Research in International Business and Finance 81 (2026) 103215

Contents lists available at ScienceDirect

Research in International Business and Finance

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

# Italian SMEs and access to credit: Does being "green" matter?

Maria Cristina Arcuri [a,*], GINO GANDOLFI [a], RAOUL PISANI [b]

[a] Banking and Finance at Department of Economics and Management, University of Parma, Via J.F. Kennedy 6, Parma 43125, Italy
[b] Banking and Finance at Department of Economics and Management, University of Trento, Via Inama 5, Trento 38122, Italy

ARTICLE INFO

*JEL classification:*
F64
G21
G32

*Keywords:*
Green MSMEs
Bank credit
Cost of credit

ABSTRACT

This study explores if Italian MSMEs (Micro, Small, Medium-sized Enterprises) operating in green industries (green MSMEs) are recognized more creditworthy by the banking system than those operating in non-green sectors (non-green MSMEs). In more detail, we explore first if Italian green MSMEs receive more bank credit and have less cost of credit, second if they have a better creditworthiness (in terms of lower probability of default) than non-green ones. We carry out a panel regression with 245,784 observations, of which 7896 refer to green firms and 237,888 to non-green firms over the period 2015–2022. Propensity score matching is also used to check for potential selection bias. Due to the lack of a mandatory green rating, the analysis was not conducted at the level of green enterprises but on "green" industries defined as such based on an assumed particularly high green component. Our results show that Italian green MSMEs pay a higher cost of funding rather than non-green ones and this seems to be, at least partially, justified by a corresponding higher credit risk; differences emerges when the size of enterprises is considered. Public policies should therefore promote the requirement of a green rating based on a rigorous and uniform methodology and provided by an agency that may be promoted by Public Authorities. This would allow for more accurate and objective assessments of the creditworthiness of green companies, improving their access to credit and reducing exposure of banks to credit risk.

## 1. Introduction

Recent studies demonstrate that higher ESG orientation of firms may decrease their operational risk level (Bouslah et al., 2018, Godfrey et al., 2009, Muhammad et al., 2015, Farza et al., 2021), facilitating the 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 results seem to be demonstrated even for Small and Medium-sized Enterprises (SMEs): green SMEs seem to have a lower probability of liquidity shortfall and bankruptcy, a higher level of reputation (than non-green firms), which facilitate the improvement of innovation processes (Huang et al., 2020, Hong and Liskovich, 2019) and the level of trust not only with shareholders but also with stakeholders including suppliers and clients (Lins et al., 2017, 2019). If these results seem encouraging, a wide literature on SMEs shows that they have a higher probability of failure than large and established firms in case of external crisis (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). This fragile condition of SMEs must be considered with regard to the investments necessary for the energy transition: if financial institutions believe the effects of green innovation could be uncertain - due to the difficult of being compliant with complex

* Corresponding author.
*E-mail addresses:* mariacristina.arcuri@unipr.it (M.C. Arcuri), gino.gandolfi@unipr.it (G. GANDOLFI), raoul.pisani@unitn.it (R. PISANI).

https://doi.org/10.1016/j.ribaf.2025.103215
Received 25 February 2025; Received in revised form 29 August 2025; Accepted 12 November 2025
Available online 13 November 2025

environmental regulations (Levi and Newton, 2016) or to the variability of energy prices (Abeberese, 2017) - firms may suffer competitive disadvantage because green investments in the short term can be costly and lead to low profitability further downgrading the solvency profiles of companies (Goss and Roberts, 2011). Moreover, previous studies (e.g., Tran et al., 2024) show that the risks of climate change affect the capital structure of enterprises. Considering the mixed results in the literature, we decided to explore the issue of access to credit for Micro and Small and Medium-sized Enterprises (MSMEs) operating in the green sectors (hereafter refereed as "green MSMEs") in the Italian context, where there is a growing focus on sustainability by financial institutions. Sustainability and the transition to a low-carbon economy have in fact become crucial for maintaining long-term competitiveness, and the banking sector plays a crucial role in this context.[1]

In our paper, we first explore if Italian green MSMEs receive more or less bank credit than non-green ones; and second if there is coherence – in the case of green MSMEs - between the level of credit risk from one side and the cost of credit from the other side. Univariate *t*-tests indicate statistically significant differences in bank credit and cost of credit, with green MSMEs exhibiting lower level of short-term bank credit and higher financial expenses than non-green firms. This statistical significance remains when we control for a set of control variables related to profitability, financial structure, and other firm characteristics, including age, size and geographical area, running panel fixed effects (FE) regressions. By using the approach of Propensity Score Matching (PSM) into the analysis of the level and cost of bank credit of green and non-green Italian MSMEs, we ensure the construction of a matched sample in our statistical tests. We focus on companies belonging to the "industry in the strict sense", term used by ISTAT, the Italian National Institute of Statistics,[2] to identify the secondary economic sector, of which it is particularly interesting to examine the green aspects since it deals with the production of material goods through processes of transformation of raw materials. In addition, over 94 % of our sample is made up of manufacturing companies which, having a greater concentration of tangible assets (e.g., higher 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). The study of the level of bank credit received by Italian MSMEs is also important in view of their important role: in Italy in 2023 the shares of employment and value added generated by MSMEs are particularly high (75 % and 63.7 % respectively)[3] compared to the EU average.

The remainder of the paper is organized as follows: in Section 2 we present a literature review; in Section 3, we describe the data, variables and research method used in the study; in Section 4, we show our findings; in Section 5, we conclude by highlighting key results and their implications.

## 2. Literature review

The current decade has been affected by major shocks that have generated significant economic turbulence. If Covid-19 pandemic made severe effects to the real (International Trade Center, 2020, Kuckertz et al., 2020, Demirguc-Kunt et al., 2021, Donthu and Gustafson, 2020; García-Carbonell et al., 2021, OECD, 2020) and financial economy (Rizvi et al., 2020, Dzingirai and Chekenya, 2020, Chiang, 2020), more recently, the Russian-Ukrainian war has severely impacted on commodity markets (Lo et al., 2022, Jagtap et al., 2022), contributing to a further volatility of energy prices (Lambert et al., 2022, He-Lee, 2022) and damage to the environment (Pereira et al., 2022). The two crises have caused a significant downgrade of the solvency profiles (Mirza et al., 2020) and consequent reductions in long-term valuations in many industries (Abbas Rizvi et al., 2022) which risk to be further accentuated by high the rise in interest rates by the monetary authorities in response to the rise in inflation rates.

Although SMEs rely on a higher flexibility and adaptive capacities (Bartz and Winkler, 2016; Battisti and Deakins, 2012; Burns, 2016, Gilmore et al., 2013) than bigger firms, at the same time they have a higher probability of failure than large and established firms in case of external crisis (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), partly due to their ownership structure (Martin et al., 2019). The fragile condition of the SMEs must therefore be taken into consideration with regard to both external shocks induced by global warming and the investments necessary for the energy transition: if financial institutions and markets do not adequately recognize green investments as important intangible asset in lowering credit risk, firms may suffer competitive disadvantage because investment in environmentally responsible practices in the short term can be costly and lead to low profitability further downgrading the solvency profiles of companies (Goss and Roberts, 2011). In this sense, if from a theoretical and macroeconomic standpoint, the effects of "greening" the firms are considered definitely positive on the economic growth (Kasztelan, 2017; Lavrinenko et al., 2019; Šipilova et al., 2017; Li et al., 2022) and in terms of a relationship between economic growth and the environment (Kang and Lee, 2021; Mol and Sonnenfeld, 2000; D'Amato and Korhonen, 2021; D'Amato and Korhonen, 2021; Korhonen and Granberg, 2020; Palahì et al. 2020; Taherzadeh, 2021), the advantages of green investments at the firm level are not always extremely clear. In more details, studies mainly carried out in the first decade of the current century demonstrate that financial risk of socially and environmentally responsible firms is higher than other firms (Kiernan, 2007; Seeger and Hipfel, 2007) while in some other cases investigations appear to be inconclusive (Lee and Faff, 2009). More recent studies (mostly carried out in the second and third decade of this century), on the other hand, demonstrated that higher environmental orientation may decrease operational risk at the firm level (Bouslah et al., 2018, Godfrey et al., 2009,Muhammad et al., 2015, Farza et al., 2021), facilitate the access to financial markets (Jo and Na, 2012, Zeidan et al., 2015), take advantage of better conditions on banking loans (Bauer and Hann, 2010, Goss and Roberts, 2011; Magnanelli and

[1] https://www.crif.it/media/tvkjbqf2/esg-outlook-2024-crif.pdf

[2] ISTAT is a public research organization, which is the main producer of official statistics in Italy.

[3] Source: SME Performance Review 2024 - Italy country sheet. https://ec.europa.eu/docsroom/documents/60571

Izzo, 2017; Sharfman and Fernando, 2008; Chen et al., 2022; Umar et al., 2021). The relationship between green orientation and financial risk during the COVID-19 pandemic has been recently investigated specifically on MSMEs in south and eastern Europe (Wellalage and Kumar, 2020) and on MSMEs in eastern Europe (Wellalage et al., 2021): findings demonstrate that green companies showed a lower probability of liquidity shortfall and bankruptcy and a better access to external finance. Green firms are believed to have a higher level of reputation (than non-green firms), boosting innovation processes (Huang et al., 2020, Hong and Liskovich, 2019) and enhancing their level of trust not only with shareholders but also with stakeholders including suppliers and clients (Lins et al., 2017, 2019). A further element of attention concerns trade credit which is particularly important in Italy for two reasons: a) trade credit has always been traditionally a significant source of finance for MSMES and b) from 2011 to 2024 it has become even more relevant due to the strong reduction in bank loans to businesses (these have decreased from approximately 994–667 billion euros especially in the short-term component and supporting investments in working capital, particularly by MSMEs) due to the new prudential supervision rules on credit risk following Basel 2 and the financial crisis of 2011 that particularly affected Italy. In this sense, a recent empirical analysis (Arcuri and Pisani, 2021) on Italian Medium Enterprises (MEs) showed that green MEs rely more on trade credit than non-green MEs. They offer more trade credit to their clients (accounts receivable) and at the same time they receive more trade credit from their suppliers (accounts payable) than non-green ones. These results were evaluated considering the literature on trade credit. Basically, the literature identifies three reasons that justify the use of trade credit:

a) the first is a "substitution effect" of trade credit compared to banking credit. This effect generally concerns more recently established/smaller companies, with more limited access to bank credit (Fisman and Love, 2003; Nilsen 2002), especially in the event of financial crisis (Love et al., 2007) and during monetary restrictions (Brechling and Lipsey, 1963; Duca, 1986; Herbst, 1974; Jaffee and Modigliani 1969; Jaffee 1971; Mateut, 2005; Meltzer, 1960; Wilner, 2007). The substitution effect is compatible with the already Italian experience in the years after 2011 but according to the size of the companies analysed (green and non-green MEs);
b) the second relates to the nature of the relationships between companies in an industry or in a production chain. In this sense trade credit can be seen as a component of a long-term portfolio management strategy (Hu et al., 2024; Emery, 1987), an instrument for consolidating customer relationships through product quality guarantee (Deloof and Jegers, 1996), for price discrimination (Bougheas et al., 2009;Lee and Stowe, 1993; Long et al., 1993; Petersen and Rajan, 1997; Schwartz and Whitcomb, 1978 and 1979), to increase profitability of firms (Martínez-Sola and García-Tereul, 2014) and to address changing demand conditions (Long et al., 1993). This second explanation may be more appropriate than the first because some of the companies examined belonged to specific economic industries;
c) finally, the third reason could also be explained by a competitive advantage of supplier companies compared to the banks among green firms in the exploitation of the informal means that guarantee the repayment of the loan. This competitive advantage may result from better and/or less costly information on the financial situation of client firms (Biais and Gollier, 1997; Petersen and Rajan, 1997; Pike et al., 2005), monitoring advantages (Bukart and Ellingsen, 2004; Emery, 1987; Freixas, 1993; Schwartz and Whitcomb, 1979), and product market imperfections (Brennan et al., 1988) representative of the existence of a common know-how and less well known business practices outside the supply chain. This third reason could apply to green enterprises whose production processes are more affected by new technologies or technical innovations than others.

As a result of all these considerations, if on the one hand the most recent literature seems to recognize that green companies have a lower operational, liquidity and bankruptcy risk than non-green ones, but on the other hand in Italy these companies seem to be more dependent on trade credit (and not to bank credit) compared to non-green ones, we wonder if Italian green MSMEs actually receive more bank credit and/or at lower costs than non-green ones and whether this result is actually explained by a lower probability of default of the former compared to the latter.

Therefore, our hypotheses are the following:

**Hypothesis 1**. : *Green Italian MSMEs receive more bank credit and/or at lower costs than non-green MSMEs*.

**Hypothesis 2**. : *Green Italian MSMEs are characterized by a lower riskiness than non-green ones.*

## 3. Research design

### *3.1. Sample*

The main sources of data are the AIDA Bureau Van Dijk database (hereinafter, AIDA), containing all financial and governance data of Italian MSMEs, and ISTAT. Our final sample includes all companies for which data are available for the period 2015–2022: it consists of 30,723 MSMEs (245,784 observations). The MSMEs included in our sample belong to an "industry in the strict sense".[4]. 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".[5]. In our sample, there

[4] The "industry in the strict sense" is distinguished from agriculture (primary sector), extracting or producing raw materials, and services (tertiary sector), providing non-material services.

[5] ISTAT specifies the list of Ateco codes included in each Section (https://www.istat.it/classificazione/documenti-ateco/).

are 301 companies (0.98%) in Section B, 28,948 (94.22%) in Section C, 280 (0.91%) in Section D, and 1,194 (3.89%) in Section E.

According to the study by the Politecnico di Milano and Camera di Commercio di Milano (2012), also referred to by Arcuri et al. (2024), we selected industries which have an important green component, among those in 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 of the territory (Code 39.00.09), Waste water treatment (Code 37.00.00), Energy Storage (Code 27.20.00). It follows that our definition of green SMEs is based on the firm industry, and not on some firm-specific characteristics. Table 1 shows the distribution of observations by type of sector (Panel A) and size (Panel B) of firms included in the sample.

### 3.2. Variables

In order to verify our research hypothesis, we use the following three dependent variables: "Long-term bank credit", i.e., debt due over 12 months, divided by total assets (Eq. 1); Short-term bank credit", i.e., 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). Our main independent variable is the dummy variable "Green", which is equal to 1 when a firm is green following the specific criteria defined above (see Section 3.1), and 0 otherwise. We control for a large set of firm-level characteristics. First, we account for firm age and size as standard controls for information asymmetries (Aristei and Angori, 2022). Age is the number of years of a firm's activity, in particular, we use the logarithm of (1 + Age); Size (i.e., natural logarithm of total assets) of the firm. We consider the potential impact of trade payables and receivables, in both cases divided by total assets. Accounts payable and receivable are, in fact, related to firm performance and growth (Ferrando and Mulier, 2013), also in case of listed SMEs, whose working capital management affects their performance (Afrifa et al., 2014). Specifically, trade credit is an important source of finance for firms, and it may be complementary to or substitute for bank credit (e.g., Elemes and Filip, 2022; Goto et al., 2015; Yang, 2011; Bougheas et al., 2009). Moreover, the study of choices regarding the use of bank credit and trade credit by firms is relevant to measure the potential effects on operating performance (e.g., Afrifa et al., 2024). We also include in our analysis the amount of fixed investments divided by total assets; these allow to control, at least partially, for a firm's strategic choice between short- and long-term financing and for investment tangibility (Aristei and Angori, 2022). Consistently with existing studies (e.g., Moro et al., 2017), we account for firm profit; we use as an independent variable the ROA (Return on Assets), which, as is known, indicates how profitable a company is relative to its total assets. Furthermore, as previous studies associate the returns of asset with the concept of volatility (Barra and Ruggiero, 2023) and other research (e.g., Mabandla and Marozva, 2024) show a significant effect of earnings volatility on corporate leverage, we include σROA (the standard deviation of the ROA) among our independent variables. We also include the Liquidity ratio, expressed in terms of quick ratio, as a determinant in our models.[6] Finally, we consider the geographical area of MSMEs (i.e., their location in Italy: North, South or Central Italy). Table 2 reports the description for the abovementioned variables, which were directly downloaded or calculated from data extracted by AIDA.

### 3.3. Methodology

To test our research hypothesis, we perform FE regressions using the covariates described in Section 3.2. The main model equations are:

$$\text{Long-term bank credit}_{it} = \beta_0 + \beta_1\text{Green}_i + \beta_2\text{Age}_{it-1} + \beta_3\text{Size}_{it-1} + \beta_4\text{Short-term bank credit}_{it-1} + \beta_5\text{Account payable}_{it-1} + \beta_6\text{Account receivable}_{it-1} + \beta_7\text{Fixed investments}_{it-1} + \beta_8\text{ROA}_{it-1} + \beta_9\sigma\text{ROA}_{it-1} + \text{Year FE*Geographical area FE} + \varepsilon_{it} \quad (1)$$

$$\text{Short-term bank credit}_{it} = \beta_0 + \beta_1\text{Green}_i + \beta_2\text{Age}_{it-1} + \beta_3\text{Size}_{it-1} + \beta_4\text{Account payable}_{it-1} + \beta_5\text{Account receivable}_{it-1} + \beta_6\text{ROA}_{it-1} + \beta_7\sigma\text{ROA}_{it-1} + \beta_8\text{Liquidity ratio}_{it-1} + \text{Year FE*Geographical area FE} + \varepsilon_{it} \quad (2)$$

$$\text{Financial expenses}_{it} = \beta_0 + \beta_1\text{Green}_i + \beta_2\text{Age}_{it-1} + \beta_3\text{Size}_{it-1} + \beta_4\text{Short-term bank credit}_{it-1} + \beta_5\text{Long-term bank credit}_{it-1} + \beta_6\text{Account payable}_{it-1} + \beta_7\text{Account receivable}_{it-1} + \beta_8\sigma\text{ROA}_{it-1} + \beta_9\text{Liquidity ratio}_{it-1} + \text{Year FE*Geographical area FE} + \varepsilon_{it} \quad (3)$$

where *i* is the firm, *t* is the time period, and $\varepsilon_{it}$ represents the measurement errors. Moreover, to consider any difference at regional and year levels not captured by other independent variables, the interaction between Year FE and Geographical area FE is added to the model (*Year*Geographical area FE*). To address potential endogeneity issues, we use regressors lagged by one year. We estimate Eqs. 1, 2 and 3 using a FE panel model with clustered standard errors at firm level. To address potential sample selection bias, we use the methodology of Propensity Score Matching - PSM (see Section 4.2).

## 4. Results

### 4.1. Descriptive statistics and univariate analysis

In Table 3, we present summary statistics for the full sample and the sub-samples of green and non-green MSMEs. We also provide

[6] Liquidity ratio is strongly correlated to equity/total assets (see Table A1), so we exclude the latter from our models.

**Table 1**
Observations by type of sector and firm size.

| Panel A: Observations by type of firm sector | | |
|---|---|---|
| **Type of sector** | **No. of observations** | **% of total** |
| Green | 7896 | 3.21 |
| Non-green | 237,888 | 96.79 |
| **Total** | **245,784** | **100** |
| Panel B: Observations by firm classification | | |
| **Classification** | **No. of observations** | **% of total** |
| Micro | 34,424 | 14.01 |
| Small | 159,272 | 64.80 |
| Medium | 52,088 | 21.19 |
| **Total** | **245,784** | **100** |

**Table 2**
Variable definitions.

| Variable | Definition |
|---|---|
| *Dependent variables* | |
| Long-term bank credit | debt due over 12 months, divided by total assets |
| Short-term bank credit | debt due within 12 months, divided by total assets |
| Financial expenses | financial interest on loans from companies to financial intermediaries and on bonds issued, divided by total assets |
| *Explanatory variables* | |
| Green | Dummy variable, equal to 1 when a firm is green following the criteria defined above, and 0 otherwise |
| Age | logarithm of (1 + Age) |
| Size | natural logarithm of total assets |
| Account payable | trade payables divided by total assets (trade credit) |
| Account receivable | trade receivables divided by total assets |
| Fixed investments | fixed investments divided by total assets |
| ROA | Return on Assets |
| σROA | standard deviation of the ROA |
| Liquidity ratio (quick ratio) | (Current assets - inventories) / Short-term liabilities |
| North | dummy variable, equal to 1 when a firm is located in the North of Italy, and 0 otherwise |
| South | dummy variable, equal to 1 when a firm is located in the South of Italy, and 0 otherwise |

the results from the univariate *t*-tests showing the significance of the mean differences between green and non-green MSMEs.

Green MSMEs are younger, and bigger than non-green ones. Green firms show substantially the same Long-term bank credit and lower Short-term bank credit than non-green ones; nevertheless, green SMEs pay higher financial expenses. Moreover, green MSMEs show higher Accounts payable, Account and Financial receivable, Fixed investments, Liquidity ratio, and ROA volatility, whereas they have lower Equity/Total Assets than non-green companies. Finally, the two groups do not show statistically significant differences for the variable ROA.[7]

Univariate Pearson correlation coefficients (in Appendix A, Table A1) demonstrate that Long-term bank credit, Short-term bank credit and Financial expenses are positively correlated. Green is negatively related to Short-term bank credit. Furthermore, the variables for Age, Account payable and receivable, Financial receivable, ROA, σROA, Equity/Total Assets and Liquidity ratio are negatively related to Long-term bank credit, whereas Size and Fixed investments are positively related to it. The variables for Size, Financial receivable, ROA, Equity/Total Assets and Liquidity ratio are negatively related to Short-term bank credit whereas Account payable, Fixed investments, σROA are positively related to it. The variables for Age, Size, ROA, Equity/Total Assets and Liquidity ratio are negatively related to Financial expenses whereas Account payable and receivable, Fixed investments and σROA are positively related to them.

### *4.2. Level and cost of bank credit*

Table 4 reports the FE panel regression results for the full sample. Columns (1) and (2) show the results for Eqs. 1 and 2, where the dependent variable is Long-term bank credit and Short-term bank credit, respectively. Green MSMEs appear to be more financially constrained than non-green ones when it comes to accessing both Long-term bank credit (column 1) and Short-term bank credit (column 2). This is an interesting finding: studies examining the firm-level implications of financial frictions have traditionally focused on long-term liabilities (Bernanke and Gertler, 1989; Holmstrom and Tirole, 1997; Kiyotaki and Moore, 1997). However, given the specific financial structure of SMEs, short-term credit constraints can have significant effects on investment decisions of this kind of firms

[7] These results obviously also depend on the composition of the sample being investigated and, in particular, on the criterion adopted to identify green companies.

**Table 3**
Descriptive statistics and difference in means.

| | Full Sample | | Green | | Non-green | | *t*-test Green vs. Non-green | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | **Mean** | **St. dev.** | **Mean** | **St. dev.** | **Mean** | **St. dev.** | **Δ** | ***t*-test** |
| Long-term bank credit | 0.086 | 0.118 | 0.087 | 0.110 | 0.086 | 0.118 | 0.001 | (0.723) |
| Short-term bank credit | 0.099 | 0.199 | 0.078 | 0.107 | 0.100 | 0.201 | −0.022*** | (−8.825) |
| Financial expenses | 0.127 | 0.615 | 0.177 | 0.758 | 0.125 | 0.610 | 0.052*** | (5.982) |
| Age | 30.007 | 15.918 | 24.386 | 13.743 | 30.193 | 15.952 | −5.807*** | (−31.941) |
| Size | 8.645 | 0.960 | 8.722 | 1.074 | 8.643 | 0.955 | 0.079*** | (7.107) |
| North | 0.707 | 0.455 | 0.513 | 0.499 | 0.714 | 0.452 | −0.201*** | (−38.699) |
| South | 0.131 | 0.338 | 0.301 | 0.458 | 0.125 | 0.331 | 0.175*** | (45.654) |
| Account payable | 0.177 | 0.171 | 0.192 | 0.167 | 0.177 | 0.171 | 0.015*** | (7.734) |
| Account receivable | 0.249 | 0.188 | 0.275 | 0.212 | 0.248 | 0.187 | 0.026*** | (12.301) |
| Financial receivable | 0.007 | 0.034 | 0.009 | 0.039 | 0.007 | 0.034 | 0.003*** | (5.702) |
| Fixed investments | 0.307 | 0.205 | 0.377 | 0.214 | 0.305 | 0.205 | 0.071*** | (29.854) |
| ROA | 0.054 | 0.125 | 0.055 | 0.122 | 0.055 | 0.126 | −0.0002 | (−0.123) |
| σROA | 0.056 | 0.087 | 0.066 | 0.081 | 0.056 | 0.087 | 0.010*** | (9.989) |
| Equity/Total Assets | 0.356 | 0.221 | 0.330 | 0.217 | 0.357 | 0.221 | −0.028*** | (−10.716) |
| Liquidity ratio | 1.515 | 1.221 | 1.592 | 1.228 | 1.513 | 1.221 | 0.079*** | (5.520) |

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

**Table 4**
Panel regression – Full sample.

| | ***Long-term bank credit*** (1) | ***Short-term bank credit*** (2) | ***Financial expenses*** (3) |
|---|---|---|---|
| Green | −0.011*** | −0.020*** | 0.001*** |
| | (0.001) | (0.002) | (0.0004) |
| Age | −0.010*** | 0.030*** | −0.001*** |
| | (0.001) | (0.001) | (0.0001) |
| Size | −0.001*** | 0.006*** | −0.001*** |
| | (0.0003) | (0.0004) | (0.0001) |
| Short-term bank credit | 0.061*** | | 0.027*** |
| | (0.001) | | (0.0004) |
| Long-term bank credit | | | 0.012*** |
| | | | (0.0005) |
| Account payable | −0.032*** | 0.535*** | −0.017*** |
| | (0.002) | (0.003) | (0.0005) |
| Account receivable | 0.023*** | −0.057*** | 0.002*** |
| | (0.002) | (0.002) | (0.0004) |
| Fixed investments | 0.152*** | | |
| | (0.001) | | |
| ROA | −0.081*** | −0.141*** | |
| | (0.002) | (0.004) | |
| σROA | −0.076*** | 0.132*** | −0.0001 |
| | (0.004) | (0.006) | (0.001) |
| Liquidity ratio | | −0.019*** | −0.001*** |
| | | (0.0003) | (0.0001) |
| Constant | 0.088*** | −0.127*** | 0.025*** |
| | (0.003) | (0.004) | (0.001) |
| Year FE* Geographical area FE | Yes | Yes | Yes |
| $R^2$ | 0.108 | 0.242 | 0.044 |
| No. of observations | 197,451 | 195,834 | 195,837 |

The table presents the results for FE panel regression obtained through Eqs. 1, 2, and 3 on the full sample. In column (1), the dependent variable is Long-term bank credit; in column (2), the dependent variable is Short-term bank credit; in column (3), the dependent variable is Financial expenses. The standard errors are in parentheses. $R^2$ reported is within $R^2$. *, **, *** indicate 10 %, 5 % and 1 % significance levels, respectively.

(Nicolas, 2022). In general, access to finance is one of the main obstacles to firms' innovation and growth (Mina et al., 2013; Nanda and Kerr, 2015; Hall et al., 2016), because the returns to innovation are often uncertain and skewed. This is even more true for green innovations, where the risks and uncertainties are higher than for standard innovations (Cuerva et al., 2014; Ghisetti et al., 2017). Financial constraints may therefore be a major obstacle to the implementation of green research projects (Cecere et al., 2020; Demirel and Parris, 2015). Table 4, column 1, also shows that firms receive less Long-term bank credit when Age, Size, Accounts payable, ROA and σROA increase; firms receive more Long-term bank credit when Short-term bank credit, Account receivable and Fixed investment increase. Table 4, column 2, shows that firms use less Short-term bank credit when Account receivable, ROA and Liquidity ratio increase; firms receive more Short-term bank credit when Age, Size, Accounts payable and σROA increase. Finally, Table 4, in column 3,

reports the results for the panel regression related to Eq. 3, in which the dependent variable is the Financial expenses. Green SMEs seem to pay higher financial expenses than non-green ones. Green sectors are probably perceived by banks as riskier. However, previous studies have documented that companies with better environmental performance have less credit risk (e.g., Zeidan et al., 2015). Moreover, of course, financial expenses increase when bank credit increases (especially Short-term bank credit), and when Account receivable increase, and they decrease when Age, Size, Account payable and Liquidity ratio increase.

To address potential sample selection bias, we use the PSM (Rosenbaum and Rubin, 1983, 1985). We find the means of several control variables to be significantly different when segmented green and non-green MSMEs, with t-value ranging from −38.699 for the *North* variable to 45.654 for the *South* variable (Table 3). To adjust for observable differences between green and non-green MSMEs, we use control variables to match green MSMEs and non-green ones. These control variables are consistent with the main indicators used in the literature to assess the creditworthiness of enterprises (Altman, 1968; Beaver, 1966; Lin et al., 2011; Min et al., 2006; Ohlson, 1980) and they are related to the profitability, financial structure, solvency and liquidity of enterprises. Table B1 in Appendix B shows that after we perform PSM, the t-values of the difference in means range from −0.495–1.596. After obtaining the balanced sample via PSM, we perform univariate test to compare the mean levels of *Long-term bank credit, Short-term bank credit* and *Financial expenses* between green and non-green firms. We report these results in Appendix B, Table B2. The differences between green and non-green MSMEs for Short-term bank credit and Financial expenses are still statistically significant at the 1 % level; furthermore, the differences between green and non-green MSMEs for Long-term bank credit become statistically significant at the 1 % level post PSM. Appendix B, Table B3 provides results from a panel regression identical to that presented in Table 4 but for the PSM sample. The coefficient on the *Green* dummy remains significant: green MSMEs are more financially constrained and pay higher financial expenses than non-green ones. Most inferences are unchanged from Table 4.

### 4.3. Robustness checks

#### 4.3.1. Level and cost of bank credit: differences between green and non-green MSMEs

Table 5 shows the FE panel regression results for green and non-green sub-samples. Columns (1) and (2) refer to Eq. 1, where the dependent variable is Long-term bank credit; columns (3) and (4) refer to Eq. 2, where the dependent variable is Short-term bank credit; columns (5) and (6) refer to Eq. 3, where the dependent variable is Financial expenses. With increasing Age and Size, non-green MSMEs receive less Long-term bank credit and more Short-term bank credit while the Age of green MSMEs only positively affects the level of Short-term bank credit. Older non-green MSMEs and, in general, larger SMEs pay fewer Financial expenses.

We note that there is a more pronounced substitution effect between account payable and bank credit for green SMEs, particularly

**Table 5**
Panel regression – green and non-green subsamples.

| | ***Long-term bank credit*** | | ***Short-term bank credit*** | | ***Financial expenses*** | |
|---|---|---|---|---|---|---|
| | **Green** (1) | **Non-green** (2) | **Green** (3) | **Non-green** (4) | **Green** (5) | **Non-green** (6) |
| Age | −0.004 | −0.010*** | 0.016*** | 0.030*** | 0.00001 | −0.0001*** |
| | (0.002) | (0.001) | (0.002) | (0.001) | (0.0002) | (0.0001) |
| Size | −0.001 | −0.001*** | 0.001 | 0.007*** | −0.0003** | −0.002*** |
| | (0.001) | (0.0003) | (0.001) | (0.0004) | (0.0001) | (0.0001) |
| Short-term bank credit | 0.136*** | 0.060*** | | | 0.024*** | 0.028*** |
| | (0.012) | (0.001) | | | (0.001) | (0.0004) |
| Long-term bank credit | | | | | 0.018*** | 0.012*** |
| | | | | | (0.001) | (0.001) |
| Account payable | −0.037*** | −0.031*** | −0.144*** | 0.554*** | −0.0005 | −0.017*** |
| | (0.009) | (0.002) | (0.009) | (0.003) | (0.001) | (0.0005) |
| Account receivable | 0.025*** | 0.023*** | 0.095*** | −0.060*** | 0.0001 | 0.002*** |
| | (0.008) | (0.002) | (0.007) | (0.003) | (0.001) | (0.0004) |
| Fixed investments | 0.174*** | 0.150*** | | | | |
| | (0.007) | (0.002) | | | | |
| ROA | −0.007 | −0.083*** | −0.099*** | −0.146*** | | |
| | (0.011) | (0.002) | (0.010) | (0.004) | | |
| σROA | −0.093*** | −0.075*** | 0.023 | 0.137*** | 0.011*** | −0.001 |
| | (0.016) | (0.004) | (0.015) | (0.006) | (0.001) | (0.001) |
| Liquidity ratio | | | −0.036*** | −0.018*** | −0.001*** | −0.001*** |
| | | | (0.001) | (0.0004) | (0.0001) | (0.0001) |
| Constant | 0.039*** | 0.089*** | 0.080*** | −0.134*** | 0.008*** | 0.026*** |
| | (0.013) | (0.003) | (0.013) | (0.005) | (0.001) | (0.001) |
| Year FE* Geographical area FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.134 | 0.107 | 0.176 | 0.243 | 0.168 | 0.043 |
| No. of observations | 6452 | 190,999 | 6405 | 189,429 | 6405 | 189,432 |

The table presents the results for FE panel regression obtained through Eqs. 1, 2, and 3 on the green and non-green samples. In columns (1) ad (2), the dependent variable is Long-term bank credit; in columns (3) and (4), the dependent variable is Short-term bank credit; 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 10 %, 5 % and 1 % significance levels, respectively.

as regards short-term bank credit (the coefficients are −0.037 and −0.144 for green enterprises). In the case of green MSMEs, the increase in Account receivable leads to a greater use of Short-term bank credit (the coefficient is positive unlike the coefficient for non-green companies, which is negative). Fixed investments, on average higher for green MSMEs (see Table 3), will lead to a greater use of Long-term bank credit, precisely for this kind of enterprises (the coefficient is positive and higher than that of non-green firms). Non-green MSMEs show a negative relationship between ROA and Long-term bank credit; the negative relationship between σROA and Long-term bank credit is greater for green MSMEs, which on average show a higher σROA (see Table 3) than non-green ones; σROA in fact also entails greater financial expenses for green companies (the coefficient is positive and significant).

#### 4.3.2. Level and cost of bank credit: differences between micro, small and medium enterprises

Table 6 shows results considering the size of enterprises included in our sample. The firm size is proxied by the number of firm employees: micro-sized firms are those having less than 10 employees; small-sized firms have between 10 and 49 employees; and medium-sized firms have between 50 and 249 employees. Micro, small- and medium-sized firms make up 14.01 %, 64.80 % and 21.19 % of the sample, respectively (see Table 1). We run our model for different micro-, small- and medium-sized companies separately. Table 6, in columns (1), (4), and (7), reports the results for the panel regression related to Eq. 1 (dependent variable: Long-term bank credit), for micro, small and medium firms respectively. Table 6, in columns (2), (5), and (8), reports the results for the panel regression related to Eq. 2 (dependent variable: Short-term bank credit), for micro, small and medium firms respectively. Columns (3), (6), and (9) of Table 6 report the results for the panel regression related to Eq. 3 (dependent variable: Financial expenses), for micro, small and medium firms respectively. The negative relationship between Green and Long-term bank credit is more evident in the case of micro enterprises (the coefficient of *Green* variable is higher than that of the same variable for small- and medium-sized firms). Furthermore, Short-term bank credit contributes more to the level of Financial expenses than Long-term bank credit, and this is more the case for micro-enterprises (the coefficient is higher than that of small and medium enterprises). We also note a substitution effect between trade credit (Account payable) and bank credit (both long-term and short-term) for small- and medium-sized enterprises (the coefficients are negative and significant). In general, when ROA is higher, bank lending is reduced and when σROA is higher, Short-term bank credit is lower and Financial expenses are higher (for small and medium enterprises).[8]

### 4.4. Riskiness of firms: differences between green and non-green SMEs

According to the Merton model (Merton, 1974) it is possible to quantify the probability of default (PD) as a component of the pricing of a put option (whose value is estimated on the basis of the Black and Scholes option pricing model) written on the market value of the assets, strike corresponding to the value of the debt, same maturity as the debt. It can easily be demonstrated that, to cover the credit risk of the loans granted, creditors could in fact acquire a put option on the market value of the company's assets with the same maturity as the loan and a strike price equal to the repayment value of the debt. In this sense the PD embedded in the pricing of the put option can be expressed as the probability that the market value of the company's assets will be less than the repayment value of the loan at maturity. However, the absence of a systematic market value of the assets of the companies considered (the accounting principles applied to the statutory financial statements of unlisted companies are mainly based on the historical cost of the assets and not on their current value) implies some difficulties in the full application of the Merton model and therefore in the quantification of the PD embedded in the pricing of the put option. However, it is known that this PD is an increasing function of the volatility of the company's asset returns and the debt ratio (debt/assets), thus Table 7 shows the values of these indicators for green and non-green MSMEs and the results from the univariate *t*-tests showing the significance of the mean differences between green and non-green micro, small and medium enterprises. Therefore, we analyze the riskiness of green companies compared to non-green ones. In the period 2015-2022, medium and small green companies show on average a significant higher value of volatility of asset returns and financial expenses-total bank ratio than their non-green counterparts. Only micro green enterprises are characterized by lower leverage than non-greens. In order to better verify our H2, we also run a FE panel regression where the dependent variable is the ratio between Financial expenses and Total bank credit and main independent variables are Leverage and σROA. Main results are shown in Table 8. In general, for green MSMEs, the volatility of the ROA significantly influences the financial expenses, to a greater extent than it does not happen for corresponding non-green enterprises. This is particularly true for micro and medium green enterprises.

## 5. Conclusions

The Italian economy is based on over 4 million MSMEs, which employ almost 13 million people and generate 64 % of the country's value added. As a result, these enterprises play a crucial role in Italian economic growth. These companies are exposed to the consequences of global warming which manifests itself through storms, floods and heat waves, causing not only significant economic costs

[8] As additional robustness checks we performed analyses on the green and non-green MSME subsamples considering their size (i.e., micro, small and medium enterprises) and the results confirm those shown in the tables presented. Results are available on request.

**Table 6**
Panel regression by size – Full sample.

| | Micro | | | Small | | | Medium | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Long-term bank credit** (1) | **Short-term bank credit** (2) | **Financial expenses** (3) | **Long-term bank credit** (4) | **Short-term bank credit** (5) | **Financial expenses** (6) | **Long-term bank credit** (7) | **Short-term bank credit** (8) | **Financial expenses** (9) |
| Green | −0.028*** | −0.010 | −0.001 | −0.003** | −0.013*** | 0.001*** | −0.013*** | −0.028*** | 0.002*** |
| | (0.007) | (0.011) | (0.003) | (0.002) | (0.002) | (0.0001) | (0.002) | (0.002) | (0.0001) |
| Age | −0.011*** | 0.067*** | −0.004*** | −0.011*** | −0.001** | −0.0001** | −0.001 | 0.003*** | −0.001*** |
| | (0.002) | (0.004) | (0.001) | (0.0005) | (0.001) | (0.0004) | (0.001) | (0.001) | (0.0001) |
| Size | −0.008*** | 0.013*** | −0.006*** | −0.002*** | 0.011*** | −0.001*** | −0.007*** | 0.005*** | −0.0003*** |
| | (0.001) | (0.002) | (0.001) | (0.0003) | (0.0003) | (0.00003) | (0.001) | (0.001) | (0.00005) |
| Short-term bank credit | −0.013*** | | 0.047*** | 0.152*** | | 0.029*** | 0.189*** | | 0.024*** |
| | (0.004) | | (0.002) | (0.003) | | (0.0002) | (0.004) | | (0.003) |
| Long-term bank credit | | | 0.006*** | | | 0.018*** | | | 0.014*** |
| | | | (0.003) | | | (0.0002) | | | (0.0004) |
| Account payable | 0.029*** | 1.272*** | −0.057*** | −0.013*** | −0.183*** | −0.001*** | −0.018*** | −0.177*** | −0.002*** |
| | (0.007) | (0.007) | (0.003) | (0.002) | (0.002) | (0.0002) | (0.004) | (0.004) | (0.0003) |
| Account receivable | 0.029*** | −0.350*** | 0.012*** | −0.007*** | 0.167*** | −0.001*** | 0.006** | 0.161*** | −0.002*** |
| | (0.007) | (0.010) | (0.003) | (0.002) | (0.002) | (0.0002) | (0.003) | (0.003) | (0.0002) |
| Fixed investments | 0.131*** | | | 0.158*** | | | 0.158*** | | |
| | (0.006) | | | (0.002) | | | (0.003) | | |
| ROA | −0.050*** | −0.054*** | | −0.066*** | −0.178*** | | −0.047*** | −0.145*** | |
| | (0.008) | (0.012) | | (0.003) | (0.003) | | (0.004) | (0.004) | |
| σROA | 0.078*** | 0.152*** | −0.004 | −0.118*** | −0.071*** | 0.004*** | −0.178*** | −0.183*** | 0.007*** |
| | (0.010) | (0.016) | (0.004) | (0.005) | (0.005) | (0.0004) | (0.008) | (0.008) | (0.001) |
| Liquidity ratio | | 0.004*** | −0.002*** | | −0.042*** | −0.001*** | | −0.052*** | −0.001*** |
| | | (0.001) | (0.0003) | | (0.0002) | (0.00003) | | (0.0005) | (0.00004) |
| Constant | 0.132*** | −0.407*** | 0.081*** | 0.099*** | 0.080*** | 0.014*** | 0.111*** | 0.128*** | 0.010*** |
| | (0.015) | (0.014) | (0.006) | (0.003) | (0.003) | (0.0003) | (0.006) | (0.006) | (0.0005) |
| Year FE* Geographical area FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.031 | 0.631 | 0.019 | 0.144 | 0.262 | 0.208 | 0.163 | 0.256 | 0.211 |
| No. of observations | 24,489 | 23,663 | 23,666 | 123,785 | 123,060 | 123,060 | 49,177 | 49,111 | 49,111 |

The table presents the results for FE panel regression obtained through Eqs. 1, 2, and 3. Columns (1), (2), and (3) refer to micro enterprises; columns (4), (5), and (6) refer to small-sized enterprises; columns (7), (8), and (9) refer to medium-sized enterprises. The standard errors are in parentheses. $R^2$ reported is within $R^2$. *, **, *** indicate 10 %, 5 % and 1 % significance levels, respectively.

**Table 7**
Descriptive statistics on financial risk indicators.

| Green | | | | Non-green | | |
|---|---|---|---|---|---|---|
| **Variable** | **Leverage** | **σROA** | **Fin. expenses/Total bank credit** | **Leverage** | **σROA** | **Fin. expenses/Total bank credit** |
| **Micro** | | | | | | |
| Mean | 0.54 | 0.08 | 0.21 | 0.61 | 0.08 | 0.17 |
| St. dev. | 0.31 | 0.08 | 0.83 | 0.71 | 0.16 | 0.71 |
| Median | 0.55 | 0.05 | 0.04 | 0.59 | 0.04 | 0.04 |
| Skewness | 0.47 | 2.91 | 6.74 | 15.13 | 10.47 | 8.25 |
| Kurtosis | 1.03 | 10.78 | 54.41 | 381.22 | 193.76 | 80.43 |
| ***t*-test Green vs. Non-green** | | | | | | |
| **Δ** | −0.07 | −0.004 | 0.05 | | | |
| ***t*-test** | (−1.30) | (−0.79) | (1.55) | | | |
| **Small** | | | | | | |
| Mean | 0.56 | 0.07 | 0.17 | 0.54 | 0.05 | 0.12 |
| St. dev. | 0.27 | 0.08 | 0.75 | 0.25 | 0.06 | 0.60 |
| Median | 0.58 | 0.05 | 0.04 | 0.57 | 0.04 | 0.03 |
| Skewness | 1.53 | 8.57 | 8.63 | 2.27 | 12.98 | 10.18 |
| Kurtosis | 29.16 | 120.00 | 87.93 | 125.43 | 339.16 | 121.71 |
| ***t*-test Green vs. Non-green** | | | | | | |
| **Δ** | 0.02 | 0.02*** | 0.05*** | | | |
| ***t*-test** | (2.32) | (16.59) | (4.29) | | | |
| **Medium** | | | | | | |
| Mean | 0.61 | 0.06 | 0.18 | 0.56 | 0.05 | 0.11 |
| St. dev. | 0.25 | 0.08 | 0.75 | 0.22 | 0.05 | 0.59 |
| Median | 0.64 | 0.04 | 0.04 | 0.58 | 0.04 | 0.02 |
| Skewness | 0.34 | 5.15 | 8.64 | 0.07 | 10.90 | 10.43 |
| Kurtosis | 5.77 | 31.89 | 84.94 | 3.54 | 267.24 | 126.41 |
| ***t*-test Green vs. Non-green** | | | | | | |
| **Δ** | 0.05 | 0.01*** | 0.07*** | | | |
| ***t*-test** | (4.25) | (4.38) | (4.20) | | | |

**Table 8**
Panel regression by size – green and non-green subsamples.

| | **FULL SAMPLE** | | **MICRO** | | **SMALL** | | **MEDIUM** | |
|---|---|---|---|---|---|---|---|---|
| | **Green** (1) | **Non-green** (2) | **Green** (3) | **Non-green** (4) | **Green** (5) | **Non-green** (6) | **Green** (7) | **Non-green** (8) |
| Leverage | 0.0001 | −9.39e−06 | 0.0001 | −0.00002 | 0.0001 | −0.00002 | −0.0001 | 9.52e−06 |
| | (0.0001) | (0.00002) | (0.001) | (0.0001) | (0.0001) | (0.00003) | (0.001) | (0.0001) |
| σROA | 0.424*** | 0.338*** | 1.404*** | 0.198*** | 0.046 | 0.360*** | 1.154*** | 0.592*** |
| | (0.128) | (0.022) | (0.426) | (0.041) | (0.158) | (0.032) | (0.264) | (0.065) |
| Constant | 0.149*** | 0.108*** | 0.109** | 0.153*** | 0.164*** | 0.105*** | 0.122 | 0.086*** |
| | (0.013) | (0.002) | (0.047) | (0.006) | (0.017) | (0.002) | (0.024) | (0.004) |
| Year FE* Geographical area FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.257 | 0.227 | 0.224 | 0.226 | 0.534 | 0.537 | 0.229 | 0.056 |
| No. of observations | 5262 | 159,598 | 579 | 18,586 | 3115 | 100,981 | 1568 | 40,031 |

The table presents the results for FE panel regression where the dependent variable is Financial expenses/Total bank credit. Columns (1) and (2) refer to the full sample; Columns (3) and (4) refer to micro enterprises; Columns (5) and (6) refer to small enterprises and Columns (7) and (8) refer to medium enterprises. Columns (1), (3), (5) and (7) refer to green SMEs; Columns (2), (4), (6) and (8) refer to non-green ones. The standard errors are in parentheses. $R^2$ reported is within $R^2$. *, **, *** indicate 10 %, 5 % and 1 % significance levels, respectively.

but also huge financial losses, threatening their stability because they are weaker than larger ones. Climate change will consequently affect the performance and risks of MSEMEs leading lenders and investors to focus more on sustainable and green investments. Investments in green technologies should be particularly suitable for improving the financial rating of companies: recent studies on green companies demonstrate greater financial resilience, a lower operational risk and probability of default than non-green ones. In light of this, this study examines whether Italian green MSMEs receive more or less bank credit than non-green ones and whether there is consistency between their credit risk on one hand and the cost of credit on the other. In our analysis, the sample of "green companies" is such because they belong to industries with an important green component such as Collection, Reuse, Recycling of Waste, Efficiency of

water systems, Planning and reclamation of the territory, Waste water treatment, Energy Storage. These sectors are influenced by high technical specificities and intense innovations both from a technological and regulatory point of view (Wang et al., 2025; Görçün et al., 2025; Li et al., 2025) leading these companies to be more investment-oriented and also with higher volatility of asset returns over the years than non-green ones. Both these data (together with the technical complexity of the production processes) express, in the case of financial intermediaries, a perception of greater operational risk (which is a significant source of credit risk) of these green companies compared to non-green ones. This perception might explain, on the one hand, the reduced ease of access to bank credit together with its higher cost and, on the other hand, their greater orientation towards trade credit on the basis of the competitive advantages of supplier firms over banks in assessing the creditworthiness of client companies (Biais and Gollier, 1997; Petersen and Rajan, 1997; Pike et al., 2005). For these reasons, Hypotheses 1 and 2 are rejected. However, the reduced access of green companies to bank credit is a worrying fact: on the one hand the risk is that investments for the green transition will be slowed down or even postponed, and on the other hand, the fact that much of the financing of green companies comes from trade credit implies a concentration of risks within the respective industries which is far from optimal. This implies the need for green companies and their investments to be increasingly integrated into business operations, allowing SMEs to identify and manage potential risks related to sustainability as well as the need to be better known and appreciated by the financial system also because the green transition is increasingly strategic. This dissemination of knowledge could be facilitated by operators who issue companies with a specific green rating based on a rigorous, standardized and as uniform as possible in order to avoid further misunderstandings and the dissemination of partial and difficult to compare information. It follows that one of the main policy recommendations is the creation of rigorous and harmonized frameworks to evaluate and disclose the greenness of SMEs, and support comparability. And it is precisely in this direction that the legislation is moving; for example, the *Corporate Sustainability Reporting Directive* (CSRD – EU Directive 2022/2464) will oblige listed SMEs to provide information on the environmental impacts of their activities starting from 2029. Indeed, an important limitation of this study is that we focus on green industries with a supposed "particularly high green component" and not on green companies based on a minimum green rating, due to the absence of a mandatory credit rating and the lack of comparability of rating systems offered by private agencies. In this sense, it would be advisable to repeat the analysis by selecting green companies on the basis of methodologically stable and reliable external ratings.

## Author Statement

The authors confirm that:

- the work has not been published;
- the article is not under consideration for publication elsewhere;
- the article's publication is approved by all authors;
- if accepted, the article will not be published elsewhere in the same form, in English or in any other language, including electronically, without the written consent of the copyright-holder.

## CRediT authorship contribution statement

**Pisani Raoul:** Writing – review & editing, Writing – original draft, Validation, Supervision, Formal analysis, Conceptualization. **Maria Cristina Arcuri:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Gandolfi Gino:** Supervision, Conceptualization.

## Declaration of Competing Interest

The authors have no conflicts of interest to disclose.

## Appendix A. Univariate Pearson correlation matrix

Table A1 shows the Univariate Pearson correlation matrix for the full sample.

**Table A1**
Pearson correlation coefficients - Full sample

| | Long-term bank credit | Short-term bank credit | Financial expense | Green | Age | Size | Account payable | Account receivable | Financial receivable | Fixed investments | ROA | σROA | Equity/Total Assets | Liquidity ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Long-term bank credit | 1 | | | | | | | | | | | | | |
| Short-term bank credit | 0.083* | 1 | | | | | | | | | | | | |
| Financial expenses | 0.079* | 0.174* | 1 | | | | | | | | | | | |
| Green | 0.002 | −0.020* | 0.003 | 1 | | | | | | | | | | |
| Age | −0.021* | −0.003 | −0.022* | −0.064* | 1 | | | | | | | | | |
| Size | 0.050* | −0.006* | −0.056* | 0.014* | 0.202* | 1 | | | | | | | | |
| Account payable | −0.012* | 0.449* | 0.017* | 0.016* | −0.088* | 0.050* | | | | | | | | |
| Account receivable | −0.061* | 0.092* | 0.007* | 0.025* | −0.038* | −0.003 | 0.463* | 1 | | | | | | |
| Financial receivable | −0.013* | −0.016* | −0.002 | 0.012* | 0.008* | 0.091* | −0.004* | −0.019* | 1 | | | | | |
| Fixed investments | 0.271* | 0.006* | 0.028* | 0.061* | 0.110* | 0.073* | −0.232* | −0.380* | 0.106* | 1 | | | | |
| ROA | −0.117* | −0.138* | −0.099* | −0.0003 | −0.029* | 0.046* | −0.039* | 0.078* | 0.005* | −0.141* | 1 | | | |
| σROA | −0.050* | 0.081* | 0.054* | 0.020* | −0.099* | −0.127* | 0.034* | −0.045* | −0.002 | −0.070* | −0.166* | 1 | | |
| Equity/Total Assets | −0.341* | −0.477* | −0.349* | −0.022* | 0.212* | 0.152* | −0.344* | −0.204* | 0.056* | 0.089* | 0.255* | 0.030* | 1 | |
| Liquidity ratio | −0.140* | −0.247* | −0.098* | 0.011* | 0.077* | 0.001 | −0.233* | −0.043* | 0.017* | −0.181* | 0.199* | 0.022* | 0.644* | 1 |

The table shows the Pearson correlation matrix for the full sample. * indicates significance levels at 5 %.

## Appendix B. . PSM and panel regressions

Table B1 shows that after the PSM, t-values of the difference in means range from −0.495–1.596.

**Table B1**
Propensity Score Matching (Full sample)

| | Green | | Non-green | | *t*-test Green vs. Non-green | |
|---|---|---|---|---|---|---|
| **Variable** | **Mean** | **St. dev** | **Mean** | **St. dev** | **Δ** | ***t*-test** |
| Age | 25.368 | 13.391 | 24.989 | 13.642 | 0.379 | (1.463) |
| Size | 8.858 | 0.958 | 8.851 | 0.966 | 0.007 | (0.397) |
| North | 0.511 | 0.500 | 0.510 | 0.500 | 0.001 | (0.148) |
| South | 0.299 | 0.458 | 0.292 | 0.455 | 0.007 | (0.834) |
| Fixed investments | 0.380 | 0.207 | 0.379 | 0.213 | 0.001 | (0.231) |
| ROA | 0.065 | 0.069 | 0.065 | 0.077 | 0.000 | (0.017) |
| Equity/Total Assets | 0.308 | 0.195 | 0.310 | 0.205 | −0.002 | (−0.495) |
| Liquidity ratio | 1.501 | 1.061 | 1.464 | 1.327 | 0.037 | (1.596) |

The table reports a comparison of variables for green and non-green MSMEs from the PSM methodology for the full sample to assess the extent of balancing achieved on the two matched samples. To adjust for observable differences between green and non-green MSMEs, we use control variables to match green MSMEs and non-green ones. No. of observations: 10,884, of which 5549 are green and 5335 are non-green.

Table B2 reports univariate differences between green and non-green MSMEs for Long-term bank credit, Short-term bank credit and Financial expenses, after obtaining the balanced sample via PSM.

**Table B2**
Univariate differences between green and non-green MSMEs

| | Green | | Non-green | | *t*-test Green vs. Non-green | |
|---|---|---|---|---|---|---|
| **Variable** | **Mean** | **St. dev** | **Mean** | **St. dev** | **Δ** | ***t*-test** |
| Long-term bank credit | 0.101 | 0.112 | 0.121 | 0.123 | −0.020*** | (−9.015) |
| Short-term bank credit | 0.086 | 0.104 | 0.104 | 0.110 | −0.018*** | (−8.728) |
| Financial expenses | 0.155 | 0.669 | 0.105 | 0.552 | 0.051*** | (4.094) |

The table presents a univariate *t*-test for the full sample after PSM. Significance at the 1 %, 5 % and 10 % level are indicated by ***, **, and *, respectively. No. of observations: 10,884, of which 5549 are green and 5335 are non-green.

Table B3 shows results from a panel regression identical to that presented in Table 4 for the PSM sample.

**Table B3**
Panel regression post PSM – Full sample

| | ***Long-term bank credit*** | | ***Short-term bank credit*** | ***Financial expenses*** |
|---|---|---|---|---|
| Green | −0.017**** | | | |
| | (0.002) | −0.021*** | 0.001*** | |
| | | (0.002) | (0.0002) | |
| Age | −0.010*** | | | |
| | (0.002) | 0.008*** | −0.0005*** | |
| | | (0.002) | (0.0002) | |
| Size | −0.005*** | | | |
| | (0.001) | 0.003*** | −0.001*** | |
| | | (0.001) | (0.0001) | |
| Short-term bank credit | 0.106*** | | | |
| | (0.010) | | 0.025*** | |
| | | | (0.001) | |
| Long-term bank credit | | | | |
| | | | 0.016*** | |
| | | | (0.001) | |
| Account payable | −0.079*** | | | |
| | (0.009) | −0.164*** | −0.002** | |
| | | (0.008) | (0.001) | |
| Account receivable | 0.003 | | | |
| | (0.008) | 0.136*** | −0.0003 | |
| | | (0.006) | (0.0005) | |
| Fixed investments | 0.166*** | | | |
| | (0.006) | | | |

(*continued on next page*)

**Table B3** (*continued*)

| | *Long-term bank credit* | | *Short-term bank credit* | *Financial expenses* |
|---|---|---|---|---|
| ROA | −0.088*** | | | |
| | (0.015) | −0.125*** | | |
| | | (0.013) | | |
| σROA | −0.063*** | | | |
| | (0.014) | −0.021* | 0.004*** | |
| | | (0.012) | (0.001) | |
| Liquidity ratio | | | | |
| | | −0.037*** | −0.001*** | |
| | | (0.001) | (0.0001) | |
| Constant | 0.153*** | | | |
| | (0.012) | 0.114*** | 0.014*** | |
| | | (0.010) | (0.001) | |
| Year FE* Geographical area FE | Yes | Yes | Yes | |
| $R^2$ | 0.143 | | | |
| | | 0.209 | 0.170 | |
| No. of observations | 10,570 | 10,570 | 10,570 | |

The table presents the results for FE panel regression obtained through Eqs. 1, 2, and 3; In column 1, 2 and 3, the dependent variable is Long-term bank credit, Short-term bank credit, and Financial expenses, respectively. The standard errors are in parentheses. $R^2$ reported is within $R^2$. *, **, *** indicate 10 %, 5 % and 1 % significance levels, respectively.

## Data availability

Data will be made available on request.

## References


Abbas Rizvi S.K., Yarovaya L., Mirza N., Naqvi B. The impact of COVID-19 on the valuations of non-financial European firms Heliyon (2022), Article e09486, ⟨10.1016/j.heliyon.2022.e09486⟩.

Abeberese, A.B., 2017. "Electricity cost and firm performance: evidence from India". Rev. Econ. Stat. 99 (5), 839–852.

Afrifa, G.A., Tauringana, V., Tingbani, I., 2014. Working capital management and performance of listed SMEs. J. Small Bus. Entrep. 27 (6), 557–578. https://doi.org/10.1080/08276331.2015.1114351.

Afrifa, G.A., Tingbani, I., Alshehabi, A., Halabi, H., 2024. Short-term credit policies and operating performance. Rev. Quant. Financ. Account. 62, 1755–1790. https://doi.org/10.1007/s11156-024-01249-5.

Altman, E.I., 1968. Financial ratio, discriminant analysis,and the prediction of corporate bankruptcy. J. Financ. 23, 589–609. https://doi.org/10.2307/2978933.

Arcuri, M.C., Di Tommaso, C., Pisani, R., 2024. Does gender matter in financing SMEs in green industry? Res. Int. Bus. Financ. 69, 102222. https://doi.org/10.1016/j.ribaf.2024.102222.

Arcuri, M.C., Pisani, R., 2021. Is trade credit a sustainable resource for medium-sized italian green companies? Sustainability 13, 2872. https://doi.org/10.3390/su13052872.

Aristei, D., Angori, G., 2022. Heterogeneity and state dependence in firms' access to bank credit. Small Bus. Econ. 59, 47–78. https://doi.org/10.1007/s11187-021-00545-x.

Barra, C., Ruggiero, N., 2023. Bank-specific factors and credit risk: evidence from Italian banks in different local markets. J. Financ. Regul. Compliance 31 (3), 316–350. https://doi.org/10.1108/JFRC-04-2022-0051.

Bartz, W., Winkler, A., 2016. Flexible or fragile? The growth performance of small and young businesses during the global financial crisis—Evidence from Germany. J. Bus. Ventur. 31 (2), 196–215. https://doi.org/10.1016/j.jbusvent.2015.10.002.

Battisti, M., Deakins, D., 2012. Perspectives from New Zealand small firms: crisis management and the impact of the Canterbury earthquakes. In New Zealand Centre for Small & Medium Enterprise Research (Ed.), BusinesSMEasure. Massey University, pp. 1–41.

Bauer, R., Hann, D. (2010). Corporate environmental management and credit risk. ⟨http://dx.doi.org/10.2139/ssrn.1660470⟩.

Beaver, W., 1966. Financial ratios as predictors of failure. empirical research in accounting: Selected studies. J. Account. Res. 4, 71–111. https://doi.org/10.2307/2490171.

Beck, T., Demirguc-Kunt, A., 2006. Small and medium-size enterprises: access to finance as a growth constraint. J. Bank. Financ. 30 (11), 2931–2943. https://doi.org/10.1016/j.jbankfin.2006.05.009.

Berger, A.N., Udell, G.F., 1998. The economics of small business finance: the roles of private equity and debt markets in the financial growth cycle. J. Bank. Financ. 22 (6-8), 613–673. https://doi.org/10.1016/S0378-4266(98)00038-7.

Bernanke, B.S., Gertler, M., 1989. Agency costs, collateral, and business fluctuations. Am. Econ. Rev. 14–31. https://doi.org/10.3386/w2015.

Biais, B., Gollier, C., 1997. Trade credit and credit rationing. Rev. Financ. Stud. 10, 903–937.

Bougheas, S., Mateut, S., Mizen, P., 2009. Corporate trade credit and inventories: new evidence of a trade-off from account payable and receivable". J. Bank. Financ. 33, 300–307. https://doi.org/10.1016/j.jbankfin.2008.07.019.

Bouslah, K., Kryzanowski, L., M'Zali, B., 2018. Social performance and firm risk: impact of the financial crisis. J. Bus. Ethics 149 (3), 643–669. https://doi.org/10.1007/s10551-016-3017-x.

Brechling, F. –, Lipsey, R., 1963. Trade credit and Monetary Policy" in. "Econ. J. 73 (4), 618–641. https://doi.org/10.2307/2228171.

Brennan, M., Maksimovic, V., Zechner, J., 1988. Vendor financing. J. Financ. 43, 1127–1141.

Bukart, M., Ellingsen, T., 2004. In-kind finance: a theory of trade". Am. Econ. Rev. 94 (3), 569–590. https://doi.org/10.1257/0002828041464579.

Burns, P., 2016. Entrepreneurship and small business. Palgrave.

Cecere, G., Corrocher, N., Mancusi, M.L., 2020. Financial constraints and public funding of eco-innovation: empirical evidence from European SMEs. Small Bus. Econ. 54, 285–302. https://doi.org/10.1007/s11187-018-0090-9.

Chen, Z., Mirza, N., Huang, L., Umar, M., 2022. Green banking – can financial institutions support green recovery? Econ. Anal. Policy 75, 389–395.

Chiang, T.C., 2020. US policy uncertainty and stock returns: evidence in the US and its spillovers to the European union, China and Japan. J. Risk Financ. 21, 621–657.

Cuerva, M.C., Triguero-Cano, A., Córcoles, D., 2014. Drivers of green and non-green innovation: empirical evidence in Low-Tech SMEs. J. Clean. Prod. 68, 104–113. https://doi.org/10.1016/j.jclepro.2013.10.049.
D'Amato, D., Korhonen, J., 2021. Integrating the green economy, circular economy and bioeconomy in a strategic sustainability framework. Ecol. Econ. 188, 107143. https://doi.org/10.1016/j.ecolecon.2021.107143.
D'Amato, D., Korhonen, J., 2021. Integrating the green economy, circular economy and bioeconomy in a strategic sustainability framework. Ecol. Econ. 188, 107143. https://doi.org/10.1016/j.ecolecon.2021.107143.
Davidson, P., Gordon, S., 2016. Much ado about nothing? The surprising persistence of nascent entrepreneurs through macroeconomic crisis. Entrep. Theory Pract. 40 (4), 915–941. https://doi.org/10.1111/etap.12152.
Deloof, M., Jegers, M., 1996. Trade credit, product quality, and intragroup trade: some European evidence. Financ Manag. 25, 33–43. https://doi.org/10.2307/3665806.
Demirel, P., Parris, S., 2015. Access to finance for innovators in the UK's environmental sector. Technol. Anal. Strateg. Manag. 27 (7), 782–808. https://doi.org/10.1080/09537325.2015.1019849.
Demirguc-Kunt, A., Lokshin, M., Torre, I., 2021. The sooner, the better: the economic impact of non-pharmaceutical interventions during the early stage of the COVID19 pandemic. Eco. Transit. Instit. Chang. https://doi.org/10.1111/ecot.12284.
Doern, R., Williams, N., Vorley, T., 2019. Special issue on entrepreneurship and crises: Business as usual? An introduction and review of the literature. Entrep. Reg. Dev. 31 (5–6), 400–412. https://doi.org/10.1080/08985626.2018.1541590.
Donthu, N., Gustafson, A., 2020. Effects of COVID-19 on business and research. J. Bus. Res 117, 284–289. https://doi.org/10.1016/j.jbusres.2020.06.008.
Duca, J., 1986. Trade Credit Credit Ratio. A Theor. Model" Wash. DC Board Gov. Fed. Reserve Syst.
Dzingirai, C., Chekenya, N.S., 2020. Longevity swaps for longevity risk management in life insurance products. J. Risk Financ. 21, 253–269. https://doi.org/10.1108/JRF-05-2019-0085/FULL/XML.
Elemes, A., Filip, A., 2022. Financial reporting quality and private firms' access to trade credit capital. Int. J. Account. 57 (2), 2250010. https://doi.org/10.1142/S109440602250010X.
Emery, G.W., 1987. An optimal financial response to variable demand. J. Financ. Quant. Anal. 22, 209–225. https://doi.org/10.2307/2330713.
Farza, K., Ftiti, Z., Hlioui, Z., Louhichi, W., Omri, A., 2021. Does it pay to go green? Environmental innovation effect on corporate financial performance. J. Environ. Manag. 300, 113695. https://doi.org/10.1016/j.jenvman.2021.113695.
Ferrando, A., Mulier, K., 2013. Do firms use the trade credit channel to manage growth? J. Bank. Financ. 37 (8), 3035–3046. https://doi.org/10.1016/j.jbankfin.2013.02.013.
Fisman, R., Love, I., 2003. Trade credit, financial intermediary development, and industry growth. J. Financ. 58 (1), 353–374.
Freixas, X., 1993. Short term credit versus account receivable financing. Universitat Pompeu Fabra.
García-Carbonell, N., Martín-Alcázar, F., Sánchez-Gardey, G., 2021. Facing crisis periods: a proposal for an integrative model of environmental scanning and strategic issue diagnosis. Rev. Manag. Sci. https://doi.org/10.1007/s11846-020-00431-y.
Ghisetti, C., 2017. Demand-pull and environmental innovations: Estimating the effects of innovative public procurement. Technol. Forecast. Soc. Change 125, 178–187. https://doi.org/10.1016/j.techfore.2017.07.020.
Gilmore, A., McAuley, A., Gallagher, D., Massiera, P., Gamble, J., 2013. Researching SME/ entrepreneurial research. J. Res. Mark. Entrep. 15 (2), 87–100. https://doi.org/10.1108/JRME-10-2012-0026.
Godfrey, P.C., Merrill, C.B., Hansen, J.M., 2009. The relationship between corporate social responsibility and shareholder value: an empirical test of the risk management hypothesis. Strateg. Manag. J. 30 (4), 425–445. https://doi.org/10.1002/smj.750.
Görçün, Ö.F., Saha, A., Ravi, K., Pydimarri, V., Debnath, B.K., 2025. A hybrid rough aggregation approach for the selection of artificial intelligence-based industrial cleaning robots used in public spaces from the perspective of urban waste management. Eng. Appl. Artif. Intell. 150. https://doi.org/10.1016/j.engappai.2024.109566.
Goss, A., Roberts, G.S., 2011. The impact of corporate social responsibility on the cost of bank loans. J. Bank. Financ. 35 (7), 1794–1810.
Goto, S., Xiao, G., Xu, Y., 2015. As told by the supplier: trade credit and the cross section of stock returns. J. Bank. Financ. 60, 296–309. https://doi.org/10.1016/j.jbankfin.2015.08.030.
Hall, B.H., Moncada-Paternò Castello, P., Montresor, S., Vezzani, A., 2016. Financing constraints, R&D investments and innovative performances: new empirical evidence at the firm level for Europe. Econ. Innov. N. Technol. 25 (3), 183–196. https://doi.org/10.1080/10438599.2015.1076194.
Herbane, B., 2013. Exploring crisis management in UK small- and medium-sized enterprises. J. Contingencies Crisis Manag. 21 (2), 81–95. https://doi.org/10.1111/1468-5973.12006.
Herbane, B., 2019. Rethinking organizational resilience and strategic renewal in SMEs. Entrep. Reg. Dev. 31 (5–6), 476–495. https://doi.org/10.1080/08985626.2018.1541594.
Herbst, A.F., 1974. Some empirical evidence on the determinants of trade credit at the industry level of aggregation" in. "J. Financ. Quant. Anal. 377–394.
Holmstrom, B., Tirole, J., 1997. Financial intermediation, loanable funds, and the real sector. Q. J. Econ. 112 (3), 663–691. https://doi.org/10.1162/003355397555316.
Hong H., Liskovich, I. (2019) Crime, punishment and the halo effect of corporate social responsibility. ⟨https://ceep.columbia.edu/sites/default/files/content/events/Halo_v14.pdf⟩.
Hu, D., Lu, J., Zhao, S., 2024. Does trade policy uncertainty increase commercial banks' risk-taking? Evidence from China. Int. Rev. Econ. Financ. 89 (B), 532–551. https://doi.org/10.1016/j.iref.2023.10.044.
Huang, W., Chen, S., Nguyen, L.T., 2020. Corporate social responsibility and organizational resilience to COVID-19 crisis: an empirical study of chinese firms. Sustainability 12. https://doi.org/10.3390/su12218970.
International Trade Centre (2020). SME Competitiveness Outlook 2020: COVID-19: The Great Lockdown and its Impact on Small Business. Geneva: ITC.
Jagtap, S., Trollman, H., Trollman, F., Garcia-Garcia, G., Parra-López, C., Duong, L., Martindale, W., Munekata, P.E.S., Lorenzo, J.M., Hdaifeh, A., et al., 2022. The Russia-Ukraine conflict: its implications for the global food supply chains. Foods 11, 2098. https://doi.org/10.3390/foods11142098.
Jo, H., Na, H., 2012. Does CSR reduce firm risk? Evidence from controversial industry sectors. J. Bus. Ethics 110 (4), 441–456. https://doi.org/10.1007/s10551-012-1492-2.
Jordan, J., Lowe, J., Taylor, P., 1998. Strategy and financial policy in UK small firms. J. Bus. Financ. Account. 25, 1–27.
Juergensen, J., Guimón, J., Narula, R. (2020). European SMEs amidst the COVID-19 crisis: assessing impact and policy responses: 1-12. ⟨https://doi.org/10.1007/s40812-020-00169-4⟩.
Kang, S.J., Lee, S., 2021. Impacts of environmental policies on global green trade. Sustainability 13, 1517. https://doi.org/10.3390/su13031517.
Kasztelan, A., 2017. Green growth green economy and sustainable development: terminological and relational discourse. Prague Econ. Pap. 26 (4), 487–499. https://doi.org/10.18267/j.pep.626.
Kiernan, M.J., 2007. Universal owners and ESG: leaving money on the table? Corp. Gov. Int. Rev. 15 (3), 478–485.
Kiyotaki, N., Moore, J., 1997. Credit cycles. J. Political Econ. 105 (2), 211–248. https://doi.org/10.1086/262072.
Korhonen J., Granberg B. (2020). Sweden backcasting, now? Strategic planning for Covid-19 mitigation in a liber democracy Sustainability 12: 4138 ⟨https://doi.org/10.3390/su12104138⟩.
Kuckertz, A., Br̈andle, L., Gaudig, A., Hinderer, S., Reyes, C.A.M., Prochotta, A., Berger, E.S., 2020. Startups in times of crisis–A rapid response to the COVID-19 pandemic. J. Bus. Ventur. Insights 13, e00169. https://doi.org/10.1016/j.jbvi.2020.e00169.
La Rocca, M., La Rocca, T., Cariola, A., 2010. The influence of local institutional differences on the capital structure of SMEs: evidence from Italy. Int. Small Bus. J. 28, 234–257. https://doi.org/10.1177/0266242609360614.
Lambert, L.A., Tayah, J., Lee-Schmid, C., Abdalla, M., Abdalla, I., Adbalftah, H.M.A., Esmail, S., Ahmed, W., 2022. The EU's natural gas Cold War and diversification challenges. Energy Strategy Rev. 43.

Lavrinenko, O., Ignatjeva, S., Ohotina, A., Rybalkin, O., Lazdans, D., 2019. The role of green economy in sustainable development (Case study: the EU States). Entrep. Sustain. Issues 6 (3), 1113–1126. https://doi.org/10.9770/jesi.2019.6.3(4).
Lee, D., Faff, R., 2009. Corporate sustainability performance and idiosyncratic risk: a global perspective. Financ. Rev. 44 (2), 213–237. https://doi.org/10.1111/j.1540-6288.2009.00216.x.
Lee, Y.W., Stowe, J.D., 1993. Product risk, asymmetric information, and trade credit. J. Financ. Quant. Anal. 28, 285–300.
Levi, M., Newton, D., 2016. "Flash of green: are environmentally driven stock returns sustainable?". Manag. Financ. 42 (11), 1091–1109.
Li, Y., Yang, Y., He, J., Guo, S., An, X., Li, Y., Guo, R., Lin, Y., Zhang, R., 2025. Effects of different water and fertilizer treatments on the matrix properties and plant growth of tailings waste. Sci. Rep. 15. https://doi.org/10.1038/s41598-025-87629-w.
Li, S., Zhang, W., Zhao, J., 2022. Does green credit policy promote the green innovation efficiency of heavy polluting industries?—empirical evidence from China's industries. Environ. Sci. Pollut. Res. 29, 46721–46736.
Lin, F., Liang, D., Chen, E., 2011. Financial ratio selection for business crisis prediction. Experts Syst. Appl. 38, 15094–15102. https://doi.org/10.1016/j.eswa.2011.05.035.
Lins, K.V., Servaes, H., Tamayo, A., 2017. Social capital, trust, and firm performance: the value of corporate social responsibility during the financial crisis. J. Financ. 72 (4), 1785–1824. https://doi.org/10.1111/jofi.12505.
Lins, K.V., Servaes, H., Tamayo, A., 2019. Social capital, trust, and corporate performance: how CSR helped companies during the financial crisis (and why it can keep helping them). J. Appl. Corp. Financ. 31 (2), 59–71. https://doi.org/10.1111/jacf.12347.
Lo, G.-D., Marcelin, I., Bassène, T., Sène, B., 2022. The Russo-Ukrainian war and financial markets: the role of dependence on Russian commodities. Financ. Res. Lett. 50, 103194. https://doi.org/10.1016/j.frl.2022.103194.
Long, M.S., Malitz, I.B., Ravid, S.A., 1993. Trade credit, quality guarantees, and product marketability. Financ Manag. 22, 117–127.
Love, I., Preve, L.A., Sarria-Allende, V., 2007. Trade credit and bank credit: evidence from recent financial crises". J. Financ. Econ. 83, 543.
Mabandla, N.Z., Marozva, G., 2024. The effect of earnings volatility on capital structure: a case of oligopolistic banking sector. Glob. Bus. Rev. https://doi.org/10.1177/09721509241301120.
Magnanelli, B.S., Izzo, M.F., 2017. Corporate social performance and cost of debt: the relationship. Soc. Responsib. J. 13 (2), 250–265. https://doi.org/10.1108/SRJ-06-2016-0103.
Martin, D., Romero, I., Wegner, D., 2019. Individual, organizational, and institutional determinants of formal and informal inter-firm cooperation in SMEs. J. Small Bus. Manag. 57 (4), 1698–1711. https://doi.org/10.1111/jsbm.12445.
Martínez-Sola, C., García-Tereul, P.J., 2014. Trade credit and SME profitability. Small Bus. Econ. 42 (3), 561–577. https://doi.org/10.1007/s11187-013-9491-y.
Mateut, S., 2005. Trade credit and monetary policy transmission. J. Econ. Surv. 19 (4), 655–670. https://doi.org/10.1111/j.0950-0804.2005.00262.x.
May, S., Lixl, D., 2019. Restructuring in SMEs – a multiple case study analysis. J. Small Bus. Strategy 29 (1), 85–98.
Meltzer, A.H., 1960. Mercantile credit, monetary policy and the size of firms". Rev. Econ. Stat. 42, 429–437.
Merton, R.C., 1974. On the pricing of corporate debt: the risk structure of interest rates. J. Financ. https://doi.org/10.2307/2978814.
Min, S.H., Lee, J., Han, I., 2006. Hybrid genetic algorithms and support vector machines for bankruptcy prediction. Expert Syst. Appl. 31 (3), 652–660. https://doi.org/10.1016/j.eswa.2005.09.070.
Mina, A., Lahr, H., Hughes, A., 2013. The demand and supply of external finance for innovative firms. Ind. Corp. Change 22 (4), 869–901. https://doi.org/10.1093/icc/dtt020.
Mirza, N., Rahat, B., Naqvi, B., Rizvi, S.K.A., 2020. Impact of Covid-19 on corporate solvency and possible policy responses in the EU. Q. Rev. Econ. Financ. https://doi.org/10.1016/j.qref.2020.09.002.
Mol, A.P.J., Sonnenfeld, D.A., 2000. Ecological modernisation around the world: an introduction. Environ. Polit. 9 (1), 1–14. https://doi.org/10.1080/09644010008414510.
Moro, A., Wisniewski, T.P., Mantovani, G.M., 2017. Does a manager's gender matter when accessing credit? Evidence from European data. J. Bank. Financ. 80, 119–134. https://doi.org/10.1016/j.jbankfin.2017.04.009.
Muhammad, N., Scrimgeour, F., Reddy, K., Abidin, S., 2015. The impact of corporate environmental performance on market risk: the Australian industry case. J. Bus. Ethics 132 (2), 347–362. https://doi.org/10.1007/s10551-014-2324-3.
Nanda, R., Kerr, W.R., 2015. Financing innovation. Annu. Rev. Financ. Econ. 7 (1), 445–462. https://doi.org/10.1146/annurev-financial-111914-041825.
Nicolas, T., 2022. Short-term financial constraints and SMEs' investment decision: evidence from the working capital channel. Small Bus. Econ. 58, 1885–1914. https://doi.org/10.1007/s11187-021-00488-3.
OECD (2020). Corporate sector vulnerabilities during the Covid-19 outbreak: Assessment and policy responses.
Ohlson, J.A., 1980. Financial ratios and probabilistic prediction of bankruptcy. J. Account. Res. 18 (1), 109–131. https://doi.org/10.2307/2490395.
Palahì, M., Costanza, R., Kubiszewski, I., Potočnik, J., Stuchtey, M., Nasi, R., Lovins, H., Giovannini, E., Fioramonti, L., Dixson-Declève, S., McGlade, J., Pickett, K., Wilkinson, R., Holmgren, J., Wallis, S., Ramage, M., Berndes, G., Akinnifesi, F., Safonov, G., Nobre, A., Nobre, C., Muys, B., Trebeck, K., Ragnarsdóttir, K.V., Ibañez, D., Wijkman, A., Snape, J., Bas, L., 2020. Investing in nature to transform the post COVID-19 economy: a 10-point action plan to create a circular bioeconomy devoted to sustainable wellbeing. Solut. J. 11.
Pereira, P., Zhao, W., Symochko, L., Inacio, M., Bogunovic, I., Barcelo, D., 2022. The Russian-Ukrainian armed conflict will push back the sustainable development goals. Geogr. Sustain 3, 277–287. https://doi.org/10.1016/j.geosus.2022.09.003.
Petersen, M., Rajan, R., 1997. Trade credit: theories and evidence. Rev. Financ. Stud. 10, 661–691. https://doi.org/10.1093/rfs/10.3.661.
Pike, R., Cheng, N.S., Cravens, K., et al., 2005. Trade credits terms: asymmetric information and price discrimination evidence from three continents. J. Bus. Financ. Account. 32, 1197–1236. https://doi.org/10.1111/j.0306-686X.2005.00627.x.
Politecnico di Milano; Camera di Commercio di Milano (2012). Analisi dei mercati e delle filiere "green" in Lombardia, Vittorio Chiesa, Eds.
Rizvi, S.K.A., Mirza, N., Naqvi, B., Rahat, B., 2020. Covid-19 and asset management in EU: a preliminary assessment of performance and investment styles. J. Asset Manag. 1–11. https://doi.org/10.1057/s41260-020-00172-3.
Rosenbaum, P.R., Rubin, D.B., 1983. The central role of the propensity score in observational studies for causal effects. Biometrika 70 (1), 41–55. https://doi.org/10.1093/biomet/70.1.41.
Rosenbaum, P.R., Rubin, D.B., 1985. Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. Am. Stat. 39 (1), 33–38. https://doi.org/10.1080/00031305.1985.10479383.
Schwartz, R.A., Whitcomb, D.K., 1978. Implicit transfers in the extension of trade credit. In: Bounding, E., Wilson, T.F. (Eds.), In Redistribution through the Financial System: The Grants Economics of Money and Credit. Praeger Special Studies, New York, pp. 191–208.
Schwartz, R.A.; Whitcomb, D.K. (1979) The Trade Credit Decision. In Handbook of financial economics; Bicksler, J.L., Eds.; North Holland: Amsterdam: 257-273.
Seeger, M.W., Hipfel, S.J., 2007. Leg. Versus Ethic.. Argum. Debate Corp. Soc. Responsib. 155–166.
Sharfman, M.P., Fernando, C.S., 2008. Environmental risk management and the cost of capital. Strateg. Manag. J. 29 (6), 569–592. https://doi.org/10.1002/smj.678.
Šipilova, V., Ostrovska, I., Jermolajeva, E., Aleksejeva, L., Oļehnovičs, D., 2017. Evaluation of sustainable development in rural territories in latgale region (Latvia) by using the conception of smart specialization. J. Teach. Educ. For. Sust. 19 (1), 82–104. https://doi.org/10.1515/jtes-2017-0006.
Taherzadeh, O., 2021. Promise of a green economic recovery postCovid: trojan horse or turning point? Glob. Sustain. 4 (e2), 1–6. https://doi.org/10.1017/sus.2020.33.
Tran, L.T.H., Ho, T., Ho, H.T., Phung, N.D., 2024. Climate vulnerability and capital structure: moderating effect of financial development, financial constraints, and 2015 Paris agreement. Int. Rev. Econ. Financ. 96©, 103711. https://doi.org/10.1016/j.iref.2024.103711.
Umar, M., Ji, X., Mirza, N., Naqvi, B., 2021. Carbon neutrality, bank lending, and credit risk: evidence from the eurozone. J. Environ. Manag 296, 113156. https://doi.org/10.1016/j.jenvman.2021.113156.
Van Der Wijst, N., Thurik, R., 1993. Determinants of small firm debt ratios: an analysis of retail panel data. Small Bus. Econ. 5, 55–65.

Wang, J., Zhou, S., Li, M., Ren, G., Ren, X., Xiong, X., Zhang, Y., 2025. Multi-echelon inventory optimization of waste electrical and electronic equipment closed-loop supply chain based on reinforcement learning under carbon tax policy. Eng. Appl. Artif. Intell. 154. https://doi.org/10.1016/j.engappai.2025.110987.
Wellalage, H.N., Kumar, V., 2020. Does it Pay. be Green. ? Environ. Perform. firm Financ. COVID19 Outbreaks Res. Sq.
Wellalage, H.N., Kumar, V., Hunjra, A.I., Al-Faryan, M.A.S., Al-Faryan, 2021. Environmental performance and firm financing during COVID-19 outbreaks: evidence from SMEs. Financ. Res. Lett. https://doi.org/10.1016/j.frl.2021.102568.
Wilner, B.S., 2007. The exploitation of relationship in financial distress: the case of trade credit. J. Financ. 55 (1), 153–178. https://doi.org/10.1111/0022-1082.00203.
Yang, X., 2011. Trade credit versus bank credit: evidence from corporate inventory financing. Q. Rev. Econ. Financ. 51 (4), 419–434. https://doi.org/10.1016/j.qref.2011.07.001.
Zeidan, R., Boechat, C., Fleury, A., 2015. Developing a sustainability credit score system. J. Bus. Ethics 127 (2), 283–296.