Green management, access to credit and firms' vulnerability to the COVID-19 crisis

David Aristei

Department of Economics, University of Perugia, Via, Pascoli, 20, 06123 Perugia (Italy); email: david.aristei@unipg.it; Phone: +39 075 585 5233, Fax: +39 075 585 5299.

Manuela Gallo

Department of Economics, University of Perugia, Via, Pascoli, 20, 06123 Perugia (Italy); email: manuela.gallo@unipg.it; Phone: +39 075 585 5255, Fax: +39 075 585 5299.

Abstract

This paper investigates the consequences of the COVID-19 crisis on firms' performance and financial vulnerability. Exploiting longitudinal firm-level data from the World Bank's "Enterprise Surveys follow-up on Covid-19" for 20 European countries, we assess whether green management quality and pre-pandemic credit access difficulties affect firms' ability to withstand the negative impact of the pandemic. Our empirical results indicate that environmentally-friendly firms are less vulnerable to the pandemic shock. In particular, the probability of a decline in sales and that of facing liquidity issues and repayment difficulties significantly decrease as the quality of green management improves. Conversely, prior financing constraints strongly exacerbate the negative impact of the COVID-19 shock on firms' performance and amplify pandemic-related liquidity stress and financing problems. Credit-constrained firms are not only more likely to experience cash flow shortages and delays in payments and financial obligations, but they also face higher difficulties in accessing bank credit during the pandemic. Finally, we show that the COVID-19 crisis has hampered the beneficial role that green management exerted on access to credit in the pre-pandemic period. During the pandemic, the quality of green management does not affect the probability of obtaining credit and firms with sound environmental management have a lower demand for credit, possibly suggesting a slowdown in their green investment activity.

1. Introduction

The outbreak of the COVID-19 pandemic has represented an exogenous and unexpected shock that has hit the global economy triggering an exceptional crisis, which differs from past crises with respect to its cause, scope, and severity (Ding et al., 2021). In most countries, governments have imposed temporary lockdowns to limit the spread of the coronavirus, but these restrictions have contributed to generated an enormous economic and financial distress for the corporate sector, determining a significant decline in the demand and supply of products and services and causing significant liquidity issues as a consequence of the reduction in revenues. Prolonged economic inactivity and the supply chain and employment disruptions caused by the pandemic have strongly impaired firms' operational and financial performance.

The dramatic impact of the COVID-19 crisis on the corporate sector has highlighted the need for an in-depth analysis of the factors affecting firms' resilience, which could provide valuable insights, both for firms and governments, on how to mitigate the adverse effects of exogenous shocks and stimulate economic recovery. Improved understanding of the elements that contribute to make firms more resilient to the pandemic shock can be useful to identify vulnerable firms and thus define targeted relief programs, so as to lead to more effective responses to the crisis.

Given the importance that sustainable economic development is assuming in the international landscape and considering the efforts made by enterprises in adapting to this new framework, it becomes crucial to assess the advantages generated by firms' eco-friendly behaviours, especially in term of ability to react to unexpected shocks. Previous literature has emphasized the role played by green management practices in enhancing firms' performance (Fernandez, 2022) and access to credit (Wellalage and Kumar, 2021). Firms with better green management practices are considered more trustworthy by stakeholders and by financial institutions, due to their greater efficiency and profitability, better reputation, and lower environmental risk (Zhang, 2021). Only few studies have so far investigated the relationship between firms' environmental attributes and the severity of the COVID-19's impact. Green enterprises are found to be less prone to liquidity problems and bankruptcy during the pandemic (Wellalage and Kumar, 2020) and to have better financial performance and greater resilience to the COVID-19 shock (Koçak et al. 2021). Moreover, environmentally-friendly firms are less likely to be severely affected by the pandemic than conventional firm (Zhang and Fang, 2022) and benefit from improved access to external finance during the COVID-19 crisis (Wellalage et al., 2022).

A further element affecting the severity of the COVID-19's impact on firms' performance and financial fragility is represented by prior credit constraints. Firms that faced credit access restrictions in the pre-pandemic period are more likely to experience liquidity problems and to be overdue on their obligations during the pandemic (Amin and Viganola, 2021; Khan, 2022). Prior external financing

difficulties makes enterprises less resilient to the pandemic shock and significantly more likely to experience a decline in sales (Zhang and Sogn-Grundvåg, 2022). Financial frictions exacerbate the effects of the shocks generated by the COVID-19 outbreak, by amplifying the negative effects of the pandemic on the expected sales and planned investments of credit constrained firms (Balduzzi et al., 2021). In this respect, the heightened liquidity issues and the reduced availability of credit caused by the pandemic crisis could also limit corporate environmental investments and trigger shifts in firms' eco-friendly behaviours, with harmful effects on the transition to a sustainable economy (Guérin and Suntheim, 2021).

In this paper, we contribute to the growing (but still limited) literature on the economic and financial consequences of the COVID-19 crisis by analyzing how green management practices, financing conditions, and other firm-level characteristics in the pre-pandemic period affects the impact of the pandemic shock on firms' economic performance, financial fragility, and access to credit. To these aims, our empirical analysis exploits a unique longitudinal firm-level data set for 20 European countries, obtained by merging the regular World Bank's "Enterprise Surveys" (WBES) and three rounds of the World Bank's "Enterprise Surveys follow-up on Covid-19" (WBES-COVID). To the best of our knowledge, this is the first paper to investigate the joint role of green management quality and prior financing constraints on firms' ability to withstand the pandemic shock by explicitly addressing potential endogeneity concerns. Our empirical strategy allows us to properly assess whether firms adopting environmentally-friendly management practices are characterized by greater resilience to the pandemic shock and by lower financial fragility. Furthermore, we test whether pre-pandemic credit access difficulties contribute to exacerbate the negative impact of the COVID-19 shock on firms' performance and amplify pandemic-related liquidity stress and financing problems. Finally, we investigate how green management quality affect firms' access to credit during the pandemic and empirically verify whether the COVID-19 crisis has led to significant changes in eco-friendly firms' demand and access to bank financing.

The remainder of the paper is organised as follows. Section 2 provides an overview of the relevant literature and develops the main research hypotheses. Section 3 describes the data and defines the variables. Section 4 presents the econometric methods and discusses the main empirical findings, while Section 5 offers some concluding remarks.

2. Literature review and hypotheses development

2.1 Green management and firms' resilience to the COVID-19 shock

Previous studies have shown that environmental, social and governance (ESG) practices have beneficial effects on business performance (Aragón-Correa et al., 2008; Przychodzen and Przychodzen, 2015; Leonidou et al., 2016) and play a key role in reducing risk exposure and improving

the ability to react to unexpected shocks (Bauer and Hann, 2010; Stellner et al., 2015; de Boyrie and Pavlova, 2020). Firms with sound environmental performance benefit from greater efficiency (Clarkson et al., 2011), improved profitability (Shue et al., 2016) and better image and reputation (Xing et al., 2021). Fernandez (2022) also shows that green management quality has a positive impact on labour productivity, overall sales, and product and process innovation and that green investment may be fostered by an innovative environment.

Few studies have so far investigated the relationship between firms' environmental behaviours and their economic and financial performance during the COVID-19 crisis. Albuquerque et al. (2020) point out that the pandemic provides a unique opportunity to test theories on the role of green management on firms' resilience and document that environmentally sustainable-rated enterprises display lower volatility of stock returns during the first months of pandemic, thanks to customers and investors loyalty for ESG compliant firms. The authors also find that the involving in environmental, social, and governance activities helps firms to build the resilience. Broadstock et al. (2021) show that ESG performance significantly mitigates financial risk above all during a financial crisis and highlighting as sustainable firms experience lower downside risk and are more resilient during turbulent times. Analogously, Koçak et al. (2021) investigate the resilience of environmentally-friendly companies after the outbreak of the COVID-19 pandemic and demonstrate that green enterprises have a corporate image that is valued highly by investors and contributes to their resilience to economic shocks. Moreover, Zhang and Fang (2022) analyse whether the economic consequences of COVID-19 vary by firms' types and their environmental behaviours and provide evidence that the severity of the pandemic's impact depends on firm size and whether firms invested in pollution abatement techniques. Specifically, they show that eco-friendly firms perform better during the COVID-19 pandemic. Wellalage and Kumar (2020) investigate the impact of environmental performance on different aspects of firm financing and suggest that a better firm's environmental performance contributes to decrease the probability of liquidity shortfall during the pandemic.

In line with previous literature, we thus posit and test our first research hypothesis:

HP1: *Firms adopting environmentally-friendly management practices are less likely to experience a decrease in sales (HP1a) and have a lower financial vulnerability (HP1b) during the COVID-19 pandemic.*

2.2 Credit constraints and firms' vulnerabilities during the COVID-19 pandemic

Financial constraints significantly hinder business performance and have strong negative effects on firms' growth, productivity and investment (García-Posada Gómez, 2018; De Haas et al, 2020; Ferrando and Mulier, 2022). Recent empirical studies have analysed the role played by credit constraints on firms' ability to navigate through the economic disruptions caused by the pandemic. Khan (2022) shows that

prior actual and perceived credit constraints exacerbate pandemic-induced credit risk as well as liquidity problems. More specifically, he points out that that credit-rationed firms are more likely to experience greater liquidity problems and present a higher probability to be overdue on their obligations to financial institutions with respect to unconstrained firms. Analogously, Amin and Viganola (2021) estimate the impact of pre-pandemic credit access conditions on the likelihood of a decline in sales of the firm during the pandemic. Their results show that firms with better access to finance are significantly less likely to experience a decline in sales, particularly for firms that have a stronger and long-standing relationship with important stakeholders. Balduzzi et al. (2021) investigate the role played by credit constraints in the transmission of the shocks generated by the COVID- 19 outbreak and show that credit-constrained firms hold more pessimistic expectations about future sales and orders, and plan to reduce employment and investment more, relatively to unconstrained firms, suggesting that financial frictions amplify the effects of the shocks generated by the COVID-19 pandemic. Fahlenbrach et al. (2021) also point out that firms with greater financial flexibility are less affected by the pandemic shock, while those that would have a financing deficit without raising external financing perform significantly worse during the COVID-19 crisis. Furthermore, Zhang and Sogn-Grundvåg (2022) analyse how credit constraints and firm-level characteristics affect the severity of the COVID-19's impact on firms' performance. Their empirical results indicate that small firms and firms with limited access to finance are more likely to be severely affected by the crisis.

Given all the above, our second research hypotheses can be formulated as follows:

HP2: *Prior credit constraints exacerbate the negative impact of the COVID-19 outbreak on firms' performance (HP2a) and increase pandemic-induced financial fragility (HP2b).*

2.3 Environmental management and access to credit before and during the COVID-19 pandemic
Previous research indicates that financial institutions have incorporated environmental criteria when they make lending decisions and design loan contractual terms (Weber et al., 2015). Two main theoretical frameworks have been considered in the extant literature to explain the relationship between firms' environmental performance and credit access and lending conditions: *agency theory* and *legitimacy theory*. *Agency theory* suggests that managers may hesitate to invest in environmentally friendly technologies, as these investments can be very expensive and they do not immediately improve the financial performance of the firm, but rather worsen of its financial condition. However, the adoption of environmentally sustainable practices boosts firms' corporate image and reputation, favouring their access to financial resources (Zeidan et al., 2015). Moreover, eco-friendly practices and compliance with environmental regulations contribute to reduce information asymmetries between firms and lending institutions, improving firms' credit access conditions (El Ghoul et al., 2011). *Legitimacy theory* holds that firms earn environmental legitimacy

when their performance with respect to the environment meets the expectations of institutions and stakeholders. Even though improving environmental performance is costly and its benefits may not necessarily be immediate, green investments can reduce unsystematic risk and enhance investors' perception of the firm (Bansal and Clelland, 2004). Firms can further increase their environmental legitimacy by disclosing information about their own commitment to the environment. However, this may pose concerns on the value-enhancing role of green activities due to potential green-washing behaviours, since firms with poor environmental performance may use disclosure to influence public perceptions with misleading information on their actual environmental commitment (Deegan, 2002).

Empirical studies have provided significant evidence indicating that banks have incorporated environmental criteria into credit risk management. Zhang (2021) suggests that environmental risk affects banks' lending decisions, because of its impact on firms' financial performance and credit risk, and points out that eco-friendly firms are more likely to receive a line of credit and less likely to be imposed collateral requirements. Xing et al. (2021) show that green management significantly enhances firms' availability of bank loans and that corporate environmental disclosure and pressure from local governments contribute to facilitate access to credit of environmentally-friendly firms. Accordingly, Wellalage and Kumar (2021) investigate whether firms with sound environmental commitment obtain better credit access conditions and find that environmental performance has a positive impact on loan size, particularly for small and medium enterprises, while it does not impact on loan duration and collateral requirements. Conversely, Fernandez (2022) points out that firms with above-average green management may be perceived as riskier by lending institutions and, hence, exhibit lower rates of loan approval and are subject to collateralization more frequently.

Few recent studies have examined the effect of environmental performance on firms' access to bank credit during the COVID-19 pandemic. Wellalage and Kumar (2020) show that the environmental performance of a firm is positively correlated with bank financing access during the pandemic. Firms with greater environmental performance create value and cooperation from stakeholders that leads to an increase in access to bank financing. Furthermore, Wellalage et al. (2022) investigate the association between firm-level environmental performance and firm financing during the pandemic, providing evidence on the degree to which environmental performance is advantageous when the marketplace experiences an adverse shock. Authors show a significant positive relationship between environmental performance and access to external financing, demonstrating that a firm's engagement in environmental activities provides several benefits in a crisis period, because it creates a higher level of trust between firm and shareholders, contributing to increase stakeholder collaboration.

Based on these insights, we posit and test the following hypothesis:

HP3: Green management quality contributes to enhance firms' access to credit not only in normal market conditions, but also during the COVID-19 crisis.

3. Data and measurement

3.1 Data sources

The empirical analyses carried out in this paper rely two main data sources: World Bank's "Enterprise Surveys" (WBES) with the World Bank's "Enterprise Surveys follow-up on Covid-19" (WBES-COVID). The WBES provides detailed and comparable information on firms' ownership and governance, performance, export and innovation activities and financing conditions, based on nationally representative stratified samples of enterprises operating in manufacturing, retail and service sectors. To the aims of our analysis, we focus on firms from 20 European countries (Albania, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Georgia, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Moldova, North Macedonia, Poland, Portugal, Romania, Slovak Republic, and Slovenia) and consider data from the latest releases of the WBES before the COVID-19 pandemic, which were conducted mainly in 2019 in all the countries considered with the exception of Greece, where it was carried out mostly in 2018.

After the pandemic was declared, the same firms interviewed in the regular WBES were re-contacted with the aim of assessing the economic consequences of COVID-19 on businesses. In particular, the WBES-COVID provides timely and detailed information on changes in firms' sales, employment, and liquidity after the COVID-19 outbreak, on financial vulnerabilities and access to credit, on how firms have coped with the pandemic and on expectations on the recovery from the shock. In all the countries considered (with the exception of Albania), three rounds of the WBES-COVID were conducted via phone interviews over the period between May 2020 and January 2022, with an average response rate of about 85% in the countries considered.[1] To the aims of our analysis, we merge the regular WBES and the three rounds of the WBES-COVID and obtain a unique longitudinal data set that allows us to investigate how green management practices, financing conditions, and other firm-level characteristics in the pre-pandemic period have affected the impact of the COVID-19 shock on sales, liquidity, financial fragility, and access to credit. Our main estimation sample consists of 9,519 enterprises, which participated to at least one of the WBES-COVID rounds and for which we have complete information on pre-pandemic characteristics, for a total of 23,147 firm-round observations. Table A1 in the Appendix reports the sample distribution by country and industrial sector.

3.2 The economic and financial consequences of COVID-19 on firms

We exploit data from the WBES-COVID rounds to investigate the consequences of the COVID-19 pandemic on firms' performance and financial vulnerabilities. To this aim, we first focus on the impact on sales and, as in Amin and Viganola (2021), define a binary indicator equal to one for those firms reporting a decline in sales with respect to the same month of the previous year (*Sales decrease*) and zero

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[1] Table S1 in the Supplementary Appendix reports details on the survey implementation periods in each country.

otherwise. To further assess the impact on the level of sales during the pandemic, we consider the percentage change in firm sales since the same month of the previous year (*Sales change*). Following Zhang and Fang (2022) and Zhang and Sogn-Grundvåg (2022), we also analyse firms' expectations on the length of recovery from the COVID-19 shock and define an ordinal variable (*Expected recovery*) that categorize the expected number of months needed for firm sales to get back to normal into 4 categories ("Current sales are as normal"; "1 to 6 months"; "7 to 12 months"; "More than 12 months/never").

We then focus on different dimensions of firm-level financial vulnerability induced by the COVID-19 pandemic. Following Wellalage et al. (2022b) and Kan (2022), we analyse the probability of experiencing pandemic-induced liquidity problems and define a binary indicator (*Liquidity decrease*) identifying firms that have reported a shortfall in liquidity or cash since the outbreak of COVID-19 (or since the previous round of the WBES-COVID for firms interviewed in more than one round). Moreover, we consider a dummy variable (*Trade credit decrease*) equal to one if the firm reported a decrease in purchases on credit since the COVID-19 outbreak (this information is available only in the first round of the WBES-COVID), which allows to investigate the likelihood of constraints in firms' access to trade credit from suppliers during the pandemic. Finally, we consider firms' repayment difficulties and define two binary indicators identifying firms that have delayed payments to suppliers, landlords, or tax authorities for more than one week (*Delayed Payments*) and that have been overdue on obligations to any financial institution (*Financial obligations overdue*) since the outbreak of COVID-19 (or since the previous round for firms interviewed in multiple rounds).

Complete variable definitions are reported in Table A2 in the Appendix, while Table 1 reports descriptive statistics on the economic consequences of COVID-19 disaggregated by country.

[Table 1 about here]

3.3 Measuring green management

One of the main aim of our analysis is to assess whether firms adopting environmentally-friendly management strategies before the outbreak of COVID-19 are less vulnerable to the pandemic shock. For this reason, as in De Haas et al. (2020; 2022) and Fernandez (2022), we exploit the detailed information on environmental management practices provided in the "Green Economy Module" of the regular WBES to the define a green management score. This module asks questions about four main types of green management practices: strategic objectives related to the environment and climate (1 question); managers' environmental responsibility (3 questions); monitoring and auditing of emissions and usage of resources (9 questions); environmental targets (3 questions).[2] Based on firms' replies to

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[2] Table S2 in the Supplementary Appendix reports complete details on the "Green Economy Module" questions of the WBES.

these questions, we follow the approach proposed by De Haas et al. (2020; 2022) to construct an overall environmental management score. To this aim, we first normalize the scores for each question so that they have zero mean and unit standard deviation. We then compute an unweighted average of these z-scores for each of the four areas of green management. Lastly, we create an overall green management z-score as an unweighted average of the scores for the four areas. Table 2 reports the average values of the green management score in each country, while Figure S1 in the Supplementary Appendix shows the distribution of the score in each country.

[Table 2 about here]

3.4 Firms' access to credit

In our empirical analysis, we investigate whether credit constraints before the COVID-19 outbreak represent a main determinant of firms' economic and financial fragility during the pandemic. As in Kan (2022), we exploit the detailed loan application data from pre-pandemic WBES and construct a direct survey-based proxy for difficulties in accessing bank credit, which encompasses both formal rejection by banks and self-rationing by firms (i.e., credit discouragement). Specifically, we define a binary variable (*Credit constraints*) that identify as credit-constrained those firms that, in the last WBES before to the pandemic, reported that they applied for a line of credit or a loan and were denied credit or that they did not apply due to unfavourable credit conditions and/or fear of rejection.

Furthermore, we also investigate the role of green management and other pre-pandemic firm-level characteristics on access to bank credit and financing difficulties during the COVID-19 crisis. For this reason, using the information on loan application provided in Rounds 2 and 3 of the WBES-COVID, we first define a binary indicator of credit demand (*Apply Credit*) equal to one if the firm applied for a line of credit or a bank loan since the outbreak of COVID-19 (or since Round 2 of the WBES-COVID, for firms re-interviewed in Round 3) and zero otherwise. Conditional on credit demand, we then construct a binary indicator of credit rationing (*Credit denied*) that equals one if the firm's most recent application for a line of credit or loan during the COVID-19 pandemic was rejected (and zero if it was approved).

Table 2 reports the average values of all the credit access indicators for each country, before and during the COVID-19 crisis.

3.5 Control variables

To properly assess the role of green management and credit constraints and mitigate as much as possible omitted variable bias, we control for a large set of pre-pandemic firm-level characteristics, exploiting the detailed information provided by the baseline WBES.

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Following previous empirical studies (Khan, 2022; Zhang and Fang, 2022;), we control for firm age and number of employees (both included in logarithmic terms to account for possible non-linear effects), and to variables related to its ownership structure and legal status (*Sole proprietorship*, *Domestic,* and *Family owned*). As in Birindelli et al. (2022) and Fernandez (2022), we also assess whether female-managed firms are more vulnerable to the COVID-19 shock than their male counterparts and define an indicator of female involvement in the management of the firm (*Female managed*) that equals one when the firm's top manager is a woman. We further account for business opacity by means of binary indicator for having financial statements certified by an external auditor (*Audited*) and control for export activity (*Direct exporter*). A binary variable identifying those firms located in cities with more than one million inhabitants (*Large city*) is also included to account for the environment in which the firms operate,

Moreover, as in Fernandez (2022) and Zhang Sogn-Grundvåg (2022), we control for the number of products and services contracted with banks (*Financial openness*) and include a dummy for the use of informal sources (i.e., moneylenders, friends, relatives) to finance the purchase of fixed assets or working capital (*Informal financing*) and a dummy identifying those firms that use internal funds or retained earnings as the main source of their working capital needs (*Internal financing*).

Using information provided in the WBES-COVID, we also control for the number of weeks that the firm was temporarily closed due to the COVID-19 outbreak (*Weeks closed*) to account for the pandemic-related impact on firms' operations, which significantly varies across countries, sectors and time, depending on the stages of the pandemic and on the measures that national governments adopted to limit the spread of the virus. Given the significant variation in the timing of the survey rounds, we also include the number of days between the day of interview and 11 March 2020, the day in which the World Health Organization (WHO) declared COVID-19 as a pandemic (*Days since pandemic*). Finally, we account for country- and sector-level heterogeneity by means of country and industry fixed effects and also include survey round dummies.

Table A2 in the Appendix provides complete definitions and descriptive statistics for all the explanatory variables considered in the analysis, while Table A3 reports the pairwise correlation matrix.

4. Empirical analysis

4.1 The impact of COVID-19 on firms' performance

In this sub-section, we assess how pre-pandemic green management practices and financing difficulties affect the impact the COVID-19 outbreak on firms' performance. To this aim, we first focus on the probability of having experienced a decrease in sales during the pandemic and specify the following panel probit model:

$$Sales\ decrease_{it} = 1 \left(\gamma Green\ management_{i0} + \delta Credit\ conststraints_{i0} + \boldsymbol{x_{i0}}'\boldsymbol{\beta_1} + \right.$$

$$\lambda_1 Weeks\ closed_{it} + \lambda_2 Days\ since\ pandemic_{it} + \sum_{j=2}^{20} \theta_j Country_{ij} + \qquad (1)$$

$$\left. \sum_{k=2}^{9} \eta_k Sector_{ik} + \sum_{s=2}^{3} \theta_j Round_{is} + c_i + \varepsilon_{it} > 0 \right)$$

where $1(\cdot)$ is an indicator function equal to one if the expression in parentheses is true and zero otherwise, $\boldsymbol{x_{it0}}$ is a vector of exogenous pre-pandemic firm characteristics, c_i is time-constant unobserved heterogeneity, and ε_{it} is a standard normal idiosyncratic error, capturing unobserved time-varying factors, independent of the regressors conditional on c_i.

As discussed in Zhang and Fang (2021) and Khan (2022), the economic consequences of the COVID-19 shock and both firms' environmental behaviour and financing constraints can be simultaneously affected by unobserved time-varying factors, giving rise to endogeneity issues. For this reason, we extend model (1) to allow ε_{it} to be correlated with both $Green\ management_{i0}$ and $Credit\ constraint_{i0}$ and specify a reduced-form linear equation for $Green\ management_{i0}$:

$$Green\ management_i = \boldsymbol{x_{i0}}'\boldsymbol{\beta_2} + \boldsymbol{z_{i01}}'\boldsymbol{\alpha_1} + \sum_{j=2}^{20} \theta_{j2} Country_{ij} + \sum_{k=2}^{9} \eta_{k2} Sector_{ik} + u_{i0} \qquad (2)$$

and a reduced-form probit equation for $Credit\ constraint_{i0}$:

$$Credit\ constraints_i = 1 \left(\boldsymbol{x_{i0}}'\boldsymbol{\beta_3} + \boldsymbol{z_{i02}}'\boldsymbol{\alpha_2} + \sum_{j=2}^{20} \theta_{j3} Country_{ij} + \sum_{k=2}^{9} \eta_{k3} Sector_{ik} + v_{i0} > 0 \right) \qquad (3)$$

with normal idiosyncratic error terms u_{i0} and v_{i0}, independent of the regressors and potentially correlated with ε_{it}, and where the vectors $\boldsymbol{z_{i01}}$ and $\boldsymbol{z_{i02}}$ includes strictly exogenous regressors excluded from (1). In this respect, we consider firms' perception of business licensing, trade regulations, corruption, tax rates and administration as obstacles to its operations (*Business obstacles*) as an additional instrumental variable in both equations (2) and (3), assuming that perceived obstacles directly affect a firm's environmental management and credit access, but do not exert a direct impact on businesses' performance and vulnerability during the COVID-19 pandemic. Furthermore, as in Wellalage and Kumar (2021) and Zhang and Fang (2021), we use the green management score of nearby firms (i.e., those operating in the same region of the firm) (*Peer green management*) as an instrument for a firm's green management practices. This choice is motivated based on the assumption that firms operating in regions where the average quality of green management is higher have a better knowledge of green practices and tend to have higher environmental management scores. Similarly, following De Haas et al. (2022), we use the proportion of nearby firms, excluding those operating in the same sector, that experiences credit access difficulties (*Peer credit constraints*) as an instrument for a firm's financing constraints. Since shocks in a firm's credit constraints do not affect the access to finance of the other firms operating in the same region, but in a different sector, this variable can be safely considered as an exogenous indicator of local financing conditions in the pre-pandemic period.

Parameters of equations (1), (2) and (3) can be estimated jointly by means of maximum likelihood estimation (MLE). Here, we adopt a pooled (i.e., partial) MLE method that, despite being inefficient compared to a random-effects approach, does not restrict error dependence over time and is robust to serial correlation and to any distributional misspecification other than the conditional mean . As discussed in Wooldridge (2010), pooled MLE thus represents a convenient and computationally simple estimation method in non-linear panel data models. The only additional complication is that a robust variance matrix estimator is needed to account for serial correlation: clustering at the individual-level allows obtaining valid standard errors and test statistics.

Column 1 of Table 3 reports the average partial effects (APEs) estimated from endogenous probit model for the probability of having experienced a decrease in sales during the pandemic. Before discussing the estimated APEs, we first assess the validity of our identification strategy and test the exogeneity of firms' green management and financing constraints. Results of the F tests for the joint significance of the instrumental variables in the reduced-form equations allow us to reject the null hypothesis that the instruments are weak at the 1% level, supporting the assumptions underlying our identification strategy. In particular, estimates from reduced-form models (not reported here, but available upon request) also suggest that perceived business obstacles significantly increase both the environmental management score and the probability of facing credit constraints; furthermore, coherently with De Haas et al. (2022) we find that firms' green management score increases with the quality of green management of the other firms operating in the same region and that firms are more likely to be credit constrained if nearby enterprises are also constrained. After having provided support for the instruments' validity, we assess the endogeneity of green management and financing constraints by testing the significance of the correlation between ε_{it} and the error terms u_{i0} and v_{i0}. Results from of this formal exogeneity tests indicate that both the regressors cannot be considered as exogenously determined with respect to the probability of a decrease in sales during the COVID-19 pandemic (p-values equal to 0.0012 and 0.0041). This evidence suggests that the endogenous probit model should be preferred against the standard probit, as it allows us to address the endogeneity of green management and credit constraints and obtain consistent parameter estimates.

[Table 3 about here]

Turning to the analysis of the estimated APEs, we provide strong empirical evidence on the beneficial role of environmental management on firms' performance during the COVID-19 crisis. In line with the findings of Zhang and Fang (2022), firms adopting eco-friendly management practices are less likely to have experienced a decrease in sales since the outbreak of the pandemic than conventional

firms, providing support to the validity of the research hypothesis HP1a. In particular a one standard deviation increase in the green management score reduce the probability of a decrease in sales by about 7 percentage points. Moreover, we find that having faced credit access difficulties before the pandemic significantly increases the probability of a shortfall in sales during the COVID-19 crisis by about 22 percentage points. This evidence suggests that prior credit constraints strongly exacerbate the negative impact of the pandemic on firms' performance, confirming the findings of recent empirical studies (Khan, 2022; Zhang and Sogn-Grundvåg, 2022) and supporting our research hypothesis HP2a.

With respect to control variables, our empirical results indicate that older and family-owned firms, as well as those mainly relying on internal funds for their working capital needs have a higher probability of a sales shortfall during the pandemic. Firms operating in large cities are more likely to be affected by the COVID-19 outbreak, due to more restrictive prevention measures in those places. In this respect, the probability of a decrease in sales significantly increases with the duration of temporary closure due to the COVID-19 restriction: an additional week of temporary closure increases the probability of a sales decrease by 1.5 percentage points. Furthermore, we find that the likelihood of experiencing a decrease in sales significantly decreases with the number of days since the pandemic began. This result suggests that over the course of the pandemic enterprises have been able to weather the crisis and recover from the initial negative shock to sales.[3]

We further deepen the analysis on the impact of COVID-19 crisis on firms' performances by analysing the percentage chance in sales during the pandemic. To this aim, we specify the following linear panel data model:

$$Sales\ change_{it} = \gamma Green\ management_{i0} + \delta Credit\ conststraints_{i0} + \boldsymbol{x}_{i0}{'}\boldsymbol{\beta_1} +$$
$$\lambda_1 Weeks\ closed_{it} + \lambda_2 Days\ since\ pandemic_{it} + \sum_{j=2}^{20} \theta_{j1} Country_{ij} + \quad (4)$$
$$\sum_{k=2}^{9} \eta_{k1} Sector_{ik} + \sum_{s=2}^{3} \theta_j Round_{is} + \varepsilon_{it} > 0$$

The endogeneity of green management and financing constraints is again taken into account by estimating equation (4) jointly with the reduced-form equations (2) and (3) by pooled MLE. Estimation results are presented in Column 2 of Table 3. Also in this case, we find that the instruments considered are valid and that both green management and credit constraints are endogenously determined with respect to the percentage decrease in sales during the COVID-19 pandemic.

From the estimated APEs, we notice that a one standard deviation increase in the green management score raises sales by more than 4 percentage points. This evidence confirms that environmental management quality significantly enhances firms' resilience to the COVID-19 shock. Conversely, pre-

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[3] Figure S2 in the Supplementary Appendix shows how the predicted probability of a decrease in sales varies as the number of weeks ranges from 0 and 48 (i.e., the 1st and 99th percentiles of its distribution observed in the whole estimation sample) and as the days since the onset of the COVID-19 pandemic ranges from 0 to 660. Similar predictive margins plots are defined for the other empirical analyses and presented in Figures S3, S4 and S5 in the Supplementary Appendix.

pandemic credit constraints are found to amplify the adverse effects of the pandemic, in line with the findings of Amin and Viganola (2021). Specifically, firms that have experienced financing difficulties before the pandemic are characterized by a variation in sales that is 8.7 percentage points lower than those with no credit access issues.

We also find that smaller firms and those that directly export their products or services, recur to informal financing, use internal funds to finance their day-to-day operations, and that are located in large cities experienced a significantly lower sales growth with respect to the previous year. Moreover, temporary shutdowns are found to strongly impact on the level of sales, with a one week increase in the duration of temporary closures reducing sales growth by 0.86 percentage points. Also in this case, we find that the level of sales increases with the number of days since the onset of the pandemic, suggesting that firms are moving towards a recovery from the dramatic impact of COVID-19 outbreak on their sales.

As in Zhang and Fang (2022) and Zhang and Sogn-Grundvåg (2022), we further investigate whether environmental management and prior financing difficulties affect firms' expectations on the length of recovery from the COVID-19 shock. We thus specify the following ordered probit model for the ordinal dependent variable *Expected recovery*:

$$
\begin{aligned}
Expected\ recovery_{it} = h \quad if \quad \kappa_{h-1} < (&\gamma Green\ management_{i0} + \delta Credit\ conststraints_{i0} + \\
&x_{i0}'\boldsymbol{\beta_1} + \lambda_1 Weeks\ closed_{it} + \lambda_2 Days\ since\ pandemic_{it} + \\
&\textstyle\sum_{j=2}^{20} \theta_{j1} Country_{ij} + \sum_{k=2}^{9} \eta_{k1} Sector_{ik} + \\
&\textstyle\sum_{s=2}^{3} \theta_j Round_{is} + c_i + \varepsilon_{it}) \leq \kappa_h
\end{aligned}
\tag{5}
$$

where κ_h ($h = 0, ..., 3$) are threshold parameters and ε_{it} is a standard normal idiosyncratic error. Endogeneity concerns, due to unobserved factors that may affect both the expected severity of the COVID-19 shock and firms' environmental behaviour and credit constraints, are taken into account by specifying equation (5) together with the reduced-forms (2) and (3) and jointly estimated parameters by pooled MLE methods.

Table 4 reports the average partial effects on the probability of each ordered outcome. Before commenting the estimated APEs, from the lower part of the Table, we notice that the instruments considered are relevant, supporting the assumptions underlying our instrumentation strategy. Furthermore, the null hypothesis of exogeneity is rejected (at the 1% level) for both green management and credit constraints, supporting the appropriateness of an endogenous ordered probit model.

[Table 4 about here]

Analysing the estimated APEs, coherently with the finding of Zhang and Fang (2022), we point out that environmental management quality significantly improves firms' resilience during the pandemic. In

particular, a one standard error increase in the green management score increases the probability that a firm's current sales are as normal by about 5.5 percentage points, while it reduces by about 2 percentage points the probability of a moderate (7-12 months) and severe (more than 12 months/never) impact of the COVID-19 crisis in terms of expected months for recovery.

Firms that have faced financing difficulties before the pandemic's onset are instead 31 percent less likely to have returned to their normal level of sales at the time of the interview. Moreover, perceptions on the time necessary to recover from the pandemic shock are much more pessimistic for credit constrained enterprises, which are 11.5 and 12.5 percent more likely to recover in 7-12 months and in more than one year (or never), respectively, compared to unconstrained firms. Coherently with the findings of Zhang and Sogn-Grundvåg (2022), this evidence further confirms that pre-pandemic credit access difficulties strongly hamper firms' ability to withstand the impact of COVID-19 outbreak and slow down their recovery

We do not find significant differences in the expected severity of the COVID-19's impact based on most of the firm-level characteristics considered in the analysis: only family owned firms and those that do not recur to external financing for their working capital needs are less likely to have returned to their normal sales level and tend to foresee a longer recovery. Moreover, we again point out that firms that have been temporarily closed for a longer period are more likely to experience a lengthy recovery: an additional week of temporary closure leads to a 2 percent decrease in the probability of having returned to normal sales at the time of interview and raises the probability of a prolonged recovery by about 0.8 percentage points. Finally, we notice that the expected time of recovery significantly decreases with the number of days since the COVID-19 outbreak, confirming that firms' ability to manage the challenges caused by the COVID-19 pandemic has improved over time.

4.2 Green management, credit constraints and financial fragility during the COVID-19 pandemic

In this sub-section, we assess the role of firms' green management and prior credit access difficulties constraints is affecting pandemic-induced financial fragility. Extending the analysis of Khan (2022), we explicitly address the potential endogeneity of both environmental behaviour and credit constraint with respect to the probability of experiencing liquidity and financial problems, by specifying the following panel probit model jointly with the reduced-form equations (2) and (3):

$$
\begin{aligned}
Financial\ fragility_{it} = 1\ \Big(& \gamma Green\ management_{i0} + \delta Credit\ conststraints_{i0} + \boldsymbol{x}_{i0}'\boldsymbol{\beta_1} + \\
& \lambda_1 Weeks\ closed_{it} + \lambda_2 Days\ since\ pandemic_{it} + \sum_{j=2}^{20}\theta_j Country_{ij} + \\
& \sum_{k=2}^{9}\eta_k Sector_{ik} + \sum_{s=2}^{3}\theta_j Round_{is} + c_i + \varepsilon_{it} > 0\Big)
\end{aligned} \quad (6)
$$

where $Financial\ fragility_{it}$ represents the alternative binary indicators of financial difficulties experienced during the COVID-19 pandemic considered in the analysis (i.e., *Liquidity decrease*, *Trade credit decrease*, *Delayed payments*, and *Financial obligations overdue*).

Estimation results are presented in Table 5. Wek-instrument tests again suggest that the instruments considered are valid, supporting the appropriateness of our identification strategy. Exogeneity tests indicate that the environmental management score and the credit constraints indicator are endogenous determinants of the probability of a liquidity shortfall and of being overdue on financial obligations. Both these variables can be instead considered as exogenous with respect to the probability of having delayed payments, while only the credit constraint indicator is exogenously determined with respect to the reduction in the use trade credit from suppliers.

[Table 5 about here]

Focusing on the probability of a shortfall in liquidity or cash flow (Column 1 of Table 5), the estimated average partial effects show that environmentally-friendly firms are significantly less likely to have experienced liquidity issues during the COVID-19 crisis, coherently with the findings of Wellalage and Kumar (2020) and with our research hypothesis HP1b. In particular, we find that a one standard deviation increase in the green management score reduces the probability of liquidity shortfall by 7.4 percentage points. This evidence confirms that firms' environmental management quality strongly improves their financial soundness and thus contributes to alleviate the liquidity issues triggered by the pandemic shock.

The estimated partial effect for *Credit constraints* shows that firms that experienced financing constraints before the COVID-19 outbreak are, *ceteris paribus*, 21 percent more likely to have liquidity and cash flow problems than unconstrained firms. This result is consistent with our predictions (HP2b) and with the findings of previous empirical studies (Khan, 2022) and confirms that firms with prior credit access difficulties are less able to cope with the unexpected cash flow shock caused by the revenue reduction induced by the COVID-19 outbreak.

Additionally, the pandemic triggers liquidity issues more often for domestic, family-owned and female-led enterprises, as well as for firms resorting to informal financing sources and for those located in large cities. At the same time, firms that were temporarily closed for longer periods are significantly more likely to face pandemic-induced liquidity stress. Each additional week of temporary closure increases the probability of a decrease in liquidity by 2.5 percentage points, as the consequent disruption in business revenue streams drains liquidity for all kinds of firms. We also find that the probability of a decrease in liquidity is not significantly affected by the number of days since the pandemic's outbreak, suggesting that the cash flow issues caused by the COVID-19 crisis tend to persist over time.

From Column 2 of Table 5, we notice that the probability of a shortfall in firms' access to trade credit in the months immediately after the COVID-19 outbreak reduces by about 7.4 percentage points when environmental management quality increases by one standard deviation[4]. Conversely, credit constrained firms are about 7.2 percent more likely to experience a reduction in purchases on credit than firms that had no credit access difficulties before the pandemic. On the one hand, our findings suggest that green management help to mitigate pandemic-induced financial fragility, making eco-friendly firms more resilient to shocks in credit purchases from suppliers. On the other hand, prior financing constraints strongly exacerbate financial fragility, as the decreased liquidity experienced by constrained firms during the pandemic is further compounded by a reduced ability to access input materials using trade credit. Our results also show that larger, sole proprietorship and audited firms, as well as direct exporters, are more likely to have experienced a shortfall in purchases on credit immediately after the pandemic's outbreak. Financial openness also increases the probability of a short-run decrease in credit purchases from suppliers, as firms having stronger relationships with banks may have substituted trade credit with bank credit in the early stages of the COVID-19 pandemic. Finally, we show that the probability of a decrease in trade credit is strictly related to the temporary disruption in firm operations due to the COVID-19 restriction and that it tends to significantly reduce over time.

In Column 3 and 4 of Table 5, we report the results for the probabilities of having delayed payments and of being overdue on financial obligations, as proxies for a firm's repayment difficulties and credit risk. The estimated APEs show that financially constrained firms are about 4.8 and 7.4% more likely than unconstrained firms to have delayed payments and to be overdue on their financial obligations since the onset of the pandemic, respectively. This evidence is in line with the findings of Khan (2022) and provides support to our predictions (HP2b), further emphasizing the detrimental effect of prior credit access problems on firms' financial fragility. Focusing on green management, we find that eco-friendly firms are significantly less likely to face repayment difficulties during the pandemic, whereas the quality of environmental management does not affect the probability of being overdue on financial obligations.

With respect to the other firm-level control variables, we find similar determinants of late payments and arrears in financial obligations. Younger, smaller and domestic firms have a higher probability of delaying payments and being overdue in their financial obligations. Accordingly, female-led enterprises are significantly more likely to be late in their payments (to suppliers, landlords, or tax authorities) and to be overdue in meeting their obligations to financial institutions than their male counterparts, confirming the greater financial fragility and risk characterizing firms run by female top managers

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[4] It is worth remarking that information on changes in purchases on credit is available only in Round 1 of the WBES-COVID, which was carried out between May2020 and November 2020 in the countries considered (see Table S1 in the Supplementary Appendix for additional details), and thus refers only to the early phase of the pandemic.

during the COVID-19 crisis. We also find that enterprises that mainly rely on internally generated funds to finance their working capital are significantly less likely to experience repayment difficulties and arrears during the pandemic, as they have higher internal liquidity to cope with their payment obligations and are less dependent on external financing. Moreover, it is also worth remarking that firms resorting to trade credit before the COVID-19 outbreak are significantly more likely to experience pandemic-induced repayment difficulties, as well as those using informal financing and those located in large cities. We further show that the probabilities of late payments and financial obligations overdue significantly increases with the number of weeks the firm was temporarily closed due to the COVID-19 outbreak. Finally, we show that repayment difficulties do not significantly lessen and tend to persist over time, while the probability of being overdue on financial obligations even increases with the number of days since the onset of the pandemic. This latter evidence may be indicative of the excessive corporate indebtedness and increased solvency problems emerging from the COVID-19 crisis.

4.3 Firms' green management and access to credit

We further assess the role of green management on firms' access to formal credit during the COVID-19 pandemic. We thus focus on the probability of credit denial and consider a panel probit model with endogenous sample selection, to account for the selection bias that may arise as firms that are more likely to have an application rejected may be also more likely to refrain from applying (Brown et al., 2011):

$$
\begin{aligned}
Credit\ denied_{it} = 1\ \big(&\gamma_1 Green\ management_{i0} + \delta_1 Credit\ conststraints_{i0} + \boldsymbol{x_{i0}}'\boldsymbol{\beta_1} + \\
&\lambda_{11} Weeks\ closed_{it} + \lambda_{21} Days\ since\ pandemic_{it} + \textstyle\sum_{j=2}^{20}\theta_{1j}Country_{ij} + \\
&\textstyle\sum_{k=2}^{9}\eta_{1k}Sector_{ik} + \textstyle\sum_{s=2}^{3}\theta_{1j}Round_{is} + c_i + \varepsilon_{it} > 0 \big)\ \ if\ Apply\ credit_{it} = 1 \\
Apply\ credit_{it} = 1\ \big(&\gamma_2 Green\ management_{i0} + \delta_2 Credit\ conststraints_{i0} + \boldsymbol{x_{i0}}'\boldsymbol{\beta_2} + \qquad\qquad (7) \\
&\lambda_{12} Weeks\ closed_{it} + \lambda_{22} Days\ since\ pandemic_{it} + \\
&+\alpha_1 Internal\ financing_{i0} + \alpha_1 Business\ Obstacles_{i0} + \textstyle\sum_{j=2}^{20}\theta_{2j}Country_{ij} + \\
&\textstyle\sum_{k=2}^{9}\eta_{2k}Sector_{ik} + \textstyle\sum_{s=2}^{3}\theta_{2j}Round_{is} + a_i + \omega_{it} > 0 \big)
\end{aligned}
$$

where the outcome variable $Credit\ denied_{it}$ is observed only when $Apply\ credit_{it} = 1$ (selection mechanism) and the errors ε_{it} and ω_{it} follow a bivariate standard normal distribution with arbitrary correlation $\rho_{\varepsilon\omega}$. Endogenous selectivity operates through errors correlation: when $\rho_{\varepsilon\omega} \neq 0$ a simple univariate probit model for $Credit\ denied_{it}$ on the selected sample leads to inconsistent estimates. To improve parameter identifiability, we follow Brown et al. (2011) and exclude the *Business obstacles* and *Internal financing* binary indicators from the outcome equation for $Credit\ denied_{it}$, assuming that a firm's perception of its business environment and its access to internal funding affect its loan demand behaviour, but not the bank's actual loan granting decision.

Model (7) is further extended to accommodate for the potential endogeneity of environmental management and pre-pandemic credit access difficulties with respect to firms' credit demand behaviour and credit rejection probability during the COVID-19 crisis. As discussed in the extent literature (Xing et al., 2020; Wellalage and Kumar, 2021; Fernandez, 2022; Wellalage et al., 2022a), the endogeneity of green management may be due to the fact that firms' environmental behaviour and financing policies may be jointly determined by unobservable factors related to firm quality, attitudes towards risk and credit-worthiness. At the same time, previous studies (Pigini et al., 2016; Aristei and Angori, 2022) have shown that the persistence in credit demand and rationing over time is due to the persistence in observed and unobserved heterogeneity and to true state dependence, highlighting the necessity of accounting for the endogeneity of pre-pandemic financing conditions.

Table 6 reports the average partial effects on the conditional probability of credit rejection and on the probability of having applied for a line of credit or a loan during the pandemic estimated from endogenous probit model. Before discussing the estimated APEs, from the lower part of the Table, we firstly notice that the correlation coefficient $\rho_{\varepsilon\omega}$ between the error terms of credit demand and rationing equations is statistically significant at the 1% level, confirming the necessity of accounting for endogenous sample selection.[5] Results of the weak instrument and exogeneity tests provide support to the validity of our identification strategy and indicate that firms' environmental management practices and pre-pandemic credit access difficulties are endogenously determined with respect to both credit demand behaviour and credit rationing probability during the COVID-19 crisis.

[Table 6 about here]

From the estimated APEs, reported in Columns 1 and 2 of Table 6, we highlight that the quality of green management significantly reduces the probability of applying for credit during the pandemic, but does not affect the conditional probability of being denied credit. This evidence is partly in contrast with our research hypothesis HP3 and with the findings of Wellalage et al (2022a), who show that firms' environmental performance increases access to bank credit during the COVID-19 crisis. However, it is worth remarking that, differently from Wellalage et al (2022a) who analyse firms' use of bank financing as the main source used to deal with pandemic-induced liquidity shortages, here we assess the probability of actual credit rationing by banks, addressing both sample selectivity and endogeneity concerns. In doing so, we are able to point out that, during the pandemic, green management quality mainly affects a firm's credit demand behaviour rather than banks' lending decisions. This evidence suggests that, since the

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[5] In particular, the estimated correlation coefficient is equal to -0.8672. As discussed in Brown et al. (2011) and Aristei and Gallo (2022), the negative value of cross-equation correlation suggests that firms which are more likely to have an application rejected are also less likely to apply as they anticipate rejection and prefer to remain out of the credit market.

COVID-19 outbreak, eco-friendly firms has refrained from applying for bank credit, due to lower financing needs or because they may have been discouraged from applying by unfavourable lending conditions or fear of rejection.

Analysing the impact of prior financing difficulties, in line with the findings of Khan (2022), we find that those firms that were denied credit or discouraged from applying before the pandemic are about 12.5 percent more likely to face credit rejection and 10 percent less likely to apply for additional credit during the COVID-19 crisis. Coherently with Aristei and Angori (2022), our results highlight that financing difficulties tend to significantly persist over time, due to observed firm characteristics, unobserved heterogeneity and true state dependence. Furthermore, as in Pigini et al. (2016), we provide evidence of a significant discouragement effect of prior credit restrictions on firms' loan demand behaviour during the pandemic.

With respect to control variables, we find that larger firms have a higher loan demand and are less likely to be denied credit by banks. Consistently with the extant literature (Beck et al., 2006; Ferri et al, 2019), this evidence confirms that smaller businesses are less likely to apply for bank financing, due to their lower financing needs, but face significantly higher difficulties in accessing bank credit, due to their higher informational opacity and lower availability of collateral. Similarly, sole-proprietorship firms and those whose financial statements are not certificated by external auditors, being characterized by higher information opacity, are more likely to be rationed when they apply for credit. In line with the results of Wellalage et al. (2022b) and Birindelli et al. (2022), we find that female-led businesses are characterized by a significantly higher probability (about 2.6 percentage points) of being credit rationed than their male counterparts. This evidence highlights the heightened financing difficulties experienced by female-led firms since the outbreak of the pandemic and may be indicative of stronger discrimination against women-led businesses by financial institutions during the COVID-19 crisis. We also find that firms with a larger number of products and services contracted with banks are more likely to apply for additional financing and less likely be denied credit. Thus, coherently with previous literature (Cowling et al., 2016; Angori et al., 2019), firms with stable and strong banking relationships are characterized by a higher dependence on bank financing and benefit from enhanced access to credit, especially in crisis periods. Furthermore, we show that firms resorting to trade credit from their supplier and to informal financing before the pandemic are more likely to have applied for bank credit during the pandemic, suggesting complementarity between different financing sources. At the same time, we find that firms mainly relying on internal funds for their working capital needs have a lower demand for credit, while perceived business obstacles increase the likelihood of applying for bank credit, supporting the validity of our identification strategy. The duration of temporary shutdowns due to COVID-19 restrictions significantly increase loan demand and rationing probabilities by about 0.2 and 0.6 percentage points for each additional week of

temporary closure, respectively. Finally, both credit demand and financing constraints tend to significantly reduce over the course of the pandemic, as firms recover from the COVID-19 outbreak.

In order to assess whether the role of green management (and other firm-level characteristics) on firms' financing constraints changed during the pandemic, we re-estimate the endogenous probit model with sample selection to analyse the pre-COVID-19 credit access conditions of the 8,645 enterprises analysed in the pandemic period. Results, reported in Columns 3 and 4 of Table 6, confirm the endogeneity of green management score with respect to both loan demand behaviour and credit rationing. From the estimated APEs, we find that the quality of firms' green management significantly enhances access to bank credit in the pre-COVID-19 period, coherently with the findings of Xing et al (2020), Zhang (2021) and Wellalage and Kumar (2021) and with our predictions (HP3). Specifically, a one standard deviation increase in the green management score increase the probability of applying for credit by almost 9 percentage points, while it decreases the conditional probability of credit rejection by 12 percentage points. The evidence obtained indicates that before the pandemic eco-friendly firms have a significantly higher demand for external credit, which is necessary to finance their investment in green technologies (De Haas et al., 2021). Conversely, during the COVID-19 crisis, firms with higher environmental management quality are significantly less likely to apply for credit, possibly suggesting a slowdown in their green investment activity induced by the pandemic. Moreover, in normal market conditions, green management quality strongly improves the likelihood of obtaining bank financing, as firms with sound environmental performance tend to have greater efficiency, profitability and reputation and are thus considered as less risky and more creditworthy by banks (Wellalage and Kumar, 2021). After the COVID-19 outbreak, firms' green management practices lose their relevance and do not significantly influence banks' lending decisions. Taken together, these results suggest that the pandemic shock, by heightening credit constraints and hampering the beneficial role of green management quality on access to credit, may inhibit firms' investments in green technologies and pollutants abatement and, as pointed out by Guérin and Suntheim (2021), slow down the transition to a low-carbon economy.

We further point out that domestic, family-owned and audited firms have a higher propensity to apply for additional credit. We also find that direct exporters and firms located in large cities are characterized by significantly higher loan demand and rationing probabilities In the period immediately preceding the pandemic, in line with the results of Birindelli et al. (2022), we do not find evidence of significant gender differences in credit rationing probability, while we show that female-led businesses are significantly less likely to apply for credit, due to lower financing needs, but also because they may be discouraged from applying for additional credit. Moreover, firms using trade credit and having a higher financial openness are more likely to apply for credit and have a lower

rationing probability, suggesting that access to credit from suppliers and strong banking relationships alleviate financing constraints; conversely, firms recurring to informal have limited access to finance, as they may be perceived as riskier by banks

5. Concluding remarks

In this paper, we investigate the consequences of the COVID-19 crisis on firms' economic performance, financial vulnerability, and access to credit. We carry out our empirical analysis using longitudinal firm-level data from the World Bank's "Enterprise Surveys follow-up on Covid-19" for 20 European countries, and assess whether green management quality and pre-pandemic credit access difficulties affect firms' resilience to the impact of the pandemic shock.

In line with a large part of the literature, empirical results indicate that environmentally-friendly firms are less vulnerable to the pandemic shock. In particular, firms adopting high quality green management practices are found to experiment a lower probability of a decline in sales, are exposed to lower liquidity issues and are less likely to have repayment difficulties. We further demonstrate that previous financing restrictions strongly exacerbate the negative impact of the COVID-19 shock. Credit-constrained firms are not only more likely to experience cash flow shortages and delays in payments and financial obligations, but they also face higher difficulties in accessing bank credit during the pandemic. Finally, we shows that the quality of green management does not affect the probability of access to credit during the pandemic and firms with sound environmental management have a lower demand for credit, suggesting a foreseeable slowdown in their green investment activity.

Our empirical findings offer some interesting policy implications both for firms and policymakers. In particular, policies and programmes aimed at encouraging eco-friendly behaviours by enterprises may contribute to improve the resilience of the entrepreneurial system to unexpected shocks. Furthermore, policy initiatives supporting firms' access to credit may foster the ability of the corporate sector to absorb shocks and, at the same time, favour the transition to a sustainable economy in the long run. From the firms' perspective, the awareness of the competitive advantage offered by eco-sustainable practices, in terms of better corporate performance and lower financial vulnerability, may lead enterprises to enhance their green management activities, ensuring resilience to economic and financial crises.

References

Amin, M., Viganola, D., 2021. Does Better Access to Finance Help Firms Deal with the COVID-19 Pandemic? Evidence from Firm-Level Survey Data. . Policy Research Working Papers 9697, World Bank, Washington, DC.

Angori, G. Aristei, D., Gallo, M., 2019. Lending technologies, banking relationships, and firms' access to credit in Italy: the role of firm size. Applied Economics 51(58), 6139-6170.

Aragón-Correa, J.A., Hurtado-Torres, N., Sharma, S., García-Morales, V.J., 2008. Environmental strategy and performance in small firms: A resource-based perspective. Journal of Environmental Management 86, 88-103

Aristei, D., Angori, G., 2022. Heterogeneity and state dependence in firms' access to bank credit. Small Business Economics 59(1), 47-78.

Aristei, D., Gallo, M., 2022. Are female-led firms disadvantaged in accessing bank credit? Evidence from transition economies. , International Journal of Emerging Markets 17 (6), 1484-1521.

Bansal, P., Clelland, I., 2004. Talking trash: Legitimacy, impression management, and unsystematic risk in the context of the natural environ- ment. Academy of Management Journal 47(1), 93–103.

Bauer, R., Hann, D., 2010. Corporate Environmental Management and Credit Risk. SSRN Electronic Journal. doi:10.2139/ssrn.1660470.

Beck, T., Demirguc-Kunt, A., Laeven, L., Maksimovic, V., 2006. The determinants of financing obstacles. Journal of International Money and Finance 25, 932–952.

Birindelli, G., Capozza, C., Iannuzzi, A.P., 2022. COVID-19 Outbreak and Credit Constraints for Women-Led Firms. In: Paoloni, P., Lombardi, R. (Eds), Organizational Resilience and Female Entrepreneurship – Emerging Evidence and Future Agenda. Springer, Cham, Switzerland.

Brown, M., Ongena, S., Popov, A., and Yesin, P., 2011. Who needs credit and who gets credit in Eastern Europe? Economic Policy 65, 93–130.

Clarkson, P. M., Overell, M. B., Chapple, L., 2011. Environmental reporting and its relation to corporate environmental performance. Abacus 47(1), 27-60.

Cowling, M., W. Liu, M. Minniti, and N. Zhang. 2016. UK Credit and Discouragement during the GFC. Small Business Economics 47, 049-1074.

de Boyrie, M.E., Pavlova, I., 2020. Analysing the link between environmental performance and sovereign credit risk. Applied Economics 52(54), 5949-5966-

De Haas, R., Martin, R., Muuls, M., Schweiger, H., Semelet, C., 2020. Firms' green governance. In: Transition Report 2019–2020: Better Governance, Better Economies, Chapter 4. European Bank for Construction and Development.

De Haas, R., Martin, R., Muuls, M., Schweiger, H., Semelet, C., 2022. Managerial and financial barriers during the green transition. Centre for Economic Performance (CEP) Discussion Paper No. 1837, London School of Economics and Political Science, London, UK.

Deegan, C., 2002. Introduction: The legitimising effect of social and environmental disclosures – a theoretical foundation, Accounting, Auditing & Accountability Journal 15(3), 282-311.

Ding, W., Levine, R., Lin, C., Xie, W., 2021. Corporate immunity to the COVID-19 pandemic. Journal of Financial Economics 141(2), 802–830.

El Ghoul, S., Guedhami, O., Kwok, C.C., Mishra, D.R., 2011. Does corporate social responsibility affect the cost of capital? Journal of Banking and Finance 35(9), 2388.2406.

Fahlenbrach, R., Rageth, K., Stulz, R.M., 2021. How Valuable Is Financial Flexibility when Revenue Stops? Evidence from the COVID-19 Crisis. The Review of Financial Studies 34(11), 5474-5521.

Fernandez, V., 2022. Environmental management: Implications for business performance, innovation, and financing. Technological Forecasting and Social Change, 121797.

Ferrando, A., Mulier, K., 2022. The real effects of credit constraints: Evidence from discouraged borrowers. Journal of Corporate Finance 73, 102171.

Ferri, G., Murro, P., Peruzzi, V., Rotondi, Z., 2019. Bank lending technologies and credit availability in Europe: What can we learn from the crisis? Journal of International Money and Finance 95, 128–148.

García-Posada Gómez, M., 2018. Credit constraints, firm investment and employment: Evidence from survey data. Journal of Banking and Finance 99, 121-141.

Guérin, P., Suntheim, F., 2021. Firms' environmental performance and the COVID-19 crisis. Economics Letters 205, 109956.

Khan, S.U., 2022. Financing constraints and firm-level responses to the COVID-19 pandemic: International evidence. Research in International Business and Finance 59,101545.

Koçak, E., Bulut, U., Menegaki, A.N., 2022, The resilience of green firms in the twirl of COVID-19: Evidence from S&P500 Carbon Efficiency Index with a Fourier approach. Business Strategy and the Environment 31(1), 32-45.

Leonidou, L.C., Christodoulides, P., Thwaites, D., 2016. External determinants and financial outcomes of an eco-friendly orientation in smaller manufacturing firms. Journal of Small Business Management 54(1), 5–25.

Pigini, C., Presbitero, A., Zazzaro, A., 2016. State dependence in access to credit, Journal of Financial Stability 27, 17-34.

Przychodzen, J., Przychodzen, W., 2015. Relationships between eco-innovation and financial performance - evidence from publicly traded companies in Poland and Hungary. Journal of Cleaner Production 90, 253–263.

Shu, C., Zhou, K.Z., Xiao, Y., Gao, S., 2016. How green management influences product innovation in China: The role of institutional benefits. Journal of Business Ethics 133, 471-485.

Stellner, C., Klein, C., Zwergel, B., 2015. Corporate social responsibility and Eurozone corporate bonds: The moderating role of country sustainability. Journal of Banking and Finance 59, 538-549.

Weber, O., Hoque, A., Ayub Islam, M., 2015. Incorporating environmental criteria into credit risk management in Bangladeshi banks. Journal of Sustainable Finance & Investment 5 (1–2), 1–15.

Wellalage, N.H., Boubake, S., Hunjra, A.I., Verhoeven, P., 2022b. The gender gap in access to finance: Evidence from the COVID-19 pandemic. Finance Research Letters 46, 102329.

Wellalage, N.H., Kumar, V., 2021. Environmental performance and bank lending: evidence from unlisted firms. Business Strategy and the Environment 30(7), 3309–3329.

Wellalage, N.H., Kumar, V., Hunjra, A.I., Al-Faryan, M.A.S., 2022a. Environmental performance and firm financing during COVID-19 outbreaks: Evidence from SMEs. Finance Research Letters 47, 102568.

Wooldridge, J., 2010. Econometric Analysis of Cross Section and Panel Data, 2nd ed. MIT Press, Cambridge, MA.

Xing, C. Zhang, Y., Wang, Y.,2020. Do Banks Value Green Management in China? The Perspective of the Green Credit Policy. Finance Research Letters 35, 101601.

Zhang, D., 2021. How environmental performance affects firms' access to credit: evidence from EU countries. Journal of Cleaner Production 315, 128294.

Zhang, D., Du, W., Zhuge, L., Tong, Z., Freeman, R.B., 2019. Do financial constraints curb firms' efforts to control pollution? Evidence from Chinese manufacturing firms. Journal of Cleaner Production 215, 1052-1058.

Zhang, D., Sogn-Grundvåg, G., 2022. Credit constraints and the severity of COVID-19 impact: Empirical evidence from enterprise surveys. Economic Analysis and Policy 74, 337–349.

Tables

Table 1 – The economic consequences of COVID-19 shock on firms

Country	Sales decrease	Sales change	Recovery more than 12 months/never	Liquidity decrease	Trade credit decrease	Delayed payments	Financial obligations overdue
Albania	0.8797	-50.01	0.0156	0.7265	0.4062	0.6847	0.2065
Bulgaria	0.6136	-18.01	0.0709	0.6296	0.0700	0.2293	0.0361
Croatia	0.4250	-9.81	0.0437	0.3978	0.1189	0.2440	0.0678
Cyprus	0.5439	-19.52	0.1015	0.4746	0.3140	0.2630	0.0814
Czech Republic	0.4800	-13.88	0.1191	0.4486	0.0204	0.2361	0.0484
Estonia	0.3741	-5.98	0.1161	0.3374	0.0650	0.2660	0.0211
Georgia	0.5561	-25.32	0.0718	0.5731	0.4477	0.2708	0.0874
Greece	0.6838	-24.14	0.1626	0.6517	0.2781	0.3141	0.1045
Hungary	0.4044	-9.48	0.0635	0.3682	0.0164	0.0864	0.0146
Italy	0.5825	-23.73	0.1043	0.5754	0.3508	0.4064	0.0764
Latvia	0.4230	-13.47	0.0604	0.4145	0.1977	0.2499	0.1205
Lithuania	0.5189	-12.53	0.0634	0.4937	0.1984	0.3237	0.0953
Malta	0.5276	-13.94	0.1154	0.4957	0.2130	0.1954	0.0270
Moldova	0.7077	-33.42	0.0876	0.6887	0.2566	0.4702	0.1681
North Macedonia	0.5811	-16.32	0.0844	0.5423	0.0826	0.3787	0.1365
Poland	0.5218	-14.16	0.1298	0.4291	0.2834	0.2538	0.1289
Portugal	0.5161	-15.89	0.0367	0.4688	0.2954	0.1861	0.0392
Romania	0.4713	-10.68	0.0768	0.4403	0.1245	0.2643	0.0502
Slovak Republic	0.5128	-15.05	0.0738	0.4730	0.0087	0.2625	0.0145
Slovenia	0.4469	-7.08	0.0807	0.4651	0.0574	0.2877	0.0827
Total	0.5343	-16.40	0.1122	0.4748	0.2570	0.2812	0.1014

Notes: proportions and average values are computed using sample weights, rescaled by the inverse of the number of observations in each country.

Table 2 – Firms' green management and access to credit

Country	a) Before the COVID-19 pandemic				b) During the COVID-19 pandemic	
	Green management	Financing constraints	Apply credit	Credit denied	Apply credit	Credit denied
Albania	-0.1958	0.0471	0.1653	0.0000	–	–
Bulgaria	0.0293	0.1912	0.1412	0.0216	0.0569	0.1836
Croatia	0.0024	0.0238	0.2323	0.0424	0.0994	0.2400
Cyprus	0.0883	0.0905	0.1398	0.1618	0.1159	0.1474
Czech Republic	0.2726	0.0344	0.2692	0.0094	0.0923	0.1746
Estonia	0.0937	0.0354	0.2435	0.0992	0.1250	0.1301
Georgia	-0.3633	0.1174	0.3220	0.1154	0.2240	0.0077
Greece	0.3392	0.2147	0.1105	0.1529	0.2128	0.2421
Hungary	0.0588	0.0671	0.2551	0.0112	0.0971	0.0569
Italy	0.0092	0.1322	0.0965	0.0830	0.3082	0.0359
Latvia	0.3426	0.0674	0.2304	0.0271	0.1697	0.3758
Lithuania	-0.0797	0.1111	0.2154	0.1480	0.0801	0.1445
Malta	-0.0092	0.0224	0.2001	0.0920	0.1228	0.0000
Moldova	-0.1527	0.3482	0.1970	0.3560	0.2121	0.3012
North Macedonia	0.2690	0.1477	0.1705	0.0720	0.3296	0.1520
Poland	-0.1513	0.1128	0.1235	0.0148	0.1812	0.1697
Portugal	-0.2066	0.0576	0.1558	0.1186	0.1807	0.0517
Romania	-0.1071	0.2922	0.1365	0.1768	0.1625	0.1270
Slovak Republic	0.1338	0.0990	0.1569	0.0364	0.0872	0.1318
Slovenia	0.2344	0.0260	0.3199	0.0521	0.2294	0.1246
Total	0.0000	0.1162	0.1417	0.0462	0.1897	0.1333

Notes: proportions and average values are computed using sample weights, rescaled by the inverse of the number of observations in each country.

Table 3 – Firms' sales since the COVID-19 outbreak: estimated APEs

	(1)	(2)
Model:	Pooled endogenous probit	Pooled endogenous linear regression
Dependent variable:	Sales decrease	Sales change
Green management	-0.0694***	4.1388***
	(0.0217)	(1.5354)
Credit constraints	0.2223***	-8.7043***
	(0.0557)	(1.9466)
Age (in logs)	0.0093*	0.2460
	(0.0056)	(0.4058)
Employees (in logs)	-0.0012	1.0337***
	(0.0060)	(0.3786)
Sole Proprietorship	0.0070	-0.2135
	(0.0114)	(0.7156)
Domestic	0.0189	-0.5412
	(0.0137)	(0.9260)
Female-led	0.0011	-1.0214
	(0.0094)	(0.6318)
Family owned	0.0156*	-0.7218
	(0.0081)	(0.5181)
Audited	0.0109	-0.9769
	(0.0104)	(0.6831)
Direct exporter	0.0045	-1.1543*
	(0.0105)	(0.6849)
Trade credit	-0.0032	0.7471
	(0.0087)	(0.5615)
Financial openness	0.0145**	-0.1000
	(0.0074)	(0.4624)
Informal financing	0.0277	-4.0686***
	(0.0202)	(1.3052)
Internal Financing	0.0257***	-1.9476***
	(0.0087)	(0.5469)
Large city	0.0345***	-1.6998**
	(0.0102)	(0.7182)
Weeks closed	0.0151***	-0.8601***
	(0.0016)	(0.1142)
Days since pandemic	-0.0006***	0.0887***
	(0.0001)	(0.0086)
Country and Sector FEs	Yes	Yes
Survey round FEs	Yes	Yes
Weak-instrument *F* test:		
Green management	[0.0000]	[0.0000]
Credit constraints	[0.0000]	[0.0000]
Walt test of exogeneity:		
Green management	[0.0012]	[0.0052]
Credit constraints	[0.0041]	[0.0270]
Observations	23,147	22,945

Notes: the Table reports the average partial effects on the probability of a decrease in sales and on the percentage change in sales with respect to the same month of 2019, estimated from an endogenous probit model and an endogenous linear regression, respectively. Standard errors, clustered at the firm level, are reported below the estimates. We use *Business Obstacles*, *Peer credit constraints* and *Peer green management* as additional instruments for the endogenous regressors *Credit constraints* and *Green management*. The p-values of the overidentification tests, of the Wald tests of exogeneity, and of the F tests for weak instruments are reported in square brackets. ***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Table 4 – Firms' expected recovery from COVID-19: estimated APEs from endogenous ordered probit

Ordered outcome:	(1) Current sales as normal	(2) 1 to 6 months	(3) 7 to 12 months	(4) More than 12 months/never
Green management	0.0545***	-0.0125***	-0.0202***	-0.0219**
	(0.0208)	(0.0045)	(0.0075)	(0.0089)
Credit constraints	-0.3104***	0.0710***	0.1149***	0.1246***
	(0.0573)	(0.0125)	(0.0188)	(0.0267)
Age	0.0013	-0.0003	-0.0005	-0.0005
	(0.0057)	(0.0013)	(0.0021)	(0.0023)
Employees	0.0047	-0.0011	-0.0018	-0.0019
	(0.0058)	(0.0014)	(0.0022)	(0.0023)
Sole Proprietorship	-0.0084	0.0019	0.0031	0.0034
	(0.0117)	(0.0027)	(0.0043)	(0.0047)
Domestic	-0.0142	0.0033	0.0053	0.0057
	(0.0136)	(0.0031)	(0.0051)	(0.0054)
Female-led	-0.0139	0.0032	0.0052	0.0056
	(0.0096)	(0.0022)	(0.0036)	(0.0038)
Family owned	-0.0212**	0.0048**	0.0078**	0.0085**
	(0.0083)	(0.0019)	(0.0031)	(0.0033)
Audited	-0.0115	0.0026	0.0042	0.0046
	(0.0102)	(0.0023)	(0.0037)	(0.0042)
Direct exporter	-0.0042	0.0010	0.0016	0.0017
	(0.0104)	(0.0024)	(0.0038)	(0.0042)
Trade credit	-0.0010	0.0002	0.0004	0.0004
	(0.0088)	(0.0020)	(0.0033)	(0.0035)
Financial openness	-0.0072	0.0016	0.0027	0.0029
	(0.0075)	(0.0017)	(0.0028)	(0.0031)
Informal financing	-0.0042	0.0010	0.0016	0.0017
	(0.0198)	(0.0045)	(0.0073)	(0.0079)
Internal Financing	-0.0171*	0.0039*	0.0063*	0.0068*
	(0.0088)	(0.0020)	(0.0032)	(0.0036)
Large city	-0.0401***	0.0092***	0.0148***	0.0161***
	(0.0103)	(0.0024)	(0.0039)	(0.0041)
Weeks closed	-0.0192***	0.0044***	0.0071***	0.0077***
	(0.0013)	(0.0004)	(0.0006)	(0.0005)
Days since pandemic	0.0003***	-0.0001***	-0.0001***	-0.0001***
	(0.0001)	(0.0000)	(0.0000)	(0.0000)
Country and Sector FEs		Yes		
Survey round FEs		Yes		
Weak-instrument F test:				
Green management		[0.0000]		
Credit constraints		[0.0000]		
Walt test of exogeneity:				
Green management		[0.0082]		
Credit constraints		[0.0000]		
Observations		20,468		

Notes: the Table reports the average partial effects on the probability of each level of the expected recovery, estimated from a pooled endogenous ordered probit model. Standard errors, clustered at the firm level, are reported below the estimates. We use *Business Obstacles*, *Peer credit constraints* and *Peer green management* as additional instruments for the endogenous regressors *Credit constraints* and *Green management*. The p-values of the Wald tests of exogeneity and of the F tests for weak instruments are reported in square brackets.
***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Table 5 – Firms' financial fragility since the COVID-19 outbreak: estimated APEs

	(1)	(2)	(3)	(4)
Model:	Pooled endogenous probit	Pooled endogenous probit	Pooled endogenous probit	Pooled endogenous probit
Dependent variable:	Liquidity decrease	Trade credit decrease	Delayed payments	Financial obligations overdue
Green management	-0.0742***	-0.0735***	-0.0324***	0.0192
	(0.0223)	(0.0258)	(0.0038)	(0.0127)
Credit constraints	0.2104***	0.0716***	0.0484***	0.0737***
	(0.0509)	(0.0133)	(0.0111)	(0.0243)
Age	-0.0024	-0.0043	-0.0221***	-0.0093***
	(0.0058)	(0.0062)	(0.0053)	(0.0030)
Employees	-0.0082	0.0157**	-0.0085**	-0.0100***
	(0.0062)	(0.0065)	(0.0034)	(0.0034)
Sole Proprietorship	0.0152	0.0296**	-0.0003	0.0010
	(0.0114)	(0.0125)	(0.0108)	(0.0057)
Domestic	0.0260*	0.0048	0.0335***	0.0209***
	(0.0139)	(0.0160)	(0.0128)	(0.0080)
Female-led	0.0192**	-0.0071	0.0146*	0.0115**
	(0.0094)	(0.0107)	(0.0088)	(0.0049)
Family owned	0.0192**	-0.0040	0.0069	-0.0016
	(0.0081)	(0.0093)	(0.0077)	(0.0042)
Audited	0.0014	0.0260**	-0.0010	-0.0033
	(0.0106)	(0.0122)	(0.0083)	(0.0059)
Direct exporter	0.0069	0.0234**	-0.0041	-0.0073
	(0.0105)	(0.0117)	(0.0088)	(0.0057)
Trade credit	-0.0009	0.0094	0.0311***	-0.0052
	(0.0086)	(0.0098)	(0.0082)	(0.0046)
Financial openness	0.0069	0.0181**	-0.0053	-0.0016
	(0.0074)	(0.0085)	(0.0067)	(0.0040)
Informal financing	0.0445**	0.0059	0.0317*	-0.0003
	(0.0198)	(0.0233)	(0.0179)	(0.0098)
Internal Financing	0.0075	-0.0070	-0.0299***	-0.0173***
	(0.0087)	(0.0096)	(0.0079)	(0.0045)
Large city	0.0256**	0.0156	0.0334***	0.0001
	(0.0101)	(0.0113)	(0.0096)	(0.0055)
Weeks closed	0.0252***	0.0763***	0.0138***	0.0045***
	(0.0021)	(0.0089)	(0.0016)	(0.0006)
Days since pandemic	-0.0001	-0.0014**	-0.0001	0.0001**
	(0.0001)	(0.0005)	(0.0001)	(0.0001)
Country and Sector FEs	Yes	Yes	Yes	Yes
Survey round FEs	Yes	No	Yes	Yes
Weak-instrument *F* test:				
Green management	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Credit constraints	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Walt test of exogeneity:				
Green management	[0.0022]	[0.0033]	[0.1972]	[0.0760]
Credit constraints	[0.0041]	[0.5260]	[0.4091]	[0.0432]
Observations	23,147	7,966	21,431	22,320

Notes: the Table reports the average partial effects on the probability of having experienced a decrease in liquidity, a decrease in purchases on credit, delays in payments and financial obligations overdue, estimated from endogenous probit models. Standard errors, clustered at the firm level, are reported below the estimates. We use *Business Obstacles*, *Peer credit constraints* and *Peer green management* as additional instruments for the endogenous regressors *Credit constraints* and *Green management*. The p-values of the Wald tests of exogeneity and of the F tests for weak instruments are reported in square brackets.

***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Table 6 – Firms' access to credit during and before the COVID-19 pandemic: estimated APEs

Dependent variable:	a) During the COVID-19 pandemic		b) Before the COVID-19 pandemic	
	Credit denied	Apply credit	Credit denied	Apply credit
	(1)	(2)	(3)	(4)
Green management	0.0258	-0.0514**	-0.1200***	0.0881**
	(0.0366)	(0.0219)	(0.0409)	(0.0369)
Credit constraints	0.1247**	-0.1003***		
	(0.0587)	(0.0092)		
Age	0.0131	-0.0052	-0.0229**	-0.0053
	(0.0106)	(0.0053)	(0.0116)	(0.0064)
Employees	-0.0256**	0.0247***	0.0040	0.0091
	(0.0120)	(0.0054)	(0.0125)	(0.0100)
Sole Proprietorship	0.0349*	-0.0131	-0.0326	0.0014
	(0.0197)	(0.0110)	(0.0239)	(0.0111)
Domestic	0.0145	0.0401***	-0.0108	0.1181***
	(0.0264)	(0.0132)	(0.0289)	(0.0154)
Female-led	0.0264*	-0.0114	0.0125	-0.0316***
	(0.0151)	(0.0091)	(0.0204)	(0.0115)
Family owned	0.0173	0.0099	-0.0045	0.0212*
	(0.0138)	(0.0076)	(0.0145)	(0.0115)
Audited	-0.0343*	0.0086	0.0086	0.0341*
	(0.0196)	(0.0100)	(0.0242)	(0.0175)
Direct exporter	0.0143	0.0125	0.0457**	0.0459***
	(0.0178)	(0.0100)	(0.0222)	(0.0136)
Trade credit	-0.0196	0.0306***	-0.0602***	0.0992***
	(0.0166)	(0.0083)	(0.0224)	(0.0161)
Financial openness	-0.0295**	0.0178**	-0.0574**	0.0962***
	(0.0142)	(0.0070)	(0.0230)	(0.0153)
Informal financing	0.0402	0.0430**	0.0774***	0.0291
	(0.0294)	(0.0176)	(0.0280)	(0.0185)
Large city	0.0288	-0.0079	0.0241*	0.0235**
	(0.0190)	(0.0096)	(0.0131)	(0.0115)
Weeks closed	0.0055**	0.0018**		
	(0.0022)	(0.0009)		
Days since pandemic	-0.0003***	-0.0002***		
	(0.0001)	(0.0000)		
Internal Financing		-0.0459***		-0.0864***
		(0.0078)		(0.0109)
Business Obstacles		0.0250***		0.0354***
		(0.0084)		(0.0138)
Country and Sector FEs	Yes	Yes	Yes	Yes
Survey round FEs	Yes	Yes	Yes	Yes
Walt test of no selectivity bias	[0.0033]		[0.0000]	
Weak-instrument F test:				
Green management	[0.0000]		[0.0000]	
Credit constraints	[0.0002]			
Walt test of exogeneity:				
Green management	[0.0702]	[0.0084]	[0.0023]	[0.0541]
Credit constraints	[0.0432]	[0.0312]		
Observations	15,172		8,645	

Notes: the Table reports the average partial effects on the conditional probability of being denied credit and on the probability of having applied for a loan during and before the COVID-19 pandemic, estimated from pooled endogenous probit models with sample selection. Standard errors, clustered at the firm level, are reported below the estimates. We use *Internal Financing* and *Business Obstacles* as identification variables of the probit model with selection and *Peer credit constraints* and *Peer green management* as additional instruments for the endogenous regressors *Credit constraints* and *Green management*. The p-values of the Wald tests of exogeneity and of the F tests for weak instruments are reported in square brackets.

***, ** and * denote significance at the 1, 5 and 10% levels, respectively.

Appendix

Table A1 – Firms' distribution by country and sector

Country	Sector Manufacturing	Retail	Services	Total
Albania	130	72	141	343
Bulgaria	353	106	174	633
Croatia	108	76	125	309
Cyprus	75	55	85	215
Czech Republic	268	55	137	460
Estonia	125	72	136	333
Georgia	197	110	241	548
Greece	287	119	149	555
Hungary	440	126	168	734
Italy	345	76	108	529
Latvia	122	93	125	340
Lithuania	110	92	95	297
Malta	77	51	97	225
Moldova	125	88	110	323
North Macedonia	122	99	103	324
Poland	822	91	210	1123
Portugal	648	103	133	884
Romania	403	97	145	645
Slovak Republic	162	89	104	355
Slovenia	143	62	139	344
Total	5062	1732	2725	9519

Table A2 – Variable definitions and descriptive statistics

Variable	Definition	Mean
a) Dependent variables		
Sales decrease	Equals 1 if the firm has experienced a decrease in sales compared with the same month of the previous year (i.e., 2019 for those interviewed in 2020; 2020 for those interviewed in 2021); 0 otherwise	0.5343
Sales change	Percentage change in firm sales compared with the same month of the previous year (i.e., 2019 for those interviewed in 2020; 2020 for those interviewed in 2021)	-16.40
Expected recovery	Expected time needed for the firm's sales to get back to normal. Ordinal variable with 4 categories: 0 "Current sales are as normal", 1 "1 to 6 months", 2 "7 to 12 months"; 3 "More than 12 months/never"	0.8862
Liquidity decrease	Equals 1 if the firm has experienced a decrease in liquidity or cash flow since the outbreak of COVID-19 or since the previous round of the WBES COVID-19 Follow-up Survey (for firms interviewed in more than one round); 0 otherwise	0.4748
Trade credit decrease	Equals 1 if the firm has experienced a decrease in purchases on credit since the outbreak of COVID-19; 0 otherwise	0.2570
Delayed payments	Equals 1 if the firm has delayed payments to its suppliers, its landlords, or tax authorities for more than one week (excluding payments postponed following current regulation) since the outbreak of COVID-19 or since the previous round of the WBES COVID-19 Follow-up Survey (for firms interviewed in more than one round); 0 otherwise	0.2812
Financial obligations overdue	Equals 1 if the firm has been overdue on its obligations to any financial institution since the outbreak of COVID-19 or since the previous round of the WBES COVID-19 Follow-up Survey (for firms interviewed in more than one round); 0 otherwise	0.1014
Applied credit	Equals 1 if the firm has applied for any line of credit or loan since the outbreak of COVID-19 or since Round 2 of the WBES COVID-19 Follow-up Survey (for firms re-interviewed in Round 3); 0 otherwise	0.1896
Credit denied	Equals 1 if the firm's most recent application for a line of credit or loan during the COVID pandemic was rejected; 0 if it was approved	0.1336
b) Explanatory variables		
Green management	Z-score based on the firm's green management practices in four areas: strategic objectives related to the environment and climate change, manager with explicit mandate to deal with green issues, setting environmental targets, monitoring environmental targets	0.0000
Credit constraints	Equals 1 if, in the last WBES completed before to the COVID-19 outbreak, the firm declared that it applied for a line of credit or a loan and was denied credit or that it needed a loan, but it did not apply due to unfavourable credit conditions and/or fear of rejection; 0 otherwise	0.1162
Age	Years since the firm's establishment (in logs)	2.7504
Employees	Number of full-time employees (in logs)	2.5852
Sole Proprietorship	Equals 1 if the firm's legal status is sole proprietorship; 0 otherwise	0.3671
Domestic	Equals 1 if the firm's first shareholder is domestic; 0 otherwise	0.9591
Female-led	Equals 1 if the firm's top manager is a woman; 0 otherwise	0.2306
Family owned	Equals 1 if at least 50% of the same family; 0 otherwise	0.5065
Audited	Equals 1 if the firm has its financial statement certified by external auditors, 0 otherwise	0.1417
Direct exporter	Equals 1 if the firm directly exports its production abroad; 0 otherwise	0.1033
Trade credit	Equals 1 if the firm purchases on credit material inputs or services; 0 otherwise	0.5013
Financial openness	Number of products and services contracted with banks	1.3985
Informal financing	Equals 1 if the firm uses informal finance (i.e., moneylenders, friends, relatives) to purchase fixed assets or for its working capital financing; 0 otherwise	0.0323
Internal Financing	Equals 1 if the firm uses internal funds or retained earnings as the main source of its working capital financing; 0 otherwise	0.6723
Large city	Equals 1 if the firm is located in a capital or a large city (more than 1 million inhabitants); 0 otherwise	0.1690
Weeks closed	Numbers of weeks the firm was temporarily closed due to the COVID-19 outbreak	0.7597
Days since pandemic	Days between the day of interview and 11 March 2020, day in which the World Health Organization (WHO) declared COVID-19 as a pandemic	279.0
Business Obstacles	Equals 1 if the firm perceives business licensing, trade regulations, corruption, tax rates and administration as significant obstacles to its operations; 0 otherwise	0.8366
Peer green management	Average values of the *Green management* z-score computed on the other enterprises operating in the same region of the firm	-0.0173
Peer credit constraints	Average value of the *Credit* constraints binary indicatory computed on the other enterprises operating in the same region of the firm, excluding those operating in the same sector	0.1122

Notes: average values are computed using sample weights, rescaled by the inverse of the number of observations in each country.

Table A3 – Correlation matrix of the explanatory variables

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	Green management	1.00								
(2)	Credit constraints	-0.03	1.00							
(3)	Age	0.10	-0.08	1.00						
(4)	Employees	0.24	0.00	0.20	1.00					
(5)	Sole Proprietorship	-0.11	-0.09	-0.13	-0.27	1.00				
(6)	Domestic	-0.05	0.03	0.07	-0.15	0.09	1.00			
(7)	Female-led	-0.01	0.00	-0.11	-0.12	0.10	-0.03	1.00		
(8)	Family owned	0.01	0.01	0.07	-0.04	0.01	0.07	0.05	1.00	
(9)	Audited	0.19	0.00	0.07	0.29	-0.19	-0.14	-0.08	0.05	1.00
(10)	Direct exporter	0.18	-0.03	0.07	0.26	-0.16	-0.16	-0.06	0.09	0.20
(11)	Trade credit	0.08	0.05	0.00	0.13	-0.06	0.05	-0.05	0.08	0.08
(12)	Financial openness	0.06	-0.08	0.08	0.16	-0.07	0.01	-0.10	0.06	0.10
(13)	Informal financing	0.05	0.09	-0.02	0.02	-0.03	0.00	-0.02	0.06	0.02
(14)	Large city	0.05	-0.04	0.05	0.02	-0.14	-0.03	-0.09	0.03	0.08
(15)	Weeks closed	-0.03	0.00	-0.04	-0.02	-0.04	0.02	0.03	0.00	-0.02
(16)	Days since pandemic	0.00	-0.01	0.00	-0.01	0.03	-0.01	0.03	0.02	0.00
(17)	Internal Financing	-0.02	-0.09	0.06	-0.01	0.05	0.00	-0.05	0.12	0.04
(18)	Business Obstacles	0.07	0.04	-0.03	-0.04	0.00	0.01	0.06	0.02	-0.03

		(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(10)	Direct exporter	1.00								
(11)	Trade credit	0.05	1.00							
(12)	Financial openness	0.10	0.26	1.00						
(13)	Informal financing	0.06	0.05	0.00	1.00					
(14)	Large city	0.02	0.03	-0.01	0.02	1.00				
(15)	Weeks closed	-0.03	0.00	0.01	-0.02	0.02	1.00			
(16)	Days since pandemic	0.01	-0.04	-0.04	0.00	0.01	0.12	1.00		
(17)	Internal Financing	0.05	-0.17	-0.05	-0.03	0.07	-0.01	0.04	1.00	
(18)	Business Obstacles	0.00	0.06	0.01	-0.02	0.03	0.01	-0.01	-0.01	1.00

Notes: the Table reports pairwise correlation coefficients computed on the estimation sample, computed using sample weights, rescaled by the inverse of the number of observations in each country.

Supplementary appendix

Table S1 – WBES and WBES-COVID implementation periods by country

Country	WBES	WBES-COVID Round 1	WBES-COVID Round 2	WBES-COVID Round 3
Albania	January/May 2019	June 2020	–	–
Bulgaria	January/March 2020	July/September 2020	November/December 2020	April/May 2021
Croatia	November 2018/ November 2019	September 2020	December 2020/January 2021	May/June 2021
Cyprus	December 2018/June 2019	June 2020	November/December 2020	April 2021
Czech Republic	April/November 2019	June 2020	October/November 2020	May/June 2021
Estonia	November 2018/January 2020	October 2020	February 2021	July/August 2021
Georgia	March 2019/January 2020	June 2020	October/November 2020	September/October 2021
Greece	September 2018/April 2019	June 2020	November 2020	April/May 2021
Hungary	December 2018/March 2020	September 2020	January/February 2021	May/June 2021
Italy	November 2018/October 2019	June 2020	November/December 2020	April/May 2021
Latvia	November 2018/December 2019	September 2020	February 2021	July/August 2021
Lithuania	December 2018/January 2020	October 2020	February 2021	July/August 2021
Malta	December 2018/September 2019	September 2020	January 2021	May 2021
Moldova	April/November 2019	June 2020	October/November 2020	May/June 2021
North Macedonia	December 2018/October 2019	October/November 2020	May/June 2021	December 2021/January 2022
Poland	December 2018/December 2019	July/August 2020	November/December 2020	May/June 2021
Portugal	November 2018/January 2020	September/October 2020	January/February 2021	May/June 2021
Romania	December 2018/June2020	August/September 2020	November/December 2020	April/June 2021
Slovak Republic	December 2018/March 2020	September/October 2020	January/February 2021	May/June 2021
Slovenia	December 2018/November 2019	July/August 2020	November/December 2020	May/June 2021

Table S2 – Questions in the "Green Management Module" of the WBES

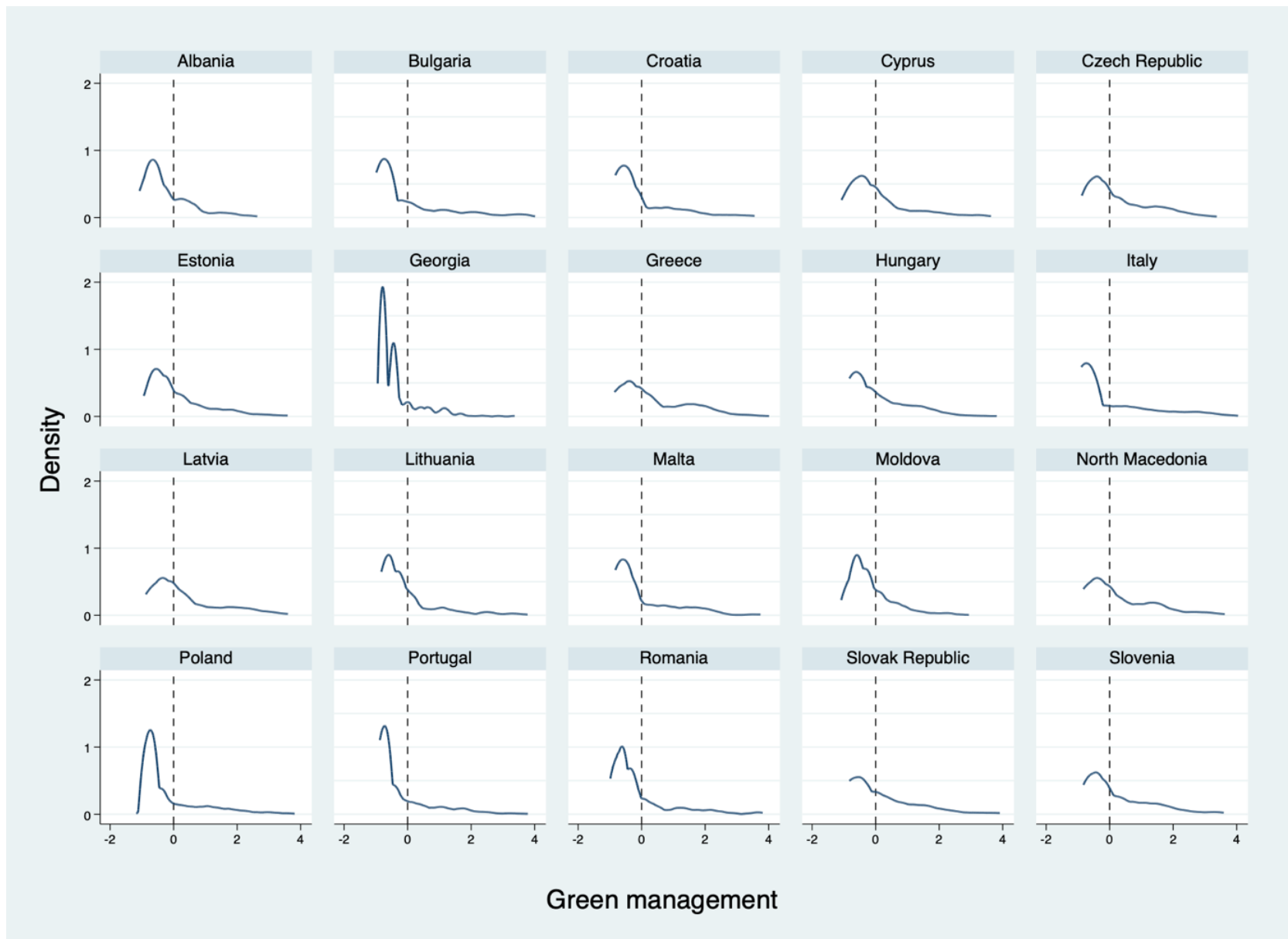| Green managerial area	Question
a) Strategic objectives	1) BMGA1: *In the last fiscal year, did this firm have strategic objectives that mention environmental or climate change issues?*
b) Managers' responsibility	1) BMGA2: *In the last fiscal year, did this establishment have a manager responsible for environmental and climate change issues?*
	2) BMGA3: *In the last fiscal year, whom did the manager responsible for environmental and climate change issues directly report to?*
	3) BMGC22: *Is the manager responsible for environmental and climate change issues evaluated against how well the establishment performs on energy consumption, CO2 emissions or other pollution or environmental targets?*
c) Monitoring	1) BMGC1: *Over the last three years, did this establishment monitor its energy consumption?*
	2) BMGC3: *Over the last three years, did this establishment complete an external audit of its energy consumption?*
	3) BMGC4: *Over the last three years, did this establishment monitor its water usage?* (Manufacturing firms only)
	4) BMGC6: *Over the last three years, did this establishment complete an external audit of its water usage*? (Manufacturing firms only)
	5) BMGC8: *Over the last three years, did this establishment monitor its CO2 emissions?*
	6) BMGC10: *Over the last three years, did this establishment complete an external audit of its CO2 emissions?*
	7) BMGC11: *Over the last three years, did this establishment monitor CO2 emissions along its supply chain?*
	8) BMGC13: *Over the last three years, did this establishment monitor its emissions of pollutants other than CO2?* (Manufacturing firms only)
	9) BMGC15: *Over the last three years, did this establishment complete an external audit of its pollutants other than CO2?* (Manufacturing firms only)
d) Targeting	1) BMGC16: *Over the last three years, did this establishment have targets for energy consumption?*
	2) BMGC18: *Over the last three years, did this establishment have targets for CO2 emissions?*
	3) BMGC20: *Over the last three years, did this establishment have targets for pollution emissions other than CO2?* (Manufacturing firms only)

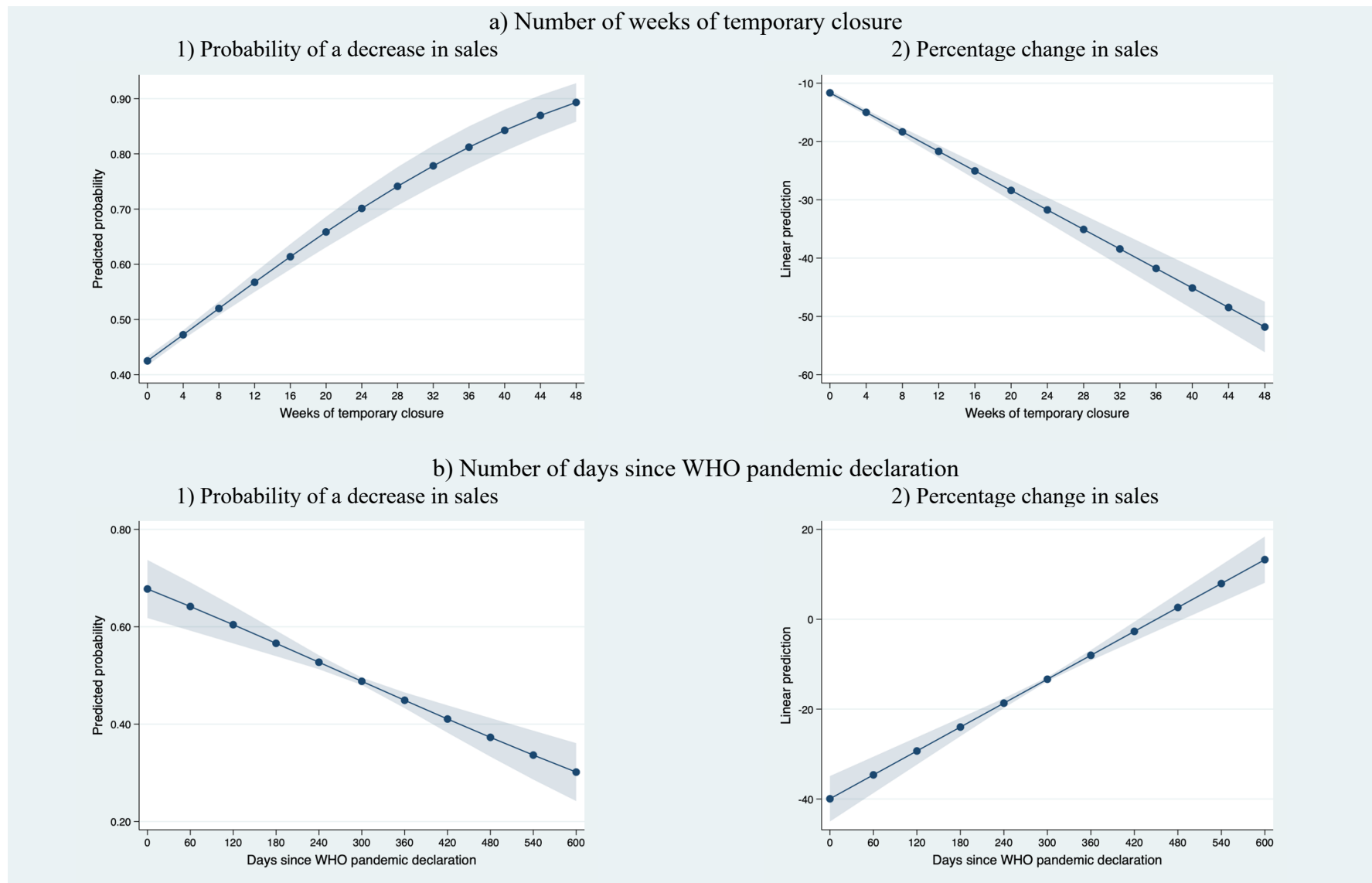Figure S1 – Distribution of the Green Management score by country

Figure S2 – Predicted probability of sales decrease and predicted percentage change in sales since the COVID-19 outbreak
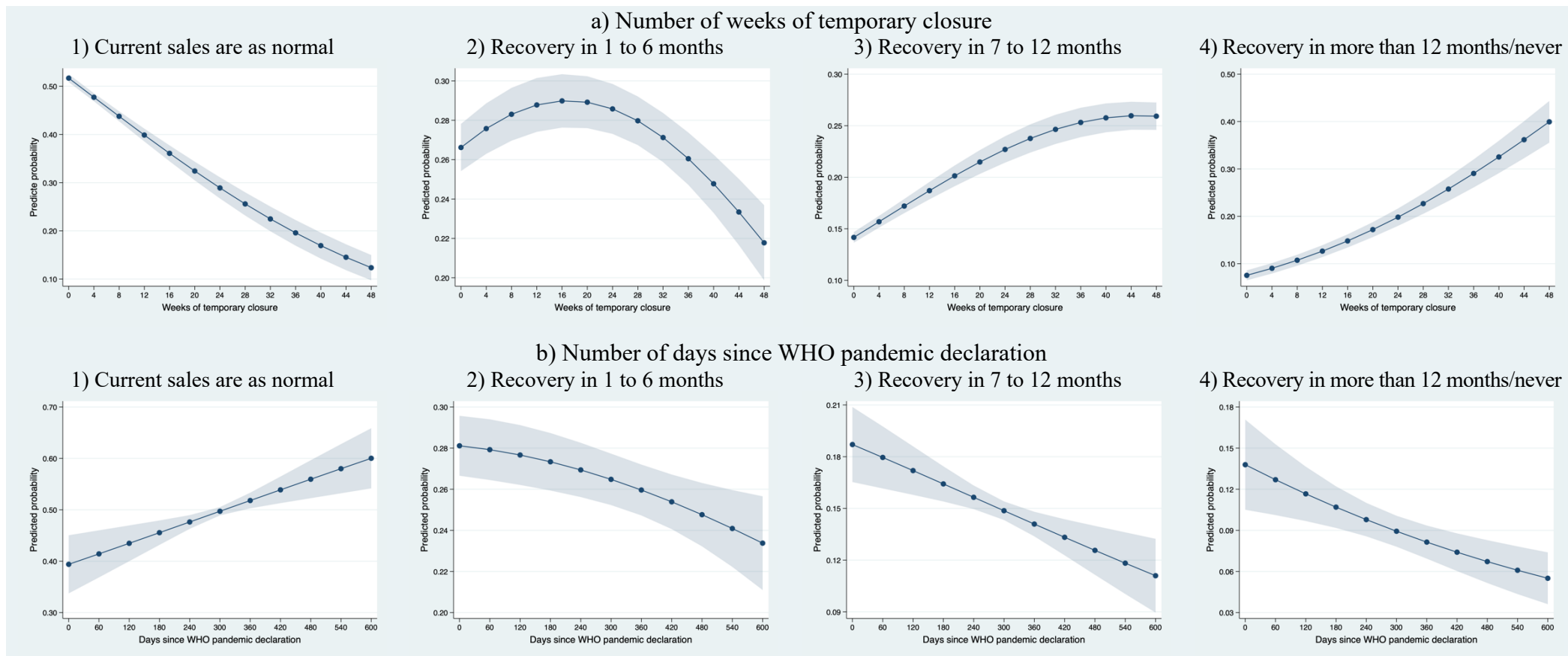
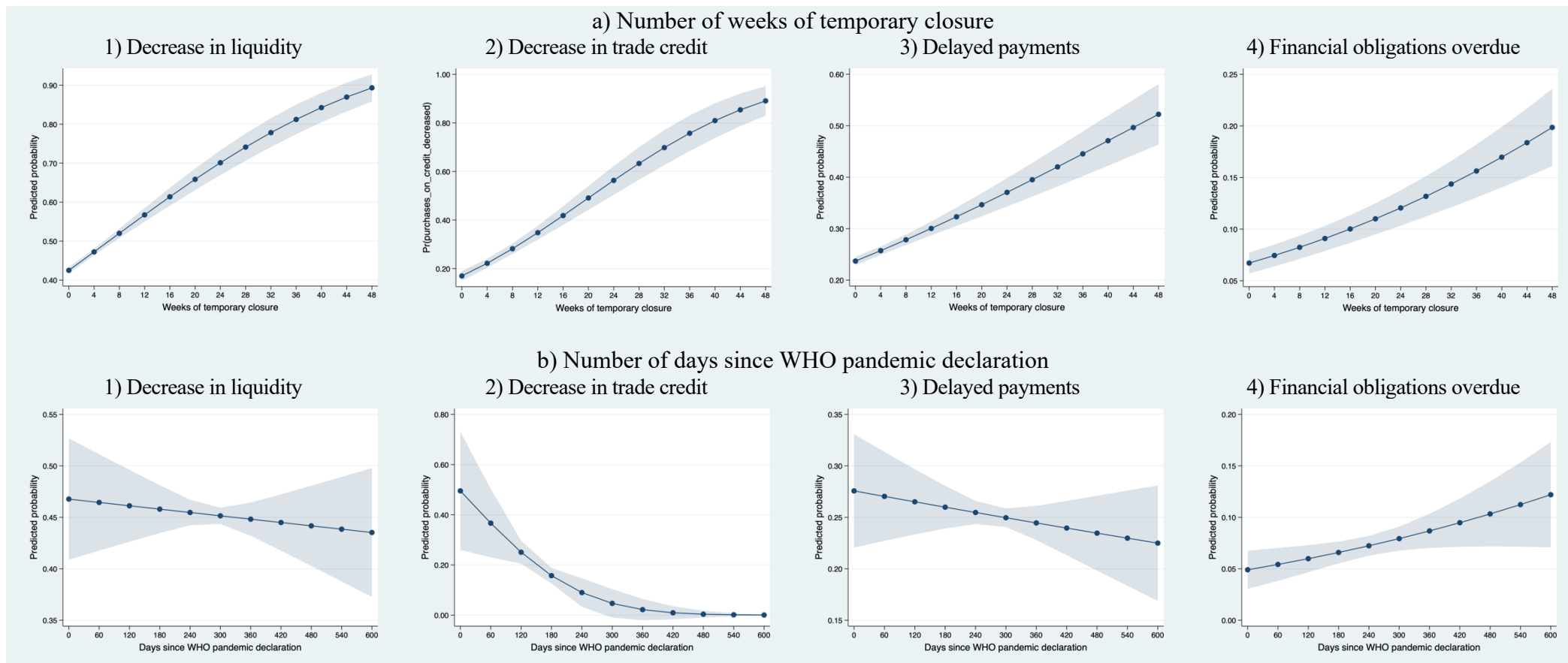Figure S3 – Predicted probabilities of expected time to recover from the COVID-19 shock

Figure S4 – Predicted probabilities of experiencing different pandemic-induced financial issues
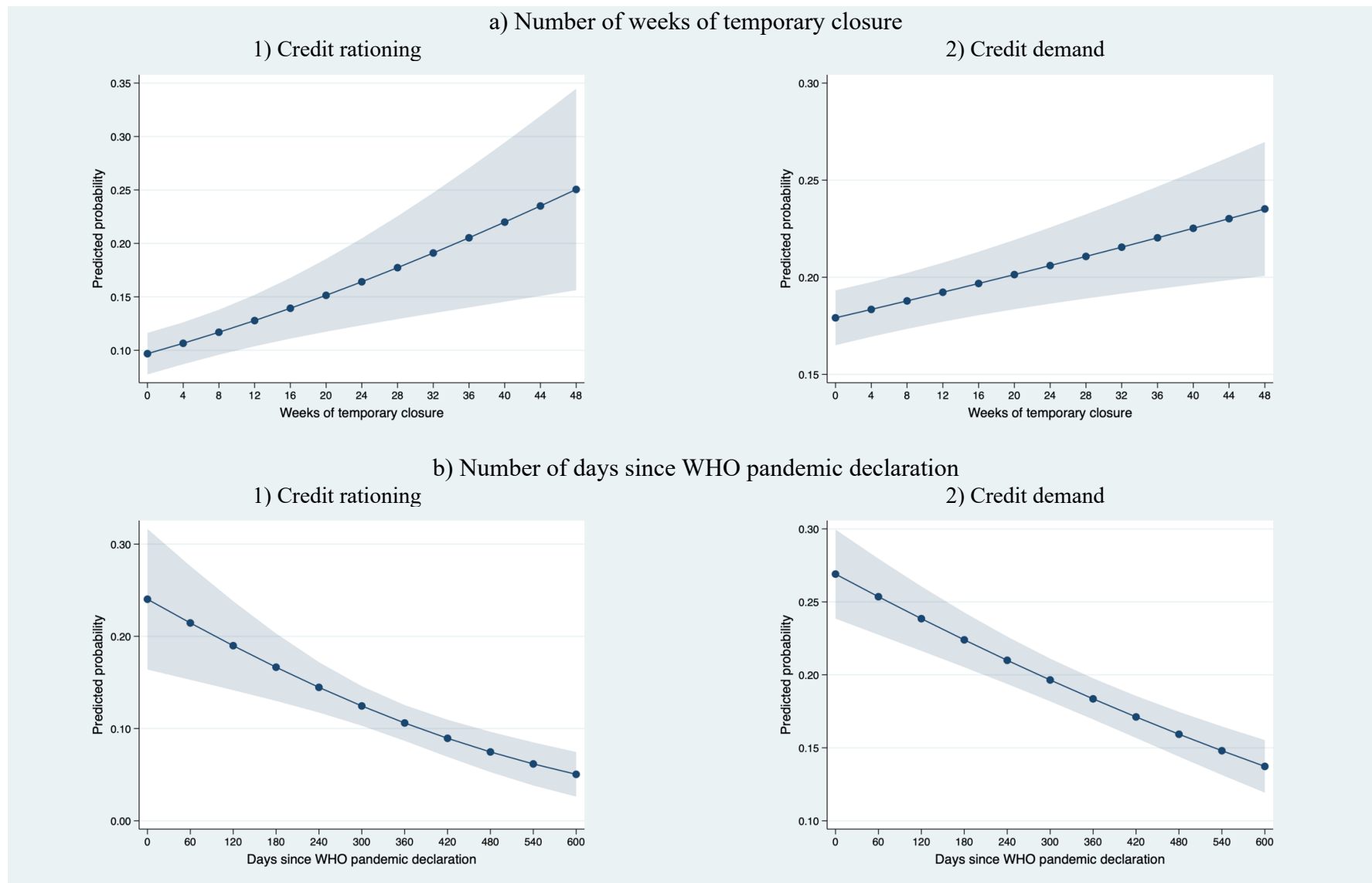
Figure S5 – Predicted probabilities of credit rationing and credit demand during the COVID-19 pandemic