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Can Financial Access Improve Firms' Environmental Performance?

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Finance for Sustainability:

Can Financial Access Improve Firms' Environmental Performance?

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Abstract

This study examines the impact of financial access on firm-level environmental sustainability by using data from the Business Environment and Enterprise Performance Surveys (BEEPS), which includes 28,000 surveys from 27 sectors in 41 countries. To achieve this, the paper contributes to three key areas of the literature. First, we analyze the effect of financial access on various dimensions of sustainable environmental performance, namely Energy, greenhouse gas (GHG) emissions, Water, Waste, and Air quality. Second, we use a comprehensive indicator of financial access that encompasses two binary variables: access to loans and access to overdraft facilities. Third, the paper employs an extended probit model approach with instrumental variables to account for endogeneity concerns when studying the effect of financial access on firm-level sustainability outcomes. This study controls for heterogeneity among firms (by country and sector), firm characteristics, reverse causality, and sample selection. Our findings suggest that firms with better financial access are more likely to invest in sustainable practices, such as energy efficiency and emissions reduction. Additionally, exporting firms and those with quality certifications exhibit superior environmental sustainability outcomes. However, weak institutional quality remains a key barrier to firms' adoption of sustainable business practices. These insights highlight the crucial role of financial access in enabling firms to transition toward greener and more sustainable operations.

JEL classification. L2; G21; Q53 ; 013; C25

Keywords. Financial access; Sustainability; Environmental Performance; Firm performance; Extended probit models.

Data Availability: The dataset analysed during the current study is available in The Business Environment and Enterprise Performance Surveys (BEEPS).

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Code availability. Stata is the software used.

1. Introduction

In order to achieve the goals outlined in the Paris Agreement, it is imperative for governments and non-state actors, particularly the private sector, to collaboratively take action. Firms, as key contributors to climate change, are largely responsible for reducing greenhouse gas (GHG) emissions to alleviate the adverse climate impacts resulting from their operations. Addressing corporate environmental performance is essential for meeting the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). There is a focus on reinforcing the resilience of companies and their supply chains, allowing them to effectively confront and adapt to climate change. This adaptation includes adjusting their operations to preserve the natural environment (OECD, 2023).

Achieving this involves allocating investments in climate adaptation and mitigation measures. These measures enable firms to combat severe climate events, cut down on energy expenses, and implement necessary actions to reach carbon neutrality by 2050 (Brasili and Harasztosi, 2023). Nevertheless, firms face credit constraints as an impeding factor to achieve sustainable targets. Higher severity of credit constraints is associated with lower incentives for stakeholders (e.g., management, owners…etc.) to invest in greener technologies since they are less likely to receive a payoff from such investments (Kaldorf and Shi, 2024). Thus, ensuring financial access is critical for companies seeking to transition to low-carbon production processes and meet SDG goals.

Nevertheless, the channels through which credit constraints hamper firm-level green performance are yet to be thoroughly researched. Initially, the literature was focused on emphasizing the determinants of firm-level environmental performance in general (Doonan et al., 2005; Hojat et al., 2010; and Cruz, 2010). Interestingly, the literature mainly focused on firm-level characteristics such as managerial framework, environmental education of employees and human capital, and firm age and size. In turn, this led to a gap where the impact of credit constraints on firm environmental performance, specifically, is underexplored.

Consequently, empirical literature seeking to tackle this research question started to evolve with varying econometric techniques and identification strategies. For instance, researchers attempted to investigate the impact of credit constraints on firm-environmental proxies such as plant-level pollution emissions, ISO certifications, and embedding mitigation strategies to business models (Andersen, 2017; Tian and Lin, 2019; Baiyegunhi, 2020). This strand of literature of course lacked a unified definition, or perhaps common variables proxying environmental performance.

In subsequent literature, researchers focused their efforts on addressing the nexus in specific countries and under specific contexts. These included EU firms, Chinese and Egyptian listed enterprises, and small and family-owned businesses (Brutscher et al., 2021; Yan et al., 2023; Agostino and Ruberto, 2023; D'Apolito et al., 2024; Khalil and Assran, 2024). These studies provided comprehensive promising analysis, yet the fact that they were limited to certain contexts

threatens their external validity. Moreover, as previously noted, they lack consistent variables or proxies for environmental performance.

Therefore, this research aims to contribute to empirical literature in three key areas. Firstly, we analyze the influence of access to finance on various dimensions of environmental performance, namely Energy, GHG, Water, Waste, and Air. This allows for a more comprehensive understanding of how credit constraints affect different aspects of environmental performance, providing insights into the specific areas where firms may face challenges or opportunities for improvement.

Secondly, we utilize a composite variable of access to finance, which directly indicates whether firms have loans or overdraft facilities, providing an accurate representation of financial access. Given the binary nature of our variables, we use probit regression models.

Laslty, by using data from the Business Environment and Enterprise Performance Surveys (BEEPS), which includes 28,000 surveys from 27 sectors in 41 countries, we explore a wide array of surveys spanning different countries and sectors, allowing to control for country, sector, and year fixed effects. Thus, this paper controls for heterogeneity among firms (by country, and sector), firms' characteristics, reverse causality and sample selection while using an extended probit model. This approach is an attempt to transcend the issue of questioning external validity and provide a broader perspective on the relationship between credit constraints and environmental performance. This paper also controls for sample selection by using a two-step probit selection model to correct for the self-selection issue.

The main findings of the study suggest that financial access is positively and significantly associated with higher performance across the five defined environmental dimensions. This suggests that access to finance plays a potential role in facilitating firms' efforts to innovate and improve their environmental practices. Additionally, the results highlight disparities in environmental performance between micro and small firms compared to larger counterparts, emphasizing the importance of targeted policies to support smaller enterprises in their environmental efforts.

Moreover, the presence of environmental regulatory requirements poses as a driver of environmental initiatives, underlining the role of regulatory frameworks in promoting environmental sustainability. Exporting firms are found to be more inclined towards higher environmental performance, likely driven by the need to comply with destination countries' environmental standards.

In contrast, weak institutional quality is found to be a barrier to firms' green performance, indicating the importance of robust institutional frameworks in fostering environmental initiatives. Finally, firms with international quality certifications exhibit higher probabilities of environmental performance, highlighting the relevance of quality standards in promoting environmental efforts. To check for the robustness of the results, we run an extended probit model with two instrumental variables in order to tackle the possible endogeneity of financial access.

The structure of the paper is organized into six sections. After the introduction, we present previous theoretical and empirical frameworks relevant to the study. The Data and Stylized Facts section will describe the dataset and highlight key trends in our variables. In the Methodology

section, we define the econometric used in the analysis. Then, the Empirical Findings section will present the results of the analysis, followed by Robustness Checks to validate the consistency and robustness of the findings. Finally, we discuss the implications for policy and future research and proceed to the Conclusion section to summarize the key insights.

2. Literature Review

2.1.Theoretical literature

From a theoretical point of view, undertaking such relatively rudimentary environmental measures requires firms to proactively innovate. This has been proposed ever since Schumpeter (1934, 1939). Yet, innovation is a complex and dynamic process, characterized by information asymmetry due to the confidentiality of the process and the imperative to protect intellectual property (Agenor and Canuto, 2017). This implies the exclusion of financial access for firms who are willing to invest in such projects within imperfect credit markets, as a direct result of information asymmetry (Stiglitz and Weiss, 1981).

Also, the Pecking Order Theory by Myers and Majluf (1984) highlights the difficulty faced by firms in accessing finance under these circumstances. This challenge primarily arises from the price disparity between financing investments through retained earnings and external debt, which becomes more costly due to information asymmetry. Finally, the Finance-Growth Nexus Theory by Levine (2005) suggests that these financial market distortions diminish the overall investment opportunities for firms.

2.2.Empirical literature

Empirically, the initial stride of literature isolated and analyzed the determinants of firm-level environmental performance in general, with no particular focus on access to credit (Doonan et al., 2005); Hojat et al., 2010; Cruz, 2010). This led to a gap in empirical research where the impact of credit constraints, particularly on firm-level environmental performance remains under-researched. Therefore, emerging studies utilized different methodologies and data sets in various attempts to analyze the causal effects of the nexus.

For instance, Andersen (2017) developed a fixed effects pooled regression model to test the relationship between plant-level pollution emissions and plant-level creditworthiness as a proxy for credit constraints. The study focused on the period between 1990 and 2009 in the United States. The author collected data from four different sources and hence created a comprehensive dataset for the analysis. Results suggested that credit constraints led firms to over-invest in physical assets and to increase their collateral capacity. In turn, this was associated with an increase in pollution emissions.[3] However, the author acknowledged that the data employed in the model are not experimental, and hence do not support strong implications regarding causality.

[3] This is attributed to the author's conceptual model that suggests a positive relationship between physical assets e.g., heavy machinery, and emissions.

By focusing on financial access as a main determinant of environmental performance, Tian and Lin (2019) aimed to test whether firms' possession of ISO 14000 certification, which corresponds to compliance with pollutant discharge standards and minimizing operational side effects, facilitates access to finance. The authors utilized World Bank survey data from 2011 to 2013 for Chinese firms. This paper applied a binary choice model, and categorized credit access into five distinct levels of responses. These ranged from firms perceiving financial access as not posing any obstacle to those considering it as a severe impediment. The study suggests that minor obstacles in financing did not significantly impact firms' environmental performance. However, moderate and major obstacles were associated with a decline in environmental performance due to high investment costs and biased incentives. Therefore, the severity of credit constraints was positively correlated with a higher probability of poor environmental performance.

Also, Ojo and Baiyegunhi (2020) attempted to analyze whether credit constraints hinder climate change adaptation strategies and efforts of rice farmers in Nigeria. The research was conducted in the southwestern part of Nigeria, including six states, and characterized by a tropical climate with wet and dry seasons. Climate data from 1970 to 2014 were obtained from the Nigeria Meteorological Agency and the International Institute for Tropical Agriculture. The authors used an econometric method of a two-stage estimation technique. In the initial stage, the predicted values for multiple credit-constraint categories were obtained by using the seemingly unrelated regression (SUR). In the subsequent stage, a generalized method of moments with instrumental variables (IV-GMM) was utilized to analyze the influence of credit constraints on the selection of adaptation strategies, incorporating predicted credit variable values as selectivity correction terms from the first stage. This identification strategy is designed to address selection bias, as households' decisions to participate in the credit market are likely non-random[4]. Findings suggested that smallholder rice farmers facing credit constraints are less likely to adopt climate change adaptation strategies.

Moreover, Brutscher et al. (2021) attempted to assess the impact of a firm's increased energy efficiency on its ability to obtain debt in European Union countries. The authors used a dataset that combines financial and ownership data from Online Resource for Business Intelligence and Standards ORBIS, with data from the European Investment Bank's Investment Survey (EIBIS) for the years 2016 to 2018. The result included a dataset of around 12,500 firms annually from various sectors across all EU countries. The study examined two types of barriers to finance to assess borrowing conditions for energy-efficient firms. Additionally, it considered a firm's proportion of building stock meeting high energy efficiency standards as an indicator of its energy efficiency[5].

[4] For instance, households with certain characteristics such as solid collaterals, financial awareness, connections …etc., are more likely to obtain access to finance. In contrast, households without such characteristics are more prone to credit constraints.

[5] The study used the percentage of a firm's buildings that meet high energy efficiency standards as a measure of how energy-efficient the firm is.

The analysis included a range of financial, operational, and ownership variables, along with firm characteristics including size, sector, and age, as controls. The application of a logistic model led to findings indicating that energy efficiency does not influence a firm's capacity to secure external financing when compared to other more significant indicators related to the financial or operational efficiency of the firm.

Furthermore, Yan et al. (2023) analyzed the impact of environmental credit constraints[6] on enterprises' decisions regarding environmental protection measures. The authors employed data from A-share listed enterprises in China spanning from 2009 to 2019. They used a difference-in-differences model for their analysis. The findings revealed a dual effect: some enterprises were prompted to engage in proactive environmental behavior, influenced by the incentive effect of environmental credit constraints on R&D investments. Conversely, certain enterprises implemented evasive strategies, as environmental credit constraints were associated with higher production costs and increased debt.

In addition, Agostino and Ruberto (2023) aimed to focus on examining nexus with a focus on small and medium-sized enterprises (SMEs). Utilizing data from the Enterprise Surveys spanning from 2018 to 2020, the study employed a Poisson model. The primary findings suggested that SMEs experiencing credit constraints tend to exhibit poorer environmental performance. And, the research indicated that such constraints highly affect the environmental footprint of firms that are less likely to seek nonfinancial goals and with limited ability to capitalize on green investment opportunities through alternative financing methods.

In a recent study conducted by D'Apolito et al. (2024), the researchers aimed to investigate the relationship between firm sustainability and access to bank credit with a similar emphasis on SMEs. Using panel data analysis, they examined 125 listed Italian SMEs across 14 regions during the period from 2017 to 2021. A quantitative assessment, based on 20 indicators categorized into three domains (disclosure, processes, and governance)[7], was employed to evaluate the extent of sustainable practices adopted by the sampled SMEs. The findings revealed that SMEs demonstrating a stronger commitment to sustainability were more likely to secure bank credit and showed improved capacity to meet the costs associated with bank debt.

Finally, Khalil and Assran (2024) attempted to examine the relationship between environmental performance and a company's ability to secure bank loans among Egyptian-listed companies from 2013 to 2022. The research aimed to understand how environmental performance impacts access to bank credit in emerging economies, considering the unique characteristics of different countries. The authors utilized a weighted least squares model (WLSM), where the findings indicated a positive association between environmental performance and access to bank credit, aligning with their theoretical proposition.

[6] Limitations or restrictions imposed on businesses or enterprises by financial institutions or credit providers based on their environmental performance or compliance with environmental regulations.

[7] The indicators include economic, environmental, social, and governance aspects e.g., emission intensity, board gender diversity, and adoption of sustainability remuneration targets.

While some studies emphasize the adverse effects of credit constraints on firms' ability to adopt environmentally sustainable practices, others examine the mechanisms and moderators shaping this relationship. However, a notable gap in the literature lies in understanding the specific dimensions of environmental performance affected by financial access, as well as providing analysis that suggests external validity. To address this gap, we attempt in this study to comprehensively analyze the influence of financial access on five dimensions of environmental performance, using a rich data set of cross-country firm level surveys.

3. Data and Stylized Facts

3.1.Data and Variables

This research utilizes the Business Environment and Enterprise Performance Survey (BEEPS), which includes a comprehensive dataset of 28,000 surveys conducted across an array of establishments spanning 27 sectors and operating within 41 countries. The surveys were obtained collaboratively by the European Bank of Reconstruction and Development (EBRD), the World Bank, and the European Investment Bank (EIB). The surveys were conducted in 2018-2020, and they provide valuable insights into key business aspects, mainly financial inclusion, and environmental performance, among others. By utilizing this dataset, the study aims to provide an analysis of the financial inclusion and environmental performance nexus and identify key trends and implications within a variety of business environments.

Besides the research question being generally underexplored, the optimum indicators of environmental performance remain unsettled and subject to ongoing debate. For instance, a strand of literature assumes that environmental sustainability is merely defined by bio-geophysical aspects Moldan et al. (2012). Different researchers assessed environmental performance by combining energy, economic, and environmental factors Sun et. al. (2020). Moreover, different literature examines environmental performance by utilizing circular economy indicators, such as the circularity of products and services, as proxies Harris et. al. (2021).

Therefore, to address this issue, we define five aspects of firm-level environmental performance, namely: *Energy, GHG, Water, Waste,* and *Air*. *Energy* is a composite variable that takes the value of 1 if the establishment monitors its energy consumption, adopts a climate-friendly energy generation on-site, adopts an energy management framework, or adopts measures to specifically tackle energy efficiency, and 0 otherwise. Similarly, *GHG* is a composite variable that takes the value of 1 if the establishment monitors its CO_2 emissions, monitors its CO_2 emissions along its supply chain, is working on achieving defined CO_2 targets, or measures its CO_2 emissions, and takes the value of 0 otherwise.

The *Water* variable is a composite variable that includes three different binary variables: whether the establishment monitors its water usage, whether the establishment performs an external water usage audit, or whether the establishment adopts a water management framework. Accordingly, the variable *Water* takes the value of 1 if either of the three variables corresponds to a response of "Yes", and 0 otherwise. The *Waste* variable takes the value of 1 if the respondent firm adopts waste minimization, recycling, and waste management practices, and 0 otherwise. Finally, *Air* is a composite variable that takes the value of 1 if the firm adopts air pollution or other pollution control measures, adopts targets to reduce pollutants other than CO_2, or monitors its air pollutants, and 0 otherwise.

It is important to highlight that three of the composite variables include mere measurement as an indicator for environmental performance e.g., measuring GHG emissions. While it is true that measuring metrics like emissions or water usage may not directly translate to improved environmental outcomes, the act of measurement itself is a foundational step toward effective environmental management. Measurement is an essential component of awareness and accountability, which are prerequisites for any substantive environmental action. The mere measurement signals that the establishment is aware of its environmental impact and is taking initial steps to quantify it.

We also construct two aggregated variables. The *Environmental Footprint* variable, takes the value of 1 if either the *GHG* or *Energy* variables are equal to 1, and the *Resource Management* variable takes the value of 1 if either *Water*, *Waste*, or *Pollutants* is equal to 1. This approach aims to capture the broader environmental impact of firms by consolidating related variables into two composite measures. The *Environmental Footprint* variable provides insight into a firm's contributions to climate change and energy usage, while the *Resource Management* variable offers an indication of its efforts in conserving natural resources and minimizing environmental harm.

The reason for the inclusion of the variable associated with air pollution in *Resource Management* rather than *Environmental Footprint* is that the latter is designed to capture only the variables contributing to global warming. On the other hand, other types of air pollutants are mostly associated with degrading air quality, which is a natural resource that is essential for humanity.

On the other hand, to measure access to finance, we develop a composite variable that takes the value of 1 if the firm has access to an overdraft facility or a credit loan from a financial institution. This consolidated measure offers a simplified yet informative assessment of firms' financial accessibility, enabling a more comprehensive analysis of their access to finance, eliminating the need for other proxy variables[8].

3.2.Stylized Facts

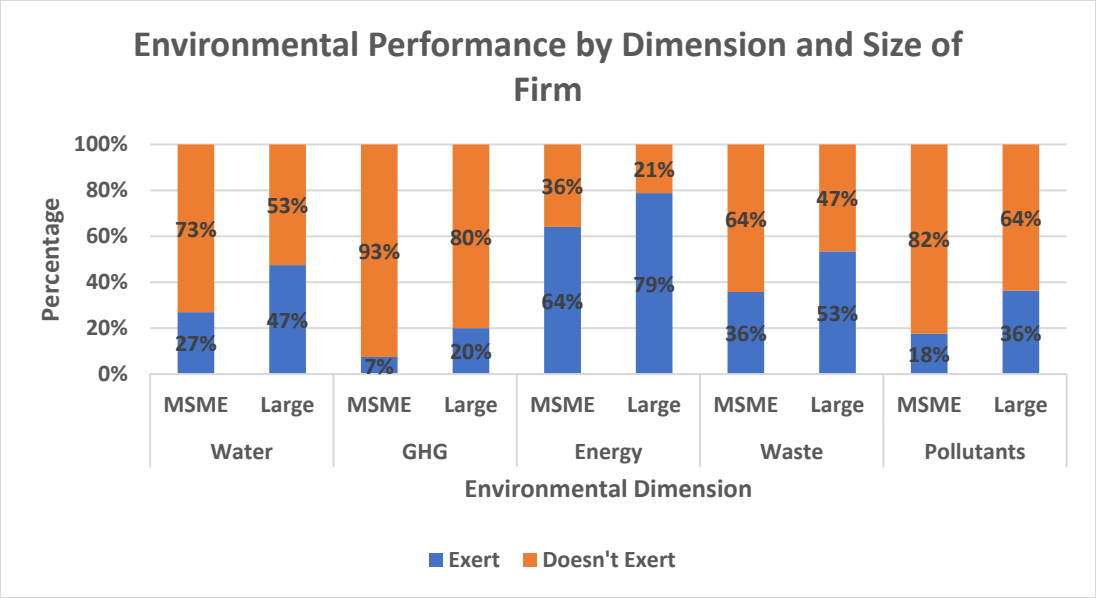
Figure 1 illustrates the comparison between firms that actively exert efforts in environmental performance measures and those that do not, categorized by their size. The data reveals that, on

[8] Proxies include for example credit worthiness, which might decrease the precision and reliability of the findings.

average, large firms demonstrate higher levels of engagement across all five performance dimensions when compared to micro, small, and medium enterprises (MSMEs). This adheres to the literature suggesting that firm size has an impact on firms' environmental responsiveness (Elsayed, 2006) and that it affects firms' abilities to implement environmental strategies (Darnall et. al., 2010).

Of particular note is the *Energy* dimension, which stands out as the most widely addressed area among both MSMEs and large firms. On average, 64% of MSMEs and 79% of large firms are actively involved in exerting efforts related to energy conservation and efficiency. Conversely, the dimension with the lowest level of engagement is *GHG*. Only 7% of MSMEs and 20% of large firms exert efforts to reduce GHG emissions, indicating a significant gap in environmental efforts in this specific area between different firm sizes.

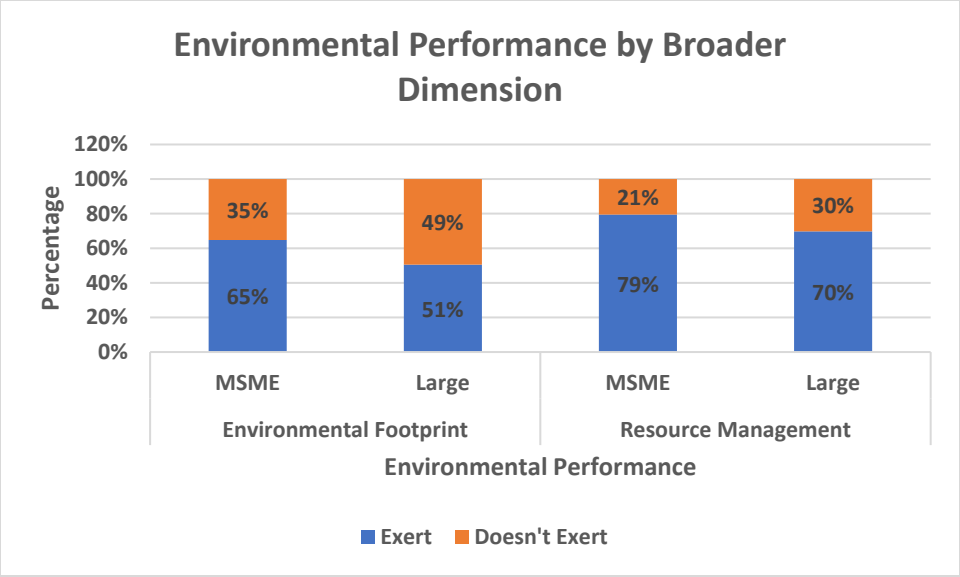
Figure 1: Environmental Performance by Dimension and Firm Size.



Source: Authors' Elaboration Using BEEPS.

Figure 2 illustrates the contrast between firms engaging in efforts related to the *environmental footprint* and *resource management* aggregate dimensions, and those that are not, segmented by their size. The figure reveals that, on average, 65% of MSMEs exert efforts in the *Environmental Footprint* dimension, whereas a higher percentage, 79%, of large firms are engaged in similar efforts. Similarly, in the *Resource Management* dimension, 51% of MSMEs are involved, compared to 70% of large firms participating in these efforts.

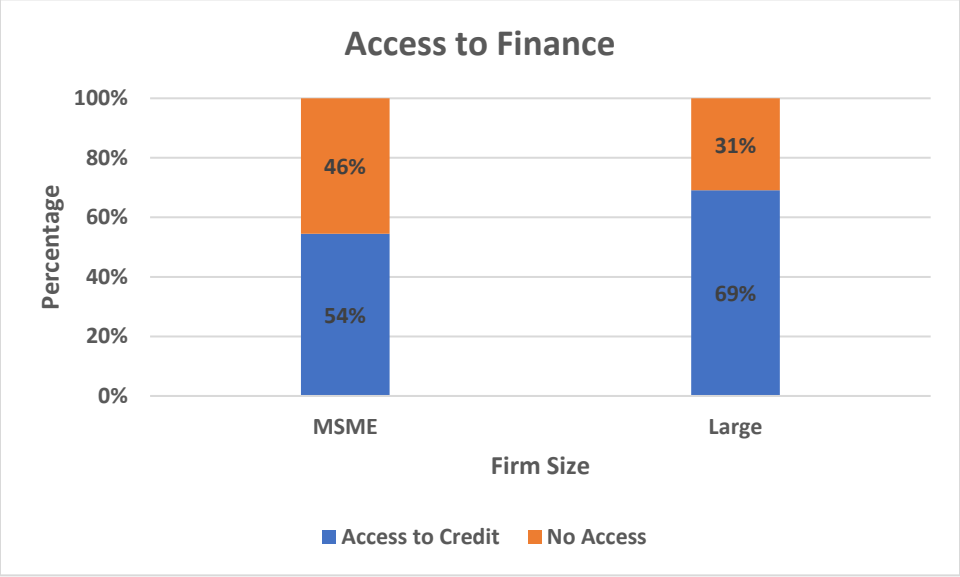
Figure 2: Environmental Performance by Broader Dimension.



Source: Author's Elaboration Using BEEPS

Figure 3 illustrates the disparity in access to finance among firms, categorized by their size. The data reveals that, on average, 54% of MSMEs have access to either overdraft facilities or credit loans, whereas a substantially higher proportion, 69%, of larger firms have accessible finance. This observation aligns with existing literature, which recognizes the heightened credit constraints faced by MSMEs compared to their larger counterparts (World Bank, 2020).

Figure 3: Firms' Access to Finance.



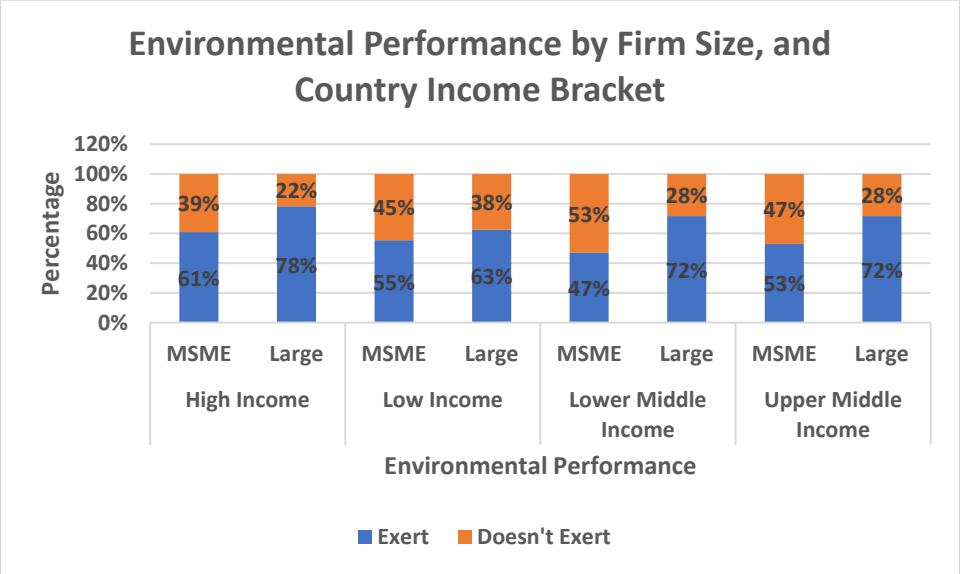
Source: Author's Elaboration Using BEEPS.

Figure 4 elaborates on firms that have scored a value of 1 in either the *Environmental Footprint* variable, the *Resource Management* variable, or both. Notably, on average, both MSMEs

and large firms demonstrate high efforts in environmental performance when operating in high-income countries.

Conversely, the data reveals a contrasting trend in lower-middle-income countries, where both categories of firms exert on average less effort in both aggregated indexes. This disparity highlights the influence of economic conditions on firms' environmental engagement, suggesting a potential correlation between financial resources and firm-level sustainability across different income levels.

Figure 4: Environmental Performance by Firm Size, and Country Income Bracket.

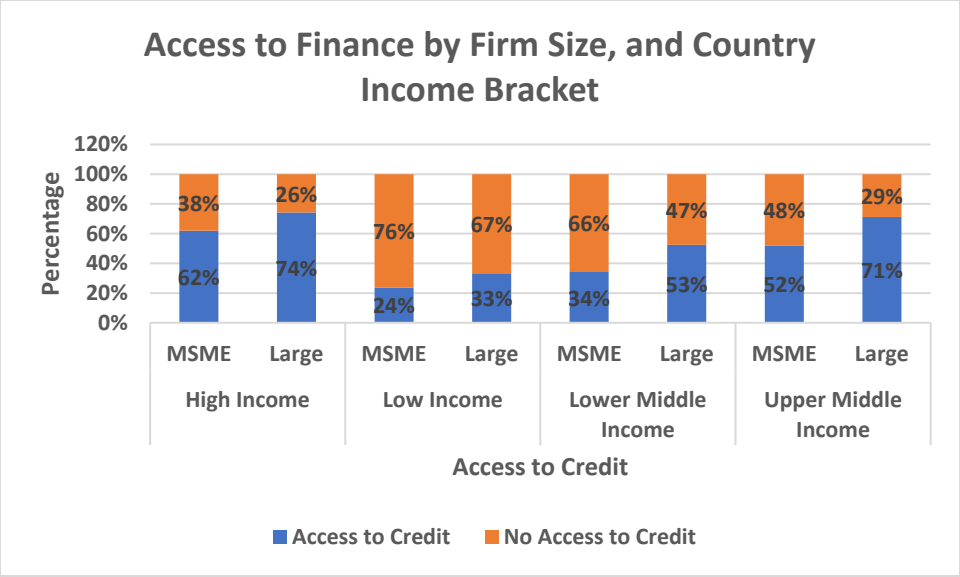


Source: Authors' Elaboration Using BEEPS.

Figure 5 shows firms' access to finance based on firm size and countries' income level. The data indicates that, on average, firms encounter notable financial constraints in low-income countries. In this category, only 24% of MSMEs and 33% of large firms can access finance. In contrast, access to finance is considerably higher in high-income countries, where 62% of MSMEs and 74% of large firms have access to credit, reflecting a more prosperous financial environment.

This disparity reflects the significant impact of economic conditions on firms' financial accessibility. It highlights the challenges faced by businesses operating in low-income countries and emphasizes the importance of addressing financial constraints to foster economic growth and development.

Figure 3: Access to Finance by Firm Size, and Country Income Bracket.

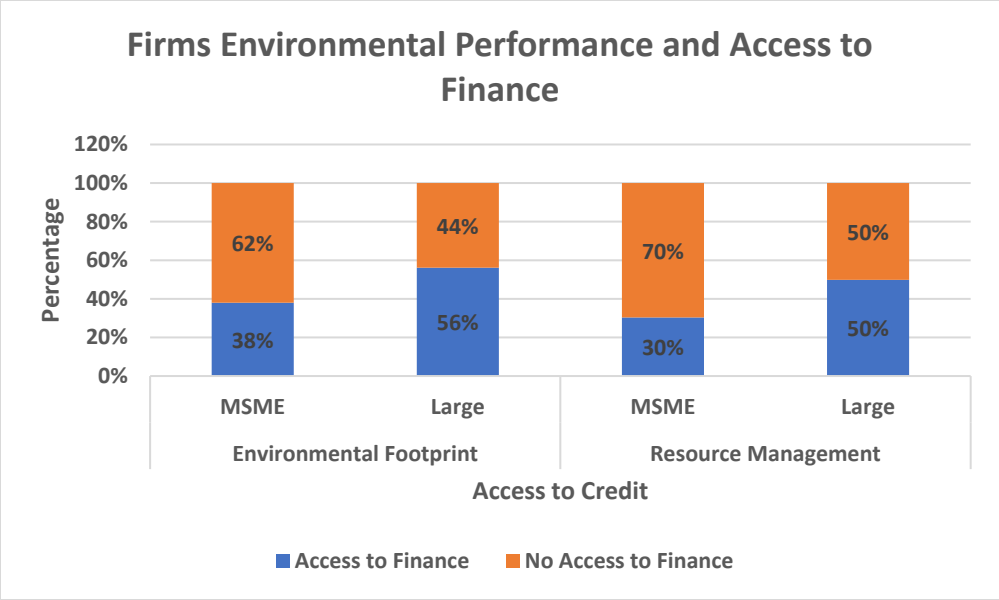


Source: Author's Elaboration Using BEEPS.

Figure 6 elaborates on firms that have access to finance while simultaneously exerting efforts in *Environmental Footprint* or *Resource Management*. On average, the data reveals that 38% of MSMEs with access to finance exert an *Environmental Footprint*, while 30% of MSMEs in the same category are similarly involved in *Resource Management* efforts.

In contrast, among large firms with access to finance, 56% are engaged in *Environmental Footprint* efforts, while 50% are involved in *Resource Management* efforts. These findings suggest that research is required to examine the relationship between financial constraints and environmental performance.

Figure 4: Firms' Environmental Performance and Access to Finance.



Source: Author's Elaboration Using BEEPS.

4. Methodology

To examine the effect of financial access on environmental performance, we estimate the following regression by using extended probit model:

$$ENV_{ijkn} = \alpha_0 + \alpha_1 Fin_{ijkn} + \alpha_2 Z_{ijkn} + f_j + f_k + f_n + \varepsilon_{ijk}$$

Environment ENV_{ijk} is the outcome variable that demonstrates environmental performance for firm i in country j in sector k and year n. In five separate regressions, the variable demonstrates five different dimensions of environmental performance: *Energy, GHG, Water, Waste,* and *Air.* Each dimension is measured by a dummy variables as exaplained in the Data section.

The variable *Financial Access* Fin_{ijkn} is the main regressor that denotes financial inclusion for firm i in country j in sector k and year n. This variable is binary, it takes the value of 1 if the respondent firm has access to either an overdraft facility or a loan from a financial institution at the time of the survey. If the firm does not have access to either of these financial resources, the variable takes the value of 0, highlighting credit constraints.

On the other hand, Z is a vector of control variables that we include based on their significance in the existing literature. Firstly, we control for environmental regulations as in Doonan et. al (2005). This is demonstrated by the *Env. Regulations* variable, which takes the value of one if the respondent firm perceives environmental regulations as a moderate, major, or severe obstacle to its operations. Also, we control for ownership structure and firm size as in Hojat et. al (2010). In this regard, the variable *Private Ownership* takes the value of 1 if 50% or more of the respondent firms' stocks are owned by private investors (either domestic or foreign). Finally, we control for firm size by allowing for size fixed effects.

Furthermore, we control for firms' exporting activities as Tian and Lin (2019). This is reflected by the binary variable *Exports* which takes the value of 1 if the respondent firm exports, and 0 otherwise. In addition, to reflect firms' innovation capabilities, the variable *Innovation* takes the value of 1 if the firm has introduced a new product, service, or process during the three years before the survey.

We use also the variable *Quality Certificate* due to its relevance, where it takes the value of 1 if the establishment has an internationally recognized quality certification and 0 otherwise. To control for the quality of institutions, we use the responses related to corruption, courts and political instability to generate a composite variable as proxy for institutions that reflect how the respondent firm perceive institutions. Thus, the *Institutions* variable takes the value of 1 if the respondent firm views corruption, courts and political instability as a moderate, major, or severe obstacle to its operations, and 0 otherwise. At last, we allow for country dummies f_j, sector dummies f_k, year dummies f_n, and ε_{ijkn} is the error term.

There is a potential for reverse causality between financial access and energy efficiency in the baseline model, as demonstrated by Brutscher et al. (2021), who empirically tested whether energy-efficient firms are more likely to obtain financial access. In other words, while financial access may influence energy efficiency, it is equally plausible that energy-efficient firms are better positioned to secure financial access. Thus, financial access is likely an endogenous variable in this context.

To address this issue, we run an extended probit model using two instrumental variables for financial access. The extended probit model has several benefits over the classical probit model. It allows deriving consistent and unbiased estimators of the effect of financial access on firm-level environmental performance, as it accounts for endogeneity of financial access and the reverse causality with firm-level environmental performance. Moreover, unlike instrumental variable probit model, it accounts for the binary nature of different endogenous regressors (StataCorp., 2021).

To run this model, we use two instrumental variables. The first variable is the respondent firm's percentage of the land occupied. The rationale for choosing this variable is that land is regarded as credible collateral for firms when applying for loans (Chakraborty et. Al, 2024). Thus, it is a dummy variable that takes the value of 1 if the respondent firm owns 50% or more of the land. Then, the second instrumental variable is a binary variable indicating whether the respondent firm's financial statements are checked and certified by an external auditor, a common requirement for obtaining credit as well (Palazuelos et al., 2018). The logic behind choosing this particular variable is that formal institutions are most likely to require external auditing before providing credit facilities (Palazuelos et Al., 2018). Hence, external auditing should only affect environmental performance if it facilitates credit access.

Initially, we perform various statistical tests to check for the validity of these instruments across five different regressions that correspond to the five different regressors, as well as the previously defined aggregated variables "Environmental Footprint", and "Resource Management".

The tests conducted for all regressions indicate that the instruments used are relevant, strong, and likely valid, suggesting that the models are well-identified. The details of the tests used and their corresponding statistics are included in the Appendix.

5. Empirical Findings

5.1. The effect of financial access on environmental performance

Table (1) elaborates on the results associated with the extended probit regressions for the effect of financial access on different dimensions of environmental performance in terms of energy, gas, water, waste, and air.

Table 1. Extended probit model results for the effect of financial access on environmental performance

	(1) energy	(2) gas	(3) Water	(4) waste	(5) air
Financial access	0.277***	0.236***	0.147***	0.101***	0.168***
	(0.0194)	(0.0272)	(0.0206)	(0.0192)	(0.0217)
Regulation	0.135***	0.170***	0.133***	0.0334+	0.168***
	(0.0235)	(0.0291)	(0.0237)	(0.0225)	(0.0245)
Private	0.249***	-0.0779	0.00981	-0.0241	-0.140**
	(0.0574)	(0.0708)	(0.0599)	(0.0536)	(0.0602)
Export	0.202***	0.220***	0.199***	0.203***	0.200***
	(0.0234)	(0.0295)	(0.0236)	(0.0222)	(0.0244)
Innovation	0.363***	0.225***	0.271***	0.409***	0.298***
	(0.0223)	(0.0274)	(0.0215)	(0.0204)	(0.0222)
Quality	0.181***	0.293***	0.245***	0.242***	0.331***
	(0.0248)	(0.0297)	(0.0244)	(0.0230)	(0.0251)
Institutions	-0.0381	-0.0148	0.0540*	-0.111***	0.0268
	(0.0271)	(0.0356)	(0.0280)	(0.0269)	(0.0293)
Observations	24722	24737	24736	24734	24733

Notes. $^{+}p < 0.15$, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust standard errors in parentheses. Standard errors are clustered by country. All regressions include country, sector, and year fixed effects. Constant terms are not reported. The estimates of the correlation between the errors are significantly different from 0, so the model suffers from endogeneity problem

Results show a positive and significant effect of financial access on the probability of exertion in the energy dimension. This highlights the importance of financial access in providing the means of innovating in the domain of energy technology which is pivotal in addressing climate

change as shown by Kober et al. (2019). Table (1) also reports the results corresponding to the GHG dimension. The result also suggests that the presence of financial access positively influences the GHG dimension. Regarding the water dimension, it is revealed that financial access has a positive and significant effect on this dimension as well as the waste management. Finally, concerning the effect of financial access on the air dimension. It yields results similar to those of other dimensions, with the financial variable increasing the probability of exerting in the air dimension.

In terms of control variables, the results indicate that the presence of environmental regulatory requirements significantly lead to an increase in the probability of different environmental performance indicators. This result aligns with the most recent empirical literature such as Nazir et. al (2024), which proposes environmental regulations as a significant means to improve environmental sustainability since firms tend to comply with environmental regulations that might pose challenges for conducting business. Accordingly, it is advised to prioritize policy interventions aimed at enhancing regulatory frameworks to ensure environmental sustainability and mitigate adverse environment-related outcomes.

Moving forward, results show that being a private firm lead to better environmental performance in terms of energy dimension. However, this effect is negative and weakly significant when it comes to the air dimension. This effect is insignificant for the remaining environmental dimensions. This result aligns with the strand of literature suggesting that public corporations are more inclined towards embracing social responsibility than their private counterparts, due to their heightened exposure to external pressures and reliance on various external stakeholders with diverse interests Lee (2009).

Furthermore, it is observed that exporting firms have higher probabilities of exerting in all environmental dimensions. This finding is not surprising since exporting firms have to align with destination countries' environmental requirements, and hence adopt more environment-friendly operations (Brandi et al., 2020). This effect is expected to aggravate in the future since environmental regulations are becoming stricter, with the CBAM[9] as an example.

The presence of innovation also has a positive effect on different environmental performance indicators. This aligns with the underlying Schumpeterian theory, as well as recent empirical findings. It would be of interest in future research to differentiate between categories of innovation, including "Green Innovation" (Akhtar et al., 2024; Wu et al., 2024). The empirical results align with the underlying Schumpeterian theory (1934, 1939). The positive effect of financial access and innovation on environmental dimensions resonates with Schumpeter's notion of innovation as a driver of technological progress and economic development.

Institutional quality yields mostly a negative and insignificant coefficient. This can be attributed to weak enforcement which reduces the effectiveness of institutions in driving environmental performance. Finally, firms that have international quality certificates observe positive and significantly higher probabilities of exerting in the energy dimension.

Table (2) reports on the extended probit model associated with the aggregated variables as

[9] The Carbon Border Adjustment Mechanism is a policy tool designed to address carbon leakage by imposing carbon costs on imported goods based on their carbon content.

previously defined in the stylized facts section. The main variable of interest maintains both its significance and direction, implying a positive effect of financial access on the aggregated dimensions of environmental performance. Howeover, the institutional quality yields a negative and significant coefficient. This aligns with recent empirical findings such as Riti et. al (2021), implying that the presence of weak institutions hinders firms' green performance. All other results remain robust to the results concluded in Table 1.

Table 2. Extended probit model results for the effect of financial access on aggregated environmental performance

	(1) Footprint	(2) resource_management
Financial access	0.275***	0.176***
	(0.0195)	(0.0191)
Regulation	0.131***	0.0838***
	(0.0236)	(0.0228)
Private	0.265***	0.0532
	(0.0575)	(0.0548)
Export	0.197***	0.202***
	(0.0235)	(0.0226)
Innovation	0.355***	0.364***
	(0.0224)	(0.0210)
Quality	0.183***	0.209***
	(0.0249)	(0.0239)
Institutions	-0.0433+	-0.0402+
	(0.0271)	(0.0265)
Observations	24737	24736

Notes. $^{+}p < 0.15$, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Robust standard errors in parentheses. Standard errors are clustered by country. All regressions include country, sector, and year fixed effects. Constant terms are not reported. The estimates of the correlation between the errors are significantly different from 0, so the model suffers from endogeneity problem.

5.2.Model extensions

In Table 3 and Table 4, we compare the effect of financial access on environmental performance in high-income and non-high income countries (namely, middle and low income level) to study whether the effect of financial access differ by income level. In this context, the results of both tables are robust to the results of Table 1.

Our findings indicate that financial access positively influences environmental performance across various dimensions, with a stronger effect in non-high-income countries. This suggests that firms in these economies, which often face greater financial constraints, rely more

heavily on external funding. Therefore, access to finance enables them to adopt energy-efficient solutions, improve waste management, and reduce greenhouse gas emissions, making financial support a crucial driver of environmental improvements in resource-limited settings.

Regarding institutional quality, we observe mostly a negative and significant effect in high-income countries but an insignificant effect in non-high-income countries. This difference suggests that in high-income economies, strong institutions effectively enforce environmental regulations and incentivize firms to comply with sustainability standards. In contrast, weaker institutions in non-high-income countries may lack enforcement capacity, reducing their effect on firms' environmental performance. As a result, while institutional quality plays a critical role in high-income settings, it does not appear to be a decisive factor in non-high income economies. Thus, the overall results of the model in Table 1 are driven by the non-high income group.

Table 3. Extended probit model results for the effect of financial access on environmental performance for High-income countries

	(1) energy	(2) gas	(3) water	(4) waste	(5) air	(6) Footprint	(7) resource_management
Financial access	0.219***	0.216***	0.0893**	0.0560*	0.202***	0.225***	0.164***
	(0.0344)	(0.0459)	(0.0371)	(0.0330)	(0.0395)	(0.0345)	(0.0338)
Regulation	0.191***	0.194***	0.120***	-0.0371	0.124***	0.181***	0.0286
	(0.0386)	(0.0442)	(0.0385)	(0.0352)	(0.0396)	(0.0387)	(0.0370)
Private	-0.136	-0.229	-0.383**	-0.0695	-0.470**	-0.102	-0.168
	(0.218)	(0.213)	(0.194)	(0.185)	(0.188)	(0.218)	(0.202)
Export	0.269***	0.191***	0.278***	0.292***	0.246***	0.247***	0.282***
	(0.0393)	(0.0477)	(0.0400)	(0.0366)	(0.0416)	(0.0394)	(0.0380)
Innovation	0.361***	0.216***	0.304***	0.362***	0.252***	0.343***	0.327***
	(0.0372)	(0.0441)	(0.0367)	(0.0338)	(0.0385)	(0.0374)	(0.0357)
Quality	0.152***	0.245***	0.279***	0.257***	0.282***	0.166***	0.197***
	(0.0411)	(0.0478)	(0.0402)	(0.0379)	(0.0423)	(0.0413)	(0.0399)
Institutions	-0.170***	-0.0212	0.146***	-0.122***	0.0565	-0.176***	-0.0848*
	(0.0484)	(0.0593)	(0.0495)	(0.0464)	(0.0523)	(0.0484)	(0.0476)
Observations	7728	7728	7728	7728	7728	7728	7728

Notes. $^{+}\ p < 0.15$, $^{*}\ p < 0.1$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$. Robust standard errors in parentheses. Standard errors are clustered by country. All regressions include country, sector, and year fixed effects. Constant terms are not reported. The estimates of the correlation between the errors are significantly different from 0, so the model suffers from endogeneity problem.

Table 4. Extended probit model results for the effect of financial access on environmental performance for High-income countries

	(1) energy	(2) gas	(3) water	(4) waste	(5) air	(6) Footprint	(7) resource_management
Financial access	0.306***	0.247***	0.179***	0.125***	0.149***	0.300***	0.180***
	(0.0237)	(0.0340)	(0.0248)	(0.0239)	(0.0262)	(0.0237)	(0.0232)
Regulation	0.0982***	0.147***	0.137***	0.0873***	0.191***	0.0971***	0.118***
	(0.0299)	(0.0392)	(0.0304)	(0.0294)	(0.0315)	(0.0299)	(0.0290)

Private	0.269***	-0.0750	0.0412	-0.00944	-0.106*	0.284***	0.0800
	(0.0598)	(0.0755)	(0.0632)	(0.0565)	(0.0638)	(0.0599)	(0.0575)
Export	0.167***	0.232***	0.159***	0.160***	0.170***	0.169***	0.160***
	(0.0294)	(0.0380)	(0.0296)	(0.0283)	(0.0305)	(0.0295)	(0.0284)
Innovation	0.360***	0.238***	0.254***	0.430***	0.326***	0.358***	0.377***
	(0.0282)	(0.0352)	(0.0267)	(0.0257)	(0.0273)	(0.0282)	(0.0262)
Quality	0.203***	0.320***	0.228***	0.247***	0.352***	0.198***	0.232***
	(0.0314)	(0.0383)	(0.0311)	(0.0292)	(0.0315)	(0.0314)	(0.0300)
Institutions	0.0195	-0.0158	0.0135	-0.109***	0.0164	0.0140	-0.0226
	(0.0329)	(0.0450)	(0.0341)	(0.0333)	(0.0357)	(0.0330)	(0.0322)
Observations	16994	17009	17008	17006	17005	17009	17008

Notes. $^{+}p<0.15$, $^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$. Robust standard errors in parentheses. Standard errors are clustered by country. All regressions include country, sector, and year fixed effects. Constant terms are not reported. The estimates of the correlation between the errors are significantly different from 0, so the model suffers from endogeneity problem.

6. Robustness Checks

To ensure the robustness of our results, after solving for the endogeneity problem that may arise from the reverse causality problem, possible self-selection problem should be solved. Self-selection means that only firms with better environmental performance can have better financial access due to their enhanced credibility or compliance. Therefore, firms may self-select into obtaining financial access, which may bias the results.

This section tests whether the results of Table 1 and Table 2 still hold after accounting for possible self-selection, although the sample is not restricted to firms adopting environmental standards that have financial access. We follow Reddy et al. (2021) and Elshaarawy and Ezzat (2023) and we run a two-step probit selection model to correct for the self-selection issue. The paper uses firm size as an exclusion restriction to generate the inverse mills ratio and it complements this with instrumental variables approach.

Table 5. IV-Heckprobit with sample correction for the effect of financial access on environmental perfoormance

VARIABLES	(1) Energy	(2) gas	(3) water	(4) waste	(5) air	(6) Footprint	(7) resource_management
Financial access	0.278***	0.232***	0.148***	0.0985***	0.164***	0.276***	0.174***
	(0.0195)	(0.0272)	(0.0206)	(0.0193)	(0.0218)	(0.0195)	(0.0191)
invmills2	-1.174***	-1.973***	-1.397***	-1.283***	-1.636***	-1.192***	-1.435***
	(0.101)	(0.141)	(0.105)	(0.0991)	(0.112)	(0.101)	(0.0983)
Regulation	0.0694***	0.0654**	0.0585**	-0.0381	0.0808***	0.0642***	0.00178
	(0.0244)	(0.0302)	(0.0245)	(0.0234)	(0.0254)	(0.0244)	(0.0236)
Private	0.0952	-0.321***	-0.174***	-0.187***	-0.344***	0.110*	-0.131**

	(0.0583)	(0.0716)	(0.0604)	(0.0543)	(0.0610)	(0.0584)	(0.0556)
Export	0.0964***	0.0414	0.0773***	0.0805***	0.0507*	0.0892***	0.0641**
	(0.0268)	(0.0342)	(0.0272)	(0.0256)	(0.0282)	(0.0269)	(0.0259)
Innovation	0.213***	-0.0175	0.0921***	0.245***	0.0916***	0.202***	0.178***
	(0.0259)	(0.0321)	(0.0254)	(0.0241)	(0.0263)	(0.0260)	(0.0247)
Quality	0.0447	0.0614	0.0887***	0.0832***	0.138***	0.0441	0.0310
	(0.0302)	(0.0377)	(0.0301)	(0.0285)	(0.0311)	(0.0303)	(0.0292)
Institutions	-0.0187	0.0130	0.0731***	-0.0902***	0.0498*	-0.0236	-0.0156
	(0.0271)	(0.0356)	(0.0279)	(0.0269)	(0.0293)	(0.0271)	(0.0265)
Observations	24,722	24,737	24,736	24,734	24,733	24,737	24,736

Notes. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Robust standard errors in parentheses. Standard errors are clustered by country. All regressions include country, sector, and year fixed effects and account for possible endogeneity of FCs. Constant terms are not reported. The estimates of the correlation between the errors are significantly different from 0.

Table 5 presents the findings of the two-step probit selection model. The results show that the coefficient of the inverse mills ratio is always negative and significant across all the specifications, pointing to selection bias in the sample. After correcting for the self-selection bias and the endogeneity problems, the main results are still robust.

4. Policy Implications

The findings of this study highlight several key areas where policy interventions can effectively address credit constraints, enhance firm-level environmental performance and promote SDGs. Policymakers should focus on developing specialized financial products tailored to address the credit constraints faced by small and micro firms. Government-backed green loan guarantees or targeted financial assistance programs can play alleviate financial barriers, thereby facilitating investment in eco-friendly technologies and environmentally sustainable practices.

Financial institutions and regulatory authorities should promote sustainable finance by integrating Environmental, Social, and Governance (ESG) criteria into credit decision-making processes. Sustainable finance policies that incentivize green investments and environmentally friendly projects can encourage firms to prioritize environmental performance.

Encouraging the development of green financial products, such as green bonds and green loans, is essential. These dedicated funding options for environmentally sustainable initiatives can support firms in implementing eco-friendly practices and technologies, thereby driving overall environmental performance.

Strengthening institutional quality is of high importance for fostering environmental performance. Policymakers, specifically in non-high income countries, should focus on enhancing legal and regulatory frameworks to ensure better enforcement of environmental standards. By improving institutional quality, a conducive environment is created for firms to engage in sustainable practices. Strengthening institutional frameworks and improving regulatory enforcement can enhance the effectiveness of environmental policies.

Governments are recommended to enforce existing environmental regulations rigorously and consider introducing new regulations that incentivize or mandate sustainable practices. Effective regulatory enforcement can drive firms towards greater environmental compliance and encourage the adoption of eco-friendly measures.

Also, providing support for exporting firms to comply with destination countries' environmental standards can significantly enhance environmental performance. Policymakers can facilitate access to international markets, offer subsidies or tax incentives for obtaining quality and environmental certifications, and promote sustainable export practices.

Encouraging innovation in green technologies through tax credits, grants, and public-private partnerships can help firms reduce their environmental impact while maintaining competitiveness. Supporting research and development in eco-friendly technologies can drive sustainable innovation across industries.

Additionally, capacity-building programs and technical assistance can help firms overcome financial barriers to implementing environmentally sustainable practices. Training programs on green technologies, energy efficiency, and waste management can enhance firms' capabilities in adopting eco-friendly measures. Facilitating industry collaboration and knowledge-sharing platforms can foster a culture of sustainability within sectors. Encouraging firms to share best practices, innovations, and lessons learned in environmental management can drive continuous improvement in environmental performance across industries.

Furthermore, public-private partnerships (PPPs) in environmental initiatives can leverage resources and expertise from both sectors to promote sustainable practices. Collaborative efforts between government agencies, financial institutions, and businesses can drive investments in green projects and facilitate knowledge sharing on environmental best practices.

Finally, introducing incentive mechanisms, such as tax incentives or subsidies for green investments, can incentivize firms to prioritize environmental performance. Rewarding firms that demonstrate commitment to sustainability through financial incentives can stimulate greater adoption of eco-friendly strategies.

By implementing these policy recommendations, governments and regulatory bodies can create an enabling environment that not only addresses credit constraints but also promotes sustainable practices and enhances overall environmental performance at the firm level.

5. Conclusion

The objective of this paper is to study the effect of financial access on firm-level environmental performance. By using data from the Business Environment and Enterprise Performance Surveys (BEEPS), we estimate an extended probit model. This model controls for heterogeneity among firms (by country, and sector), sample selection, firms' characteristics, and reverse causality. The empirical findings show that financial access is an important driver for better environmental performance across different sustainability dimensions.

The results also suggest additional implications. These include environmental regulations showing a positive effect on the probability of firm-environmental performance due to mandatory compliance. Also, exporting firms as well as firms that have quality certificates are associated with a higher level of environmental performance, as they must align with international sustainability benchmarks. Finally, weak institutions are found to be a barrier to achieving sustainable business practices.

Finally, this research is subject to time constraints. The study covers a specific period (2018-2020), which may not capture long-term trends or changes in the relationship between financial access and environmental performance. Extending the time frame of the study could provide a more comprehensive understanding of the role of finance on environmental performance in the long run.

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Appendix

Table A1: List of Sample Countries and Years of the BEEPS (2018,2020).

Country	Years
Albania	2018, 2019
Armenia	2019, 2020
Azerbaijan	2019, 2020
Belarus	2018, 2019
Bosnia and Herzegovina	2019
Bulgaria	2019, 2020
Croatia	2018, 2019
Cyprus	2018, 2019
Czech Republic	2018, 2019, 2020
Egypt	2019, 2020
Estonia	2018, 2019
Georgia	2019, 2020
Greece	2018, 2019
Hungary	2018, 2019, 2020
Italy	2018, 2019
Jordan	2019
Kazakhstan	2019
Kosovo	2018, 2019
Kyrgyz Republic	2018, 2019
Latvia	2018, 2019
Lebanon	2019, 2020
Lithuania	2018, 2019
Malta	2019
Moldova	2019
Mongolia	2018, 2019
Montenegro	2018, 2019
Morocco	2018, 2019, 2020
North Macedonia	2018, 2019
Poland	2019
Portugal	2018, 2019, 2020
Romania	2018, 2019, 2020
Russia	2018, 2019
Serbia	2018, 2019
Slovak Republic	2019, 2020
Slovenia	2018, 2019
Tajikistan	2019
Tunisia	2019, 2020

Turkey	2018, 2019
Ukraine	2018, 2019
Uzbekistan	2019
West Bank and Gaza	2019

Table A2: Instrumental Variable (IV) Tests for Environmental Impact and Resource Management

	Underidentification test		*Sargan test*		*Endogeneity test*	
	H0: IV not correlated with Financial Access		H0: instruments are valid		H0: variables are exogenous	
	F stat	P-value	F stat	P-value	F stat	P-value
Energy	*86.469*	*0.0000*	*5.717*	*0.0168*	*99.423*	*0.0000*
Gas	*87.379*	*0.0000*	*2.282*	*0.1308*	*171.011*	*0.0000*
Water	*87.117*	*0.0000*	*4.873*	*0.027*	*181.4*	*0.0000*
Waste	*86.867*	*0.0000*	*0.678*	*0.4104*	*51.46*	*0.0000*
Air	*86.717*	*0.0000*	*2.63*	*0.1049*	*157.89*	*0.0000*
Environmental Footprint	*87.379*	*0.0000*	*5.591*	*0.0181*	*97.318*	*0.0000*
Resource Management	*87.117*	*0.0000*	*2.586*	*0.1078*	*93.012*	*0.0000*