001	-0.001
	(0.017)	(0.102)	(0.052)	(0.016)	(0.054)	(0.047)	(0.001)	(0.002)	(0.002)
South	-0.015	0.064	-0.0713	-0.031 *	0.055	-0.149 * **	0.001	-0.002	-0.0003
	(0.019)	(0.101)	(0.061)	(0.017)	(0.053)	(0.056)	(0.001)	(0.002)	(0.002)
Constant	0.291 ***	0.024	0.210 * **	0.188 * **	0.061	0.327 * **	0.002 * *	0.004 * *	0.004 * *
	(0.023)	(0.125)	(0.063)	(0.016)	(0.0251)	(0.049)	(0.001)	(0.002)	(0.002)
Year dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
R^2	0.255	0.538	0.179	0.079	0.135	0.132	0.111	0.351	0.089

The table presents the results for panel regression as described in Eqs. 1, 2, and 3-Model 3 (see Table 5) divided by green sub-sectors. In columns (1), (2), and (3) the dependent variable is Long-term bank credit. In columns (4), (5), and (6) the dependent variable is Short-term bank credit, and in columns (7), (8), and (9) the dependent variable is Financial expenses. Columns (1), (4), and (7) report the results for the sub-sector "*Collection, Reuse, Recycling of Waste*"; Columns (2), (5), and (8) report the results for the sub-sector "*Efficiency of water systems*" and columns (3), (6), and (9) report the results for the sub-sector "*Wastewater treatment*". The standard errors are in parentheses. R^2 reported is within R^2. *, **, *** indicate the level of significance at 0.1, 0.05, and 0.01, respectively.

and positive, respectively. Companies in the South of Italy generally have a less robust financial structure, characterized by lower capitalization and profitability and higher dependence on bank credit compared to other external sources of financing. The structural weaknesses of the southern firms translate into worse ratings and more difficult credit access conditions compared to the rest of the country. The interest rates applied to the productive sector and the share of loans backed by real guarantees are systematically higher in the South than in the Center and North (Bank of Italy, 2022).

4.2. Regression results on green and non-green sub-samples

In this section, we report results for the two sub-samples of green and non-green companies. Table 6 shows the results for the panel regression related to Equation 1, Model 3 (see Table 5) distinguishing between green and non-green SMEs.

Table 6, in columns (1), and (2), shows some main differences between green and non-green firms. First, in green companies, the increase in the PWDM leads to a reduction in Long-term bank credit to a greater extent than in non-green companies. The coefficient of the "Female" variable is in fact higher for green than for non-green companies. Moreover, in green companies, the interactions "Short-term bank credit *Female" and "Account payable*Female" are not significant, while they are positive and significant for non-green firms. In non-green SMEs, against the same level of Short-term bank credit and Account payable, the increase in the PWDM helps to improve the negative relationship between short-term bank credit and trade credit and long-term bank credit. In other words, in the case of higher short-term bank credit and trade credit, the reduction of long-term bank credit decreases if the PWDM increases. Long-term bank credit decreases when ROA and σROA increase. Finally, Long-term bank credit tend to be lower for non-green companies located in the North of Italy and higher for green ones located in the same area.

Table 6, in columns (3), and (4), reports the results for the panel regression related to Eq. (2), Model 3 (see Table 5), distinguishing between green and non-green SMEs. The main results are the following. In green companies, the "Female" variable is not significant, unlike for non-green companies, for which the relationship is positive and significant. In non-green firms, the increase in the percentage of women in fact contributes to increasing Short-term bank credit. Moreover, in green companies, the coefficient of the interaction "Account payable*Female" is not significant, whereas in non-green SMEs, it is negative and significant. Against the same level of Account payable, the increase in the PWDM does not improve the negative relationship between trade credit and short-term bank credit. Finally, Short-term bank credit tend to be lower for green and non-green companies located in the South of Italy and when ROA and σROA increase.

Table 6, in columns (5), and (6), reports the results for the panel regression related to Eq. (3), Model 3 (see Table 5), distinguishing between green and non-green SMEs.

Table 6 shows that in green companies, the more the PWDM increases, the more Financial expenses decrease, although the relationship is not significant. In non-green companies, on the other hand, the relationship is positive and not significant.

Moreover, in green companies, the interactions "Short-term bank credit*Female" and "Long-term bank credit*Female" are not significant. In non-green companies, however, the interaction "Short-term bank credit*Female" is negative and significant: against the same level of short-term, the increase in the PWDM contributes to reducing Financial expenses. The volatility of the ROA contributes to a greater increase in the Financial expenses for green companies compared to non-green ones. The coefficient of "σROA" is higher for green than for non-green companies. Finally, Financial expenses tend to be lower for non-green companies located in the North of Italy.

5. Further analysis

5.1. Green sub-sectors

To further investigate the relationship between access to finance and the presence of females in green SMEs, we run our model for different sub-sectors separately. To avoid biased estimates, we identify the sub-sectors with an adequate number of observations and exclude those that do not have sufficient observations to run the model. We, therefore, consider among green SMEs (see for details Section 3.1), "Collection, Reuse, Recycling of Waste", "Efficiency of water systems", and "Wastewater treatment", representing 81.38%, 5.6%, and 11.95% of total green observations (i.e., 5855 observations, as shown in Table 1), respectively.

Table 7, in columns (1), (2), and (3), reports the results for the panel regression related to Eq. (1) (dependent variable: Long-term bank credit), Model 3. The variable "Female" is significant only for the sub-sector "Collection, Reuse, Recycling of Waste", where an increase in the PWDM leads to a reduction in Long-term bank credit. In all three sub-sectors, Long-term bank credit:

- decreases when Short-term bank credit and Account payable increase;.
- increases when Fixed investments increase.

Moreover, only in the "Efficiency of water systems" sub-sector, the interaction "Short-term bank credit *Female" is negative and significant: against the same level of Short-term bank credit, the increase in the PWDM increases the reduction of Long-term bank credit. Finally, ROA volatility contributes to reducing Long-term bank credit for firms belonging to the "Collection, Reuse, Recycling of Waste" sub-sector.

Columns (4), (5), and (6) of Table 7 report the results for the panel regression related to Eq. 2 (dependent variable: Short-term bank credit), Model 3. These results confirm that the variable "Female" is not a significant determinant of the level of Short-term bank credit in green sectors (see Table 6). A negative relationship exists between Account payable and Short-term bank credit, higher in "Collection, Reuse, Recycling of Waste" and "Wastewater tratment" sub-sectors. Moreover, the coefficient of the interaction "Account payable*Female" is significant only for the "Efficiency of water systems" subsector: since it is positive, against the same level of Account payable, the increase in the PWDM improves the negative relationship between trade credit and short-term bank credit. Account

Table 8
Panel regression divided by green SMEs size– Model 3.

	Long-term bank credit			Short-term bank credit			Financial expenses		
	Micro (1)	Small (2)	Medium (3)	Micro (4)	Small (5)	Medium (6)	Micro (7)	Small (8)	Medium (9)
Female	-0.018	-0.356 * **	0.227 * *	-0.092	-0.053	0.094	-0.006	-0.003	-0.004
	(0.169)	(0.111)	(0.107)	(0.144)	(0.095)	(0.100)	(0.004)	(0.004)	(0.004)
Short-term bank credit	-0.458 * **	-0.346 * **	-0.294 * **				0.012 * **	0.014 * **	0.012 * **
	(0.058)	(0.026)	(0.033)				(0.002)	(0.001)	(0.002)
Long-term bank credit							0.003	0.008 * **	0.006 * **
							(0.002)	(0.001)	(0.002)
Account payable	-0.412 * **	-0.482 * **	-0.461 * **	-0.251 * **	-0.190 * **	-0.303 * **			
	(0.084)	(0.033)	(0.053)	(0.072)	(0.029)	(0.056)			
Short-term bank credit *Female	-0.190	-0.134	0.125				0.016	-0.002	-0.019 * *
	(0.606)	(0.215)	(0.193)				(0.024)	(0.013)	(0.009)
Long-term bank credit*Female							0.013	0.017	0.009
							(0.016)	(0.016)	(0.009)
Account payable*Female	-0.832	0.798 * *	-0.499 *	0.009	0.107	-0.438			
	(1.103)	(0.369)	(0.269)	(0.946)	(0.328)	(0.291)			
Account receivable	0.087	0.030	-0.018	0.227 * **	0.104 * **	0.208 * **			
	(0.079)	(0.029)	(0.040)	(0.057)	(0.024)	(0.037)			
Fixed investments	0.174 * *	0.244 * **	0.330 * **						
	(0.069)	(0.029)	(0.041)						
ROA	-0.110	-0.049	-0.244 * **	0-.165 * *	-0.143 * **	-0.223 * **			
	(0.086)	(0.034)	(0.044)	(0.075)	(0.030)	(0.049)			
σROA	-0.394	-0.267 * *	-0.310 * *	-0.238	-0.226 *	-0.188	0.031 * **	0.009	0.022 * **
	(0.285)	(0.135)	(0.135)	(0.242)	(0.121)	(0.131)	(0.008)	(0.005)	(0.007)
Creditboom							-0.016	-0.056 * **	-0.056 * **
							(0.023)	(0.015)	(0.010)
North	0.056	0.014	0.063 * *	0.080 *	0.028	-0.017	0.002	-0.001	0.001
	(0.055)	(0.021)	(0.026)	(0.046)	(0.019)	(0.025)	(0.002)	(0.001)	(0.001)
South	-0.032	-0.017	0.009	0.027	-0.043 * *	-0.072 * *	0.001	-0.001	0.003 * *
	(0.058)	(0.024)	(0.027)	(0.049)	(0.021)	(0.026)	(0.002)	(0.001)	(0.001)
Constant	0.262 * **	0.291 * **	0.225 * **	0.122 * **	0.193 * **	0.223 * **	0.002	0.003 * **	0.002 * **
	(0.070)	(0.027)	(0.036)	(0.049)	(0.020)	(0.028)	(0.001)	(0.001)	(0.001)
Year dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
R^2	0.276	0.243	0.304	0.064	0.048	0.116	0.303	0.215	0.145

The table presents the results for panel regression as described in Eqs. (1), (2), and (3) (Model 3, Table 5) divided by green SMEs size. In columns (1), (2), and (3) the dependent variable is Long-term bank credit. In columns (4), (5), and (6) the dependent variable is Short-term bank credit, in columns (7), (8), and (9) the dependent variable is Financial expenses. Columns (1), (4), and (7) report the results for the "*Micro SMEs*"; Columns (2), (5), and (8) report the results for the "*Small SMEs*" and columns (3), (6), and (9) report the results for the "*Medium SMEs*". The standard errors are in parentheses. R^2 reported is within R^2. *, **, *** indicate the level of significance at 0.1, 0.05, and 0.01, respectively.

receivable is positive and significant only for the "Collection, Reuse, Recycling of Waste" sub-sector. The coefficient of ROA is negative and significant for both the "Collection, Reuse, Recycling of Waste" and "Wastewater treatment" sub-sectors. The volatility of ROA determines a significant reduction of Short-term bank credit only for the "Collection, Reuse, Recycling of Waste" sub-sector. Finally, Short-term bank credit tend to be lower for green companies of the sub-sectors "Collection, Reuse, Recycling of Waste" and "Wastewater treatment" located in the South of Italy.

Table 7, in columns (7), (8), and (9), reports the results for the panel regression related to Equation 3 (dependent variable: Financial expenses), Model 3 that confirm the results of Table 6: in green companies, the more the PWDM increases, the more Financial expenses decrease, although the relationship is not significant. Short-term bank credit contributes to increasing the level of Financial expenses, especially in the "Collection, Reuse, Recycling of Waste" sub-sector, where the coefficient is higher than the other two sub-sectors. The relationship between Long-term bank credit and Financial expenses is similar for the three sub-sectors. The volatility of ROA contributes to an increase in the Financial expenses for the "Collection, Reuse, Recycling of Waste" sub-sector. Finally, Creditboom is significant for all three sub-sectors but its increase contributes to reducing Financial expenses, especially for the "Wastewater treatment" sub-sector.

5.2. Size of green companies

Further investigations are made on the size of green companies, proxied by the number of firm employees: micro-sized firms are those having less than 10 or 10 employees; small-sized firms have between 11 and 50 employees; and medium-sized firms have between 51 and 250 employees. Micro, small- and medium-sized firms make up 13.46%, 66.67% and 19.87% of the sample, respectively. We also proxied the size by using the total assets and their percentile (micro companies have total assets less than 25th percentile, small companies have total assets between 25th and 75th percentile and medium companies have total assets greater than the 75th percentile, see Table B.1 in Appendix B), but the results are similar to those shown in Table 8. We run our model for different micro-, small- and medium-sized companies separately.

Table 8, in columns (1), (2), and (3), reports the results for the panel regression related to Equation 1 (dependent variable: Long-term bank credit), Model 3. The variable "Female" is significant only for small and medium firms: in particular, the increase in the PWDM leads to a reduction in Long-term bank credit for small firms and to an increase for medium ones. In all three sub-sectors, Long-term bank credit:

- decreases when Short-term bank credit and Account payable increase;.
- increases when Fixed investments increase.

Moreover, for small firms, the interaction "Account payable*Female" is positive and significant: against the same level of Account payable, the increase in the PWDM decreases the reduction of Long-term bank credit; for medium firms, the interaction "Account payable*Female" is negative and significant. Long-term bank credit decreases when profitability (i.e., ROA) of medium firms increases and ROA volatility contributes to reducing Long-term bank credit for small and medium firms. Finally, Long-term bank credit tend to be higher for medium green companies located in the North of Italy.

Table 8, in columns (4), (5), and (6), reports the results for the panel regression related to Eq. 2 (dependent variable: Short-term bank credit), Model 3. Results confirm that the "Female" variable is not a significant determinant of the level of Short-term bank credit in green sectors (see Tables 6 and 7). A negative relationship exists between Account payable and Short-term bank credit, higher for medium firms, whereas the coefficient of the interaction "Account payable*Female" is not significant. Account receivable is positive and significant regardless of the size of the green companies. The coefficient of ROA are negative and significant regardless the size, whereas that of ROA volatility is negative and significant only for small companies. Finally, Short-term bank credit tend to be lower for small and medium green companies located in the South of Italy.

Columns (7), (8), and (9) of Table 8 report the results for the panel regression related to Equation 3 (dependent variable: Financial expenses), Model 3. Table 8 confirms the results of Tables 6 and 7: in green companies, the more the PWDM increases, the more Financial expenses decrease, although the relationship is not significant. The positive relationship between Short-term bank credit and Financial expenses is similar for the three sub-sectors, while Long-term bank credit contributes to increasing the level of Financial expenses, especially for small companies. The interaction "Short-term bank credit*Female" is negative and significant for medium firms: against the same level of Short-term bank credit, the increase in the PWDM increases the reduction of Financial expenses. The volatility of ROA contributes to a greater increase in the Financial expenses for micro and medium firms. Finally, Creditboom is significant for small and medium companies: its increase contributes to reducing Financial expenses.

6. Discussion and conclusive remarks

This research aims to contribute to the literature, where findings have been conflicting, on gender differentiation in SME access to credit, taking into account the "green orientation" of companies. The research investigates specifically whether there are differences in terms of access to credit (long-term and short-term credit) and cost of credit between green and non-green Italian SMEs and whether the percentage of women among exponents and managers affects these aspects.

Our analysis shows that green SMEs seem to be more profitable, riskier, and investment-oriented than non-green ones. Furthermore, green SMEs rely more on trade credit but receive less financial credit (particularly short-term bank credit) than non-green ones

paying the same amount of financial expenses, and this higher cost of credit perhaps reflects that they are perceived as more risky than non-green ones (Levi and Newton, 2016; Abeberese, 2017; Goss and Roberts, 2011).

Considering our whole sample, the relationship between PWDM and banking credit for Italian SMEs appears to be complex. We find a quadratic relationship between PWDM, on one side, and long-term bank credit and the cost of banking credit, on the other side, and thus identify the percentage of women directors and managers that would increase the long-term bank credit and the cost of banking credit, i.e., 41.9% and 43.9%, respectively. Considering the two sub-samples of green and non-green SMEs, starting from low levels of PWDM, its increase determines: *(i)* a reduction in long-term bank credit, greater for green than for non-green SMEs; *(ii)* an increase in short-term bank credit only for non-green companies*; (iii)* a reduction in the cost of banking credit for green companies, although the relationship between the two variables (i.e., "Female" and "Financial expenses") is not significant. On the basis of these results, Hypothesis 1 is partially accepted and Hypothesis 2 is rejected.

Our empirical analysis suggests that in green SMEs the demand for financial credit changes according to PWDM and the relationship is predominantly negative. Moreover, it appears that an increase in PWDM in green SMEs leads to a reduction (statistically non-significant) in the cost of credit than in non-green firms. A high PWDM is thus associated with a greater perception of risk by lenders, which also reflects the different financial debt choices made by companies with a high PWDM. Moreover, in green companies, an increase in PWDM does not lower lender perception of risk either in terms of the loan granted or the cost of the loan itself.

These results on Italian green SMEs appear to differ from most of those in the literature on gender differentiation in credit access for female-led SMEs, both in terms of lender bias (higher interest or lower credit availability) and debtor self-restraint (greater aversion to risk and scepticism of women-led SMEs).

Our results show that financial intermediaries should include "green" parameters in the assessment of the creditworthiness of SMEs. Since the contribution of the financial system is crucial to supporting investments in the green economy and considering that green SMEs appear more profitable but also riskier than non-green companies, it is particularly important that the financial system has the information necessary to adequately quantify the green SMEs creditworthiness so that it can effectively discriminate the best borrowers from the others. This suggests that the environmental sustainability and performance of businesses should be taken into account alongside traditional financial indicators. Given the current focus on "green" issues and the increasing recognition of ESG factors in evaluating company performance, incorporating these considerations into credit assessments becomes even more crucial. Furthermore, our findings highlight the importance of women in business management, and the need to recognize and support women entrepreneurs and leaders in SMEs. Gender diversity and inclusion have been shown to contribute positively to business outcomes, innovation, and overall organizational success. By acknowledging the importance of women in business management, financial intermediaries can promote equal opportunities and foster sustainable economic growth. These actions align with the growing global emphasis on environmental sustainability, ESG performance, and gender equality in the business world.

An important limitation of this study is that it focuses on green industries characterized by a supposed "particularly high green component" and not on companies defined as "green", due to the absence of a mandatory green rating. And as further in-depth analysis, it would be important to verify whether there are any skills which are particularly important among women directors and managers in reducing or even closing the gender gap.

CRediT authorship contribution statement

Arcuri Maria Cristina: Conceptualization, Data curation, Formal analysis, Investigation, Methodology Validation; Visualization, Roles/Writing - original draft; Writing - review & editing. **Di Tommaso Caterina:** Conceptualization, Formal analysis, Investigation, Validation; Visualization, Roles/Writing - original draft; Writing - review & editing. **Pisani Raoul:** Conceptualization, Formal analysis, Investigation, Validation; Visualization, Roles/Writing - original draft; Writing - review & editing.

Declaration of Competing Interest

None.

Data availability

Data will be made available on request.

Appendix A

Table A.1
Correlation matrix - Full sample.

	Long-term bank credit	Short-term bank credit	Financial expense	Female	Age	Size	Account payable	Account receivable	Fixed investments	ROA	σROA	Equity/Total Assets
Long-term bank credit	1											
Short-term bank credit	-0.023 *	1										
Financial expenses	0.114 *	0.243 *	1									
Female	-0.017 *	0.007 *	-0.009 *	1								
Age	0.015 *	0.053 *	-0.031 *	0.050 *	1							
Size	0.028 *	0.030 *	-0.080 *	0.146 *	0.195 *	1						
Account payable	-0.269 *	-0.119 *	0.002	0.021 *	-0.124 *	0.116 *	1					
Account receivable	-0.214 *	0.084 *	0.008 *	0.005 *	-0.067 *	0.055 *	0.498 *	1				
Fixed investments	0.375 *	0.107 *	0.041 *	0.01 *	0.108 *	0.065 *	-0.262 *	-0.384 *	1			
ROA	-0.100 *	-0.176 *	-0.072 *	-0.024 *	-0.037 *	0.039 *	-0.011 *	0.087 *	-0.152 *	1		
σROA	-0.094 *	-0.103 *	0.102 *	0.020 *	-0.106 *	-0.113 *	-0.027 *	-0.055 *	-0.088 *	-0.101 *	1	
Equity/Total Assets	-0.128 *	-0.275 *	-0.408 *	0.001	0.010 *	0.051 *	-0.003	0.002	0.010 *	0.184 *	-0.275 *	1

Table A1 shows the Pearson correlation matrix for the total sample. * indicates significance levels at 5%.

Appendix B

Table B.1 Panel regression divided by green SMEs size– Model 3.

	Long-term bank credit			Short-term bank credit			Financial expenses		
	Micro (1)	Small (2)	Medium (3)	Micro (4)	Small (5)	Medium (6)	Micro (7)	Small (8)	Medium (9)
Female	-0.316	-0.206 * *	0.026	0.243	-0.104	-1.116	-0.007	-0.003	-0.001
	(0.323)	(0.092)	(0.105)	(0.230)	(0.087)	(0.086)	(0.010)	(0.003)	(0.003)
Short-term bank credit	-0.356 * **	-0.302 * **	-0.395 * **				0.016 * **	0.016 * **	0.010 * **
	(0.051)	(0.025)	(0.035)				(0.002)	(0.001)	(0.001)
Long-term bank credit							0.006 * *	0.005 * **	0.006 * **
							(0.001)	(0.001)	(0.001)
Account payable	-0.458 * **	-0.408 * **	-0.604 * **	-0.244 * **	-0.243 * **	-0.282 * **			
	(0.056)	(0.035)	(0.058)	(0.046)	(0.032)	(0.050)			
Short-term bank credit *Female	0.391	0.048	0.373				-0.021	0.011	-0.010
	(0.429)	(0.228)	(0.238)				(0.017)	(0.012)	(0.008)
Long-term bank credit*Female							0.065	0.007	0.003
							(0.050)	(0.012)	(0.006)
Account payable*Female	0.057	0.188	-0.031	2.657	0.208	0.129			
	(2.061)	(0.336)	(0.290)	(1.814)	(0.294)	(0.258)			
Account receivable	0.122 * *	-0.090 * **	-0.038	0.119 * **	0.099 * **	0.212 * **			
	(0.048)	(0.029)	(0.046)	(0.035)	(0.025)	(0.036)			
Fixed investments	0.288 * *	0.224 * **	0.249 * **						
	(0.053)	(0.030)	(0.039)						
ROA	0.019	-0.034	-0.230 * **	-0.057	-0.151 * **	-0.199 * **			
	(0.063)	(0.033)	(0.046)	(0.051)	(0.030)	(0.040)			
σROA	-0.0004	-0.324 * **	-0.155	-0.283	-0.269 * **	-0.122	0.009	0.012 * **	0.020 * **
	(0.209)	(0.114)	(0.157)	(0.185)	(0.094)	(0.136)	(0.008)	(0.004)	(0.007)
Creditboom							-0.054 * **	-0.053 * **	-0.054 * **
							(0.016)	(0.016)	(0.008)
North	0.056	0.014	0.063 * *	0.080 *	0.028	-0.017	0.002	-0.001	0.001
	(0.055)	(0.021)	(0.026)	(0.046)	(0.019)	(0.025)	(0.002)	(0.001)	(0.001)
South	-0.032	-0.017	0.009	0.027	-0.043 * *	-0.072 * *	0.001	-0.001	0.003 * *
	(0.058)	(0.024)	(0.027)	(0.049)	(0.021)	(0.026)	(0.002)	(0.001)	(0.001)
Constant	0.196 * **	0.324 * **	0.343 * **	0.176 * **	0.206 * **	0.187 * **	0.003 * **	0.002 * **	0.003 * **
	(0.039)	(0.022)	(0.032)	(0.023)	(0.012)	(0.018)	(0.001)	(0.001)	(0.001)
Year dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
R^2	0.162	0.201	0.299	0.095	0.050	0.102	0.218	0.211	0.139

The table presents the results for panel regression as described in Eqs. 1, 2, and 3 (Model 3, Table 5) divided by green SMEs size, in terms of percentiles of total assets. In columns (1), (2), and (3) the dependent variable is Long-term bank credit; in columns (4), (5), and (6) the dependent variable is Short-term bank credit; in columns (7), (8), and (9) the dependent variable is Financial expenses. Columns (1), (4), and (7) report the results for the "*Micro SMEs*"; Columns (2), (5), and (8) report the results for the "*Small SMEs*" and columns (3), (6), and (9) report the results for the "*Medium SMEs*". The standard errors are in parentheses. R^2 reported is within R^2. *, **, *** indicate the level of significance at 0.1, 0.05, and 0.01, respectively.

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