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Green Investment by Firms: Finance or Climate Driven?

Fotios Kalantzis (EIB), Helena Schweiger (EBRD), Sofia Dominguez (UNCTAD)

There is limited research on the determinants of firms' green investment strategies in developing regions despite their importance to meet global climate change targets. Understanding how changes in firm climate investment affect environmental performance is essential for policy makers and firms alike. Based on unique data from the joint European Bank for Reconstruction and Development–European Investment Bank–World Bank Group Enterprise Surveys, this paper empirically examines the role of access to finance and green management practices in firms' green investment strategies. Based on logistic regressions, the econometric analysis finds a positive influence of green management practices on the number of mitigation measures implemented. By contrast, firms that are financially constrained are less likely to pursue many mitigation measures. Finally, the results do not show significant differences in the impact of financial constraints on the type of green investment, but indicate that better green management practices lead to a higher likelihood of investing in both capital- and non-capital-intensive green measures.

Keywords: finance constraints, green management practices, mitigation strategies

JEL Classification Numbers: D22, L23, G32, L20

Contact details: Helena Schweiger, One Exchange Square, London EC2A 2JN, UK.

Phone: +44 20 7338 7991; email: schweigh@ebrd.com.

Fotios Kalantzis is Senior Economist, European Investment Bank. Sofia Dominguez is an Associate Economic Affairs Officer, United Nations Conference on Trade and Development (she was a trainee at the European Investment Bank while working on this paper). Helena Schweiger is an Associate Director, Lead Research Economist at the EBRD.

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1. Introduction

Climate change is one of today's most pressing global challenges. Despite ongoing activities to mitigate its worst effects, a further increase in the Earth's surface temperature is inevitable. This will lead to adverse economic impacts due to changes in frequencies of extreme weather events and long-term shifts in weather patterns (IPCC, 2021). While many developed countries have already started with their decarbonization efforts and are working out the best mitigation strategies for reducing GHG emissions, most developing countries are lagging and their economic growth is still reliant on GHG emissions.

Recent trends in clean energy spending point to a widening gap between advanced economies and the developing world even though emissions reductions are far more cost-effective in the latter (IEA, 2021). Emerging markets and developing economies account for over two-thirds of the global population and approximately 70% of the global energy demand, but only one-fifth of global clean energy investment. By contrast, emissions in advanced economies are declining, despite an anticipated 4% rebound in 2021 owing to massive investment in clean technologies and the energy transformation of all economic sectors. This turns the attention to current measures taken in developing countries to decarbonize their activities, highlighting the need for these economies to step up their climate action.

Collective efforts across countries and actors of the economy are deemed necessary to tackle the worst effects of climate change. These direct climate change effects are expected to significantly impact the natural environment and society at different spatial and time levels. Within society, firms are important entities by which adaptation to climate change effects occur. How affected firms play their part in this climate transition, to a large extent, determines the nature and scale of impacts and possibly firms' survival in the long run.

Existing research provides insight into firms' mitigation efforts to respond to climate change, primarily in developed economies (see, for example, Kalantzis and Revoltella, 2019; Fleitera et al, 2012, Thollander et al, 2007). However, there is limited research in the developing countries' context. Hence, while the existing literature investigates the determinants of climate-related investments in advanced economies located in the European Union and the United States, little is known about the factors influencing firms' behavior in emerging economies, which adopt comparatively less green profiles. In addition, while some determinants of firms' strategies of adapting to climate change and its policy-related impacts, such as their characteristics or green management practices, have been proposed (Fankhauser et al, 1999; Bleda and Shackley, 2008), they have not been investigated comprehensively. Yet, knowledge about these determinants is particularly important for policy makers to support favorable conditions for firms' green investment strategies. Our work is closest to that by De Haas et al (2022), who show that both financial frictions and managerial constraints slow down firm investment in more energy efficient and less polluting technologies.

Based on the unique data from the joint European Bank for Reconstruction and Development (EBRD)-European Investment Bank (EIB)-World Bank Group (WBG) Enterprise Surveys (ES), this paper empirically examines such determinants in a sample of almost 18,000 firms in 30 countries in Europe and Central Asia (ECA) and the Middle East and North Africa (MENA) regions. In this respect, the scope of firms' green investment strategies (measured by the total number of mitigation measures) and measures that firms take to follow specific strategic directions of their business model (such as to protect the affected business) are analyzed. We consider the case of 10 climate-related measures, namely: heating and cooling improvements, type of on-site energy generation, machinery and equipment upgrades, energy management, waste management, water management, air pollution control measures, upgrades of vehicles, improvements to lighting systems and other pollution control measures to investigate our testing hypotheses.

The surveys also give us access to information on firms' credit constraints and green management practices as a proxy for awareness of possible climate change effects. In terms of the latter, we collect data on firms' strategic objectives concerning the environment and climate change; whether there is a manager with an explicit mandate to deal with environmental issues; and how the firm sets and monitors targets (if any) related to energy and water usage, CO_2 emissions, and other pollutants.

We include covariates that might affect the relationship between organizational constraints and firms' green investment strategies. We follow an instrumentation strategy to isolate plausibly exogenous components of firm-level constraints, introduced by De Haas et al (2022). We first construct jack-knife instruments that reflect the financial constraints experienced by other firms in the vicinity, except those in the same 2-digit industry, and green managerial practices experienced by neighboring firms in higher size deciles. Then, we combine our firm-level data with geo-coded information on bank branches that surround each individual firm. This allows us to create proxies for exogenous differences in local credit conditions in the aftermath of the global financial crisis. We then use these instruments to allow for a causal interpretation of the observed relationship between firms' financial and managerial constraints and their green investment strategies. Our logistic IV regression results suggest that financially constrained firms pursue fewer mitigation measures (particularly in ECA), while more climate-aware firms (those with better green management practices) pursue more mitigation measures. We do not, however, find much evidence of differential impact on types of green investment, with the exception of credit constrained firms being less likely to invest in both capital- and non-capital intensive measures, while firms with better green management practices are more likely to do so.

The structure of the paper is as follows: section II provides context and presents an analysis of the efforts to reduce emissions in our sample regions, namely ECA and MENA. Section III describes our data set and the variables in our econometric analysis, while section IV develops a general framework of firms' climate-related investment strategies and derives hypotheses for econometric analysis. In section V, we describe the methodology, while empirical results are presented in section VI. The final section discusses these results and concludes by developing recommendations for policy makers.

2. Progress in reducing emissions

The adoption of the Paris Agreement at the United Nations Climate Change Conference of the Parties in 2015 (COP 21) was one of the biggest climate change milestones in history. The overarching aim of the Paris Agreement is to reduce greenhouse gas emissions and ensure that global temperature increases this century remain well below 2°C relative to pre-industrial levels, while ideally pursuing a scenario where the temperature increase remains below 1.5°C. As such, the Paris Agreement calls for very aggressive reductions in emissions – particularly carbon emissions, which account for more than three-quarters of all greenhouse gas emissions worldwide.

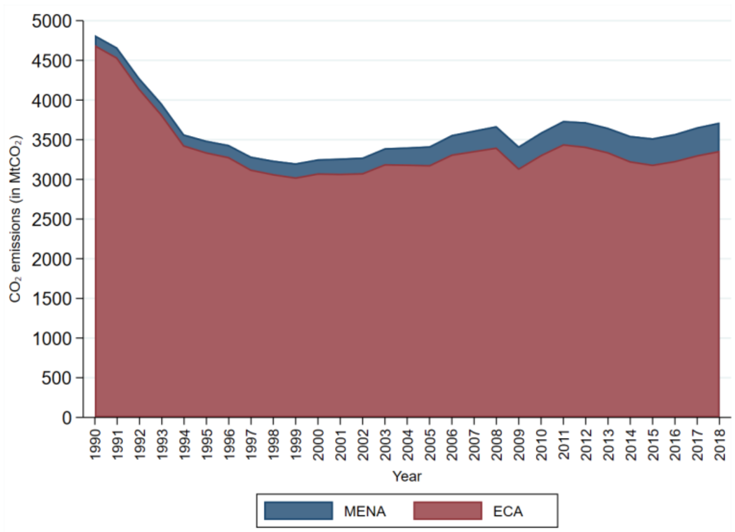
Recent negotiations at COP26 suggest that current efforts are insufficient to meet the Paris agreement goals, which means that pressure remains. If global warming is to be limited to 1.5 degrees, the CO2 emissions should be reduced by 45% by 2030 compared with 2010, and to net zero by mid-century. However, the current Nationally Determined Contribution plans (NDCs) suggest an increase in emissions by 2030 of 13.7% vs 2010 levels, which means that countries need to revisit and strengthen their 2030 targets rendering the current decade critical for the planet's future. Developing countries are expected to do their part in the climate transition, but the 2020 target of developed countries to mobilize jointly USD 100 billion to finance climate action in developing countries was not reached. The OECD[1] had shown that only USD 80 billion was provided in 2019, of which 20 billion was for adaptation.

Further support is needed to reach climate goals, which are on different paths depending on the region examined. Figure 1 presents the carbon emissions of ECA and MENA regions between 1990 and 2018, showing significant differences between the two regions. Though total CO_2 emissions are substantially higher in ECA than in the MENA region, CO_2 emissions in the former have decreased considerably since 1990. By contrast, the MENA region has been experiencing a constant rise in carbon emissions since 1990, driven by the Arab Republic of Egypt, its largest emitter (Panel A). A similar trajectory is observed when considering CO_2 emissions on a per capita or per US dollar of GDP basis (Panels B and C). At the same time, MENA carbon figures remained relatively stable between 1990 and 2018. This indicates that in the case of MENA, most of the country's growth and improvement of living standards were coupled with emissions, which underlines the need for policy makers and other key stakeholders to ensure feasible avenues for growth without compromising the environmental or climate objectives.

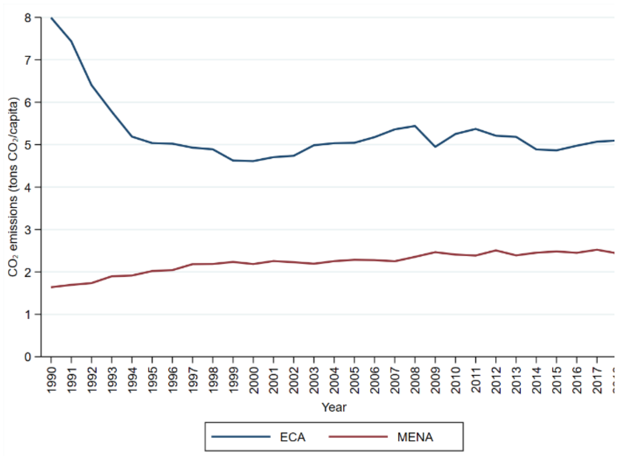
[1] https://www.oecd.org/newsroom/statement-from-oecd-secretary-general-mathias-cormann-on-climate-finance-in-2019.htm.

Figure 1. CO_2 emissions - absolute, per capita and per USD

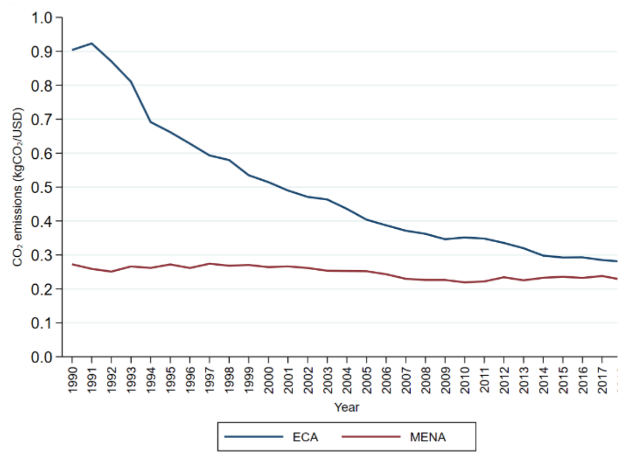
Panel A: Absolute CO_2 emissions



Panel B: CO_2 emissions per capita



Panel C: CO_2 emissions per unit of GDP

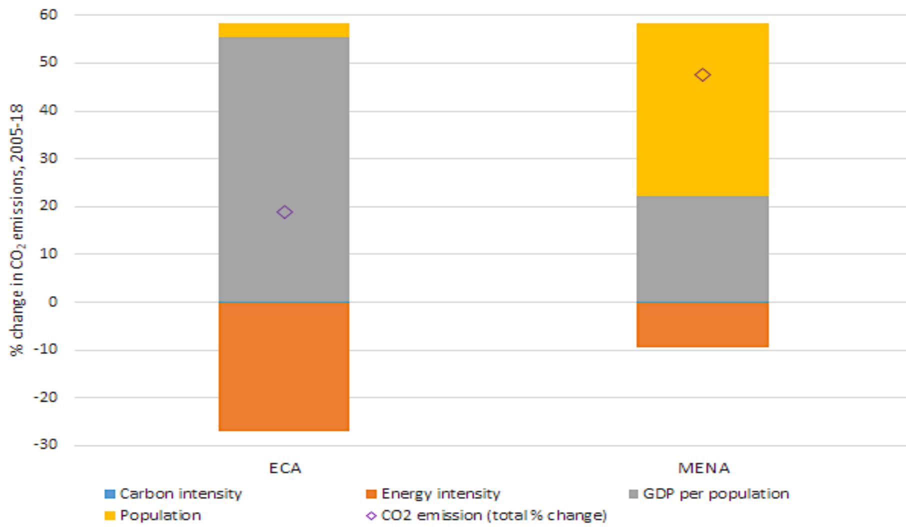


Note: Data represent unweighted averages across countries covered in Enterprise Surveys. ECA – Europe and Central Asia; MENA – Middle East and North Africa.

Source: IEA and authors' calculations.

In the more recent period between 2005 and 2018, CO_2 emissions in the MENA region increased by 47.6%, driven by population and GDP per capita growth (Figure 2). This compares to an 18.8% increase in emissions in the ECA region. Both ECA and MENA reduced their energy intensity in the same period, though the decrease was more prominent in ECA. This decrease in energy intensity in ECA was in part motivated by the European Union (EU) policies and regulations as both Central Eastern (CEE) and South-Eastern (SE) countries are EU members.

Figure 2. Drivers of changes in CO2 emissions between 2005 and 2018



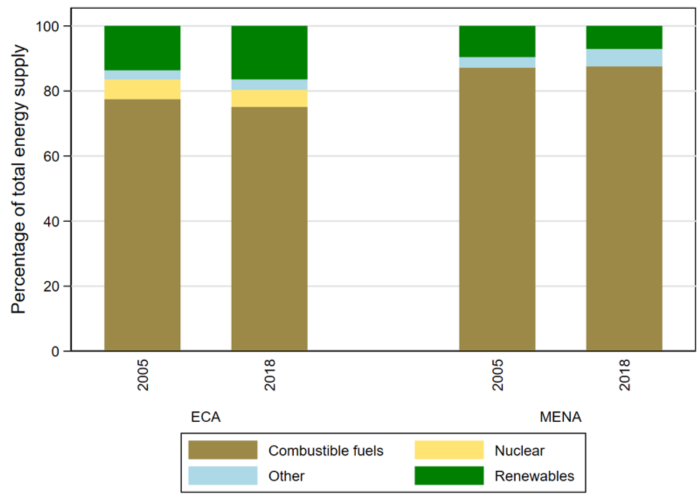
Note: Data represent unweighted averages across countries covered in Enterprise Surveys. Carbon intensity refers to carbon emissions per unit of energy. Energy intensity refers to energy use per unit of GDP. ECA – Europe and Central Asia; MENA – Middle East and North Africa.

Source: IEA and authors' calculations.

Looking at primary energy supply, combustible fuels (including coal, oil and gas) remain the most predominant energy source for MENA, accounting for over 87% of the region's electricity in 2018. Meanwhile, the share of renewable energy remains relatively small and fell by 2.5 percentage points over the observed timeframe, owing to a marginal rise in the use of other energy sources. On the other hand, ECA presents a different profile. While combustible fuels are widespread in the region, they also utilize nuclear and other renewable energy sources for their supply. In 2018, the share of renewable energy increased to 16.4% due to a decline in nuclear energy and combustible fuels. While this is positive, further efforts are required to transform the energy supply and cut emissions significantly. Given that renewables represent only a small portion of the total energy supply in both ECA and MENA, there is a large scope for intervention to switch to cleaner energy sources, especially in MENA. This will become increasingly important as there is growing pressure from governments and their citizens to respond to the climate crisis.

The ECA region has experienced a steep and steady decline in energy intensity since 1990, having decreased by almost 27% and narrowing the gap between energy intensity values compared to MENA. Meanwhile, similar to the trajectory of carbon emissions in absolute, per capita, and per US dollar of GDP terms, energy intensity in MENA has remained stable oscillating at around 100 and experiencing a 9.4% decrease between 2005 and 2018. The discrepancy in the magnitude of the change between the two regions indicates that there is still much room for improvement for the MENA region, which could benefit significantly from further investments in energy efficiency.

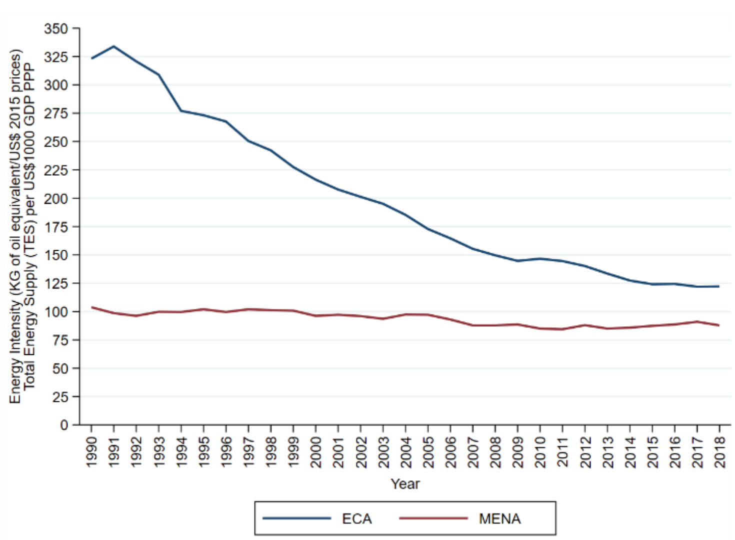
Figure 3. Breakdown of primary energy supply by fuel type (%)



Note: Data represent unweighted averages across countries covered in Enterprise Surveys. Combustible fuels include coal and peat, crude, natural gas liquids (NGL) and feedstocks, oil and natural gas. Renewables include hydro, geothermal, solar, tide, wind, biofuels and waste. Other includes heat and electricity. ECA – Europe and Central Asia; MENA – Middle East and North Africa.

Source: IEA and authors' calculations.

Figure 4. Energy intensity of GDP



Note: Data represent unweighted averages across countries covered in Enterprise Surveys. ECA – Europe and Central Asia; MENA – Middle East and North Africa.

Source: IEA and authors' calculations.

When it comes to energy-efficient production structures, firms' choices are influenced by their countries' energy policies. Several countries in the MENA region that are heavily reliant on fossil fuels for their energy supply subsidize fossil fuels and electricity generated from fossil fuels. None of them accounts for costs associated with global warming, local externalities or forgone consumption tax revenues when setting energy prices. This policy distortion makes fossil fuels (and electricity generated from them) cheaper for both households and firms, affecting behavior in terms of energy usage.

While the pre-tax fossil fuel subsidies as a percentage of GDP decreased in both the ECA and MENA regions between 2010 and 2017 (see Figure 5), they still amounted to 3.4% of GDP in MENA and 1.1% of GDP in ECA. Once tax treatment is included, both regions had large fossil fuel subsidies. This, in turn, affects firm behavior, where better-managed firms respond to incentives and increase their energy intensity if fossil fuel subsidy is relatively large (Schweiger and Stepanov, 2022). This exacerbates the issue and suggests that inadequate price signals associated with large environmentally harmful subsidies drive the energy consumption in the region.

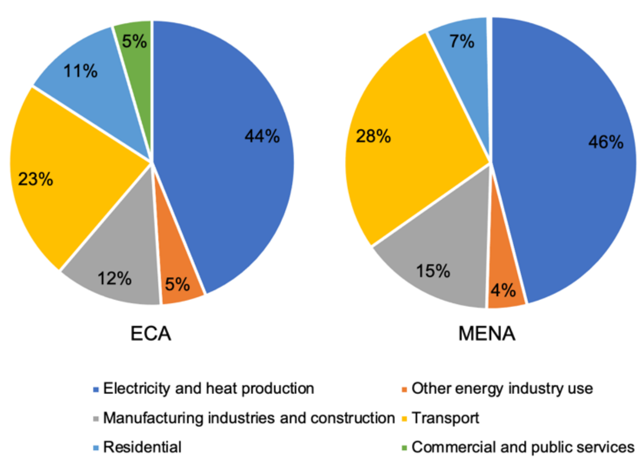
Figure 5. Fossil fuel subsidies as a percentage of GDP

Note: Data represent unweighted averages across countries covered in Enterprise Surveys and include both consumption and production-related subsidies. Post-tax subsidies include the costs associated with global warming, local externalities or foregone consumption tax revenues when setting energy prices. ECA – Europe and Central Asia; MENA – Middle East and North Africa.

Source: Coady et al (2019) and authors' calculations.

It is evident throughout that there is a need to scale up climate efforts, particularly in the MENA region. When examining the breakdown of carbon emissions by sector, it is observed that the overwhelming majority of CO_2 in ECA and MENA arises from non-residential actors, which underlines their importance in the transition to a net-zero carbon future (Figure 6). Energy-intensive industries, together with transport, dominate and account for more than half (67% and 74%) of emissions in the ECA and MENA regions. This share rises to 79% and 89%, respectively after including the manufacturing and construction sectors. By contrast, households represent 11% and 7% of emissions. Firms play an important role in the transition and it is therefore important to examine how they can become greener.

Figure 6. CO2 emissions by sector



Source: IEA.

3. Data sources

3.1. Data

Our empirical analysis is based on matching three pieces of information: (i) data from the joint EBRD-EIB-WBG Enterprise Surveys about firms' credit constraints, green management and green investments; (ii) information on the exact location of bank branches from the EBRD Banking Environment and Performance Survey (BEPS) II, and (iii) data on banks' funding structure from Bureau van Dijk's ORBIS database.

3.1.1. *Firm-level data: Enterprise Surveys*

We use the Enterprise Surveys to measure the incidence of credit constraints as well as firms' green management practices and green investments. This paper focuses on the sample of surveys taken between October 2018 and August 2020 and covered almost 28,000 enterprises in 41 economies. We focus on a sample of 30 countries in Europe and Central Asia (ECA) and Middle ECA and North Africa (MENA), where more than 20,250 enterprises were interviewed.[2] They involved face-to-face interviews with the owner or main manager of registered firms with at least five employees. Eligible firms were selected using stratified random sampling. The strata were sector (manufacturing, retail and other services), size (5-19, 20-99 and 100+ employees) and regions within a country. The main purpose of the survey is to examine the quality of the local business environment in terms of, for example, infrastructure, labor, and business-government relations. It also collects basic information on the firm, including age, size, and geographic coordinates.

Notably, the most recent Enterprise Surveys included a new Green Economy module. This unique module gathered information on key aspects of firm behavior related to the environment and climate change, including green management practices and green investments. In most economies, the response rate for the Green Economy module was over 95%. We thus have a representative snapshot—stratified by sector, firm size, and region—of firms' green credentials in each of these countries.

We obtain data on our dependent variables, number and type of climate mitigation measures, as well as green management practices, credit constraints and firm-level controls from the Enterprise Surveys. We discuss these in more detail in the next subsection.

3.1.2. *Bank-level data: Banking Environment and Performance Survey and Bureau van Dijk's ORBIS database*

The geographical coordinates of 137,407 branches, operated by 1,788 banks across the countries in our sample, were collected by specialized consultants as part of the second round of the EBRD Banking Environment and Performance Survey (BEPS II). Data collection took place by contacting banks or by downloading data from bank websites. All information was double-checked with the banks as well as with the SNL Financial database. The 1,788 banks represented more than 95% of all bank assets in these 30 countries in 2013, so we have a near complete bank branch footprint. For each branch, we know the bank it belongs to. We merge this information

[2] Selection of countries in our sample is driven by the availability of bank branch data and data on banks' funding structure. Bank branch data are not available for Cyprus, Greece, Italy, Kosovo, Lebanon, Malta, Portugal, Uzbekistan, and West Bank and Gaza. Data on banks' funding are not available for Montenegro and Tunisia. The sample in our analysis comprises of 17,902 firms with data on all the required variables used in the analysis. Table A.4 presents its breakdown by country.

with bank balance sheet information from Bureau van Dijk's (BvD) ORBIS database. We download information about each bank's pre-financial crisis assets in 2007.

3.2. Variables

3.2.1. Dependent variable: Climate mitigation measures

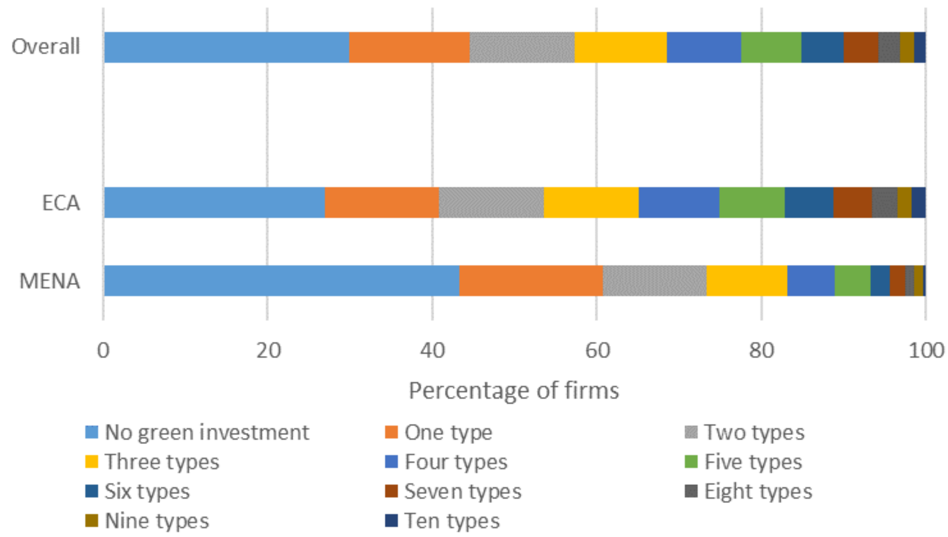
The Enterprise Surveys asked firms whether they adopted any of the ten different, potentially green, measures over the three years prior to the survey. The list included: machinery and equipment upgrades; vehicle upgrades; more climate-friendly energy generation on-site; heating and cooling improvements; waste minimization, recycling and waste management; energy management; water management; air pollution control measures; improvements to lighting systems; and other pollution control measures.

Some of these measures, such as machinery and equipment upgrades, vehicle upgrades, on-site generation of green energy and waste minimization, recycling and waste management, are capital-intensive and relate to production processes. In other words, they require large amounts of investment. Others, such as heating and cooling improvements, energy management, measures controlling air pollution, water management, lighting improvements and measures controlling other pollution, are – in comparison – less capital-intensive.

In our sample, 70% of firms have adopted at least one such measure. At the same time, 30% of respondent firms have not adopted any of them, whether capital-intensive or not, over the three years prior to the survey, while 46.1% of firms adopted both capital- and non-capital-intensive measures. These patterns vary across regions and economies within regions. In ECA, 26.9% of firms made no green investments, compared with 43.3% of firms in MENA (see Figure 7). Five or more green investments were undertaken by a quarter of ECA firms (25.1%), but only 11.1% of MENA firms. Half of ECA firms made both capital- and non-capital-intensive investments, compared with 29.5% of MENA firms (Figure 8). In MENA, firms were more likely to make non-capital- or capital-intensive investments only than ECA firms.

Based on the percentage of firms making a certain number of different green investments in Figure 7, we consider two categorical groupings: one with four categories and one with six categories. Four category version of the number of different green investments variable has the following categories: no green investments; one green investment; two to four different green investments; and five or more different green investments. Six-category version of the same variable has the following categories: no green investment; one green investment; two different green investments; three different green investments; four different green investments; and five or more different green investments.

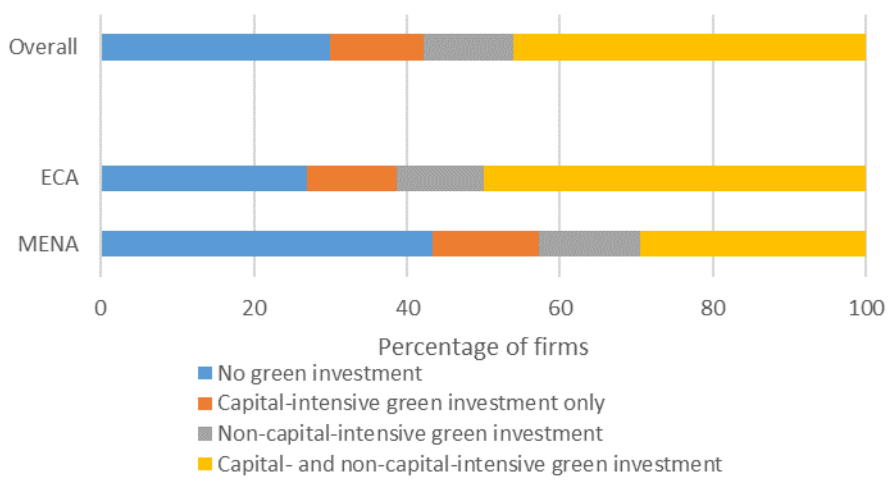
Figure 7: Breakdown of the number of different green investments by firms



Note: Data represent unweighted averages across countries in our sample. ECA – Europe and Central Asia; MENA – Middle East and North Africa.

Source: Enterprise Surveys and authors' calculations.

Figure 8: Breakdown of firms' green investment by capital intensity



Note: Data represent unweighted averages across countries in our sample. Capital-intensive green investments are investment in more climate-friendly energy generation on site, machinery and equipment upgrades, vehicle upgrades and investment in waste minimization, recycling and waste management. ECA – Europe and Central Asia; MENA – Middle East and North Africa.

Source: Enterprise Surveys and authors' calculations.

3.2.2. *Independent variable: Green management practices*

The Green Economy Module asked firms about their green management practices in four areas. The first area concerns whether firms have strategic objectives related to the environment and climate change. The second area looks at whether firms employ a manager with an explicit mandate to deal with green issues. Conditional on the existence of such an environmental manager, additional information was collected on whom they report to, and whether their performance is evaluated against how well the establishment performs on energy consumption, CO_2 emissions or other pollution or environmental targets. The third area covered by the Green Economy Module asks whether firms have clear and attainable environmental targets. Lastly, the fourth area looks at whether firms actively and frequently monitor their energy and water usage, CO_2 emissions and other pollutants in order to reduce their environmental footprint.

We normalize the scores for each question such that they have a mean of 0 and a standard deviation of 1 in the sample. We then aggregate them to average z-scores for each of the four areas of green management. Lastly, we create an overall green management z-score as a normalized unweighted average of the four categories. A z-score above zero indicates that a firm's green management practices are better than the sample average.

3.2.3. *Independent variable: Credit constraints*

To identify credit-constrained enterprises, we combine answers to various survey questions and first distinguish between firms with and without a demand for credit. Among the former, we then identify those that were credit constrained as those that were either discouraged from applying for a loan or were rejected when they applied. Non-credit constrained firms are those that either had no need for credit or whose demand for credit was satisfied.[3]

3.2.4. *Firm covariates*

Firm-level control variables include the log of firm age (and its square), percentage of employees with a university degree, and dummy variables for whether the firm is publicly listed, a sole proprietorship, an exporter, and whether an external auditor reviews its financial statements. In the main paper, we present estimates without firm covariates; estimates with firm covariates included can be found in the Appendix.

[3] We start by using the question: "Did the establishment apply for any loans or lines of credit in the last fiscal year?" For firms that answered "No", we move to the question: "What was the main reason the establishment did not apply for any line of credit or loan in the last fiscal year?" Firms that answered "Yes", were asked: "In the last fiscal year, did this establishment apply for any new loans or new credit lines that were rejected?" We classify firms that applied for credit and received a loan as unconstrained while we classify firms as credit constrained if they were either rejected or discouraged from applying due to "Interest rates are not favorable"; "Collateral requirements are too high"; "Size of loan and maturity are insufficient"; or "Did not think it would be approved".

3.2.5. Local credit market conditions controls

To control for local credit market conditions, we use detailed data about the banking sectors in our sample countries. We connect the firm and branch data by drawing circles with a radius of 15km around the coordinates of each firm and then linking the firm to all branches inside that circle. For each firm, we first measure the number of bank branches within a 15km radius. Next, we calculate the branch-weighted average asset size of banks with branches within this radius. This allows us to control for the number and the size of banks that make up the local credit market around each firm.

3.3. Descriptive statistics

Table 1 presents summary statistics (mean, median, standard deviation, minimum, maximum) for the explanatory variables (Figures 7 and 8 show the relative frequencies for the outcome variables). It shows that almost a quarter of firms are credit constrained (24.6%). The standardized green management variable is by construction close to zero on average, but varies between -1.91 and 6.98. Close to a fifth of the firms in our sample are exporters, and 6% of them are publicly listed. Among the firms, 19.7% are sole proprietorships and 39.4% had their annual financial statements checked and certified by an external auditor. On average, 30.9% of the firms' employees had a university degree. The table also shows that all firms in our sample have at least one bank branch within a 15km radius. The change in local branch-weighted average Tier 1 ratio between 2007 and 2014, one of our instrumental variables, was on average 1.7 percentage points.

Table 1: Summary statistics

	N	Mean	Median	Std. Dev.	Min	Max
	(1)	(2)	(3)	(4)	(5)	(6)
Credit constrained	17,902	0.246	0.000	0.431	0.000	1.000
Green management	17,902	-0.019	-0.394	0.973	-1.908	6.980
Firm age (log)	17,902	2.719	2.833	0.727	0.000	5.263
Firm age (log squared)	17,902	7.920	8.027	3.722	0.000	27.700
Exporter	17,902	0.193	0.000	0.394	0.000	1.000
Percentage of employees with a university degree	17,902	30.850	22.220	27.310	0.000	100.000
Publicly listed	17,902	0.060	0.000	0.238	0.000	1.000
Sole proprietorship	17,902	0.197	0.000	0.398	0.000	1.000
Audited	17,902	0.394	0.000	0.489	0.000	1.000
No. bank branches	17,902	247.600	87.000	417.100	1.000	3649.000
Local banks' average asset size in 2007 (log)	17,902	15.220	15.670	1.614	10.250	18.450
Leave-one-out mean credit constraints	17,902	0.238	0.182	0.203	0.000	1.000

Change in local average Tier 1 ratio (\% points)	17,902	1.702	1.529	7.684	-35.880	44.600
Leave-one-out mean green management practices	17,902	0.193	0.000	0.697	-1.317	6.980
No data on leave-one-out mean credit constraints	17,902	0.007	0.000	0.081	0.000	1.000
No data on leave-one-out mean green management	17,902	0.118	0.000	0.323	0.000	1.000

Source: Authors' calculations based on Enterprise Surveys and BEPS II.

4. Firms' mitigation strategies

4.1. Scope and strategic preferences of mitigation

The number and quality of green measures that a firm adopts communicates its green investment strategy. The scope of firms' transition to a low-carbon future describes the degree of adjustment required (Smit and Wandel, 2006) or the extent to which the firm reduces its environmental impact by, for example, pursuing several climate mitigation measures simultaneously. However, the mitigation measures pursued show different strategic preferences that reflect climate objectives and the level of ambition. A firm has a choice to implement multiple of these strategic measures at the same time, possibly with different intensities. Therefore, a mitigation strategy can be conceptualized as the combination of mitigation measures with possibly distinct strategic preferences that a company has. A first fundamental distinction between mitigation measures that a firm seeks to implement to reduce its energy cost and, in parallel, its carbon footprint was made by Thollander et al (2007).

Based on the work of Thollander et al (2007), we develop a framework by which all mitigation measures can be assigned to one strategic preference. For such a framework, two different aspects are considered in terms of how the mitigation measures can affect firms' carbon performance in line with Kalantzis and Revoltella (2019). Mitigation measures that help firms reduce their carbon footprint relate directly or indirectly to the company's production model. Measures that are considered supportive, including energy management systems, improvement to lighting and air control measures, are less capital intensive and part of the "low-hanging fruit" strategies. By contrast, mitigation measures linked to the production line, such as more climate-friendly energy generation, machinery and equipment, and vehicle upgrades, are more capital intensive and usually are pursued by firms where the energy cost is an important input in their production processes. We express the measures along these two strategic preferences as measures to improve support processes and measures to improve production processes.

4.2. Hypotheses on determinants of firms' mitigation measures

In theory, measures targeted at production processes have high scope for emissions reductions, as they are related to producing their products or services. In energy-intensive firms, energy efficiency and mitigation measures are given higher priority in the investment budget because of the potential returns and cost savings that these measures entail. As a strategic investment, they are expected to be more prevalent in energy-intensive industries compared to non-energy intensive sectors. Nevertheless, empirical studies find that mitigation strategies concerning support processes have higher returns than those in production processes. Energy efficiency potentials are higher for production processes if suitable management practices relating to support processes are adopted by the firm (Backlund et al, 2012; Waide and Brunner, 2011; EC, 2006). As an example, Waide and Brunner (2011) illustrate that supporting management practices are vital in disseminating energy efficiency measures that would otherwise be concentrated on one piece of machinery and yield limited returns in the automotive industry. According to Backlund et al (2012) and Waide and Brunner (2011), while improvements in the technical potential of production processes are important to decarbonize activities, the returns of supporting processes that apply such technologies to their context and systems have greater potential.

In addition, capital spending for production processes is higher than investments in support processes. In their study, Kalantzis and Revoltella (2019) examine the impact of energy audits, a green management practice, on production versus support processes, measured by machinery equipment and the quality of buildings, respectively. They find that not only are energy efficiency measures easier to implement for support processes, but they also stand at a lower price point compared to production processes. Investments in support processes can also be less disruptive to a firms' operation than those that focus on machinery and equipment and that may involve obtaining further certifications and licenses for quality control purposes. Overall, there are push factors for firms to incline their efforts towards energy savings on support processes rather than production due to associated costs, lead times, and potential returns. We stipulate two key hypotheses:

Hypothesis 1. Better green management practices overcome the information barriers to mitigation measures and induce firms to pursue, at least, "low-hanging fruit" (that is, non-capital-intensive) measures.

Hypothesis 2. The higher a firm's awareness of possible climate change effects, as reflected by better green management practices, the more mitigation measures it will pursue.

Asymmetric information poses a challenge to mitigation strategies, as information constraints hinder a firm's awareness and willingness to implement measures to address climate-related concerns. EIB (2020) finds a positive correlation between access to information about climate needs and investment in climate-related measures. Indeed, firms that make efforts to improve information through green management practices, such as the employment of dedicated climate staff members, energy audits and climate targets, are more likely to invest in climate. All these practices can help alleviate information asymmetries by disseminating knowledge on the impact of climate-related risks and potential solutions to mitigate such. As outlined by Kalantzis and Revoltella (2019), this knowledge exchange can also support energy planning and the design of energy-saving strategies and associated measures. While there is a consensus that access to information is important for mitigation strategies, there are differences in the magnitude of effect reported by different studies. Kalantzis and Revoltella (2019) examine the effect of energy audits on firms' energy efficiency investments and report that firms that conduct energy audits are more likely to invest in energy efficiency measures than those who do not. Meanwhile, Thollander et al (2007) find that while information campaigns lead to increased awareness regarding the importance of energy efficiency, they translate to a marginally small rise in the implementation of energy efficiency measures. In light of the above, we expect awareness of climate change, as reflected by better green management, to be positively correlated with the number of mitigation measures. We also expect that better green management practices overcome the information barriers to mitigation and induce firms to pursue, at least, "low-hanging fruit" measures. As such, we investigate two additional hypotheses:

Hypothesis 3. Credit constraints matter more for capital-intensive mitigation measures - in other words, climate measures in production processes.

Hypothesis 4. The more finance constrained a firm is, the fewer the mitigation measures it will pursue.

An additional barrier to mitigation strategies are financial constraints. Mitigation and energy efficiency investments can be costly and require sufficient financial capital for firms to undertake, especially if they are capital-intensive. This is in line with existing literature, which asserts that financial constraints are negatively correlated with climate-related mitigation measures (e.g. Götz, 2018, Fleitera et al, 2012). Fleitera et al (2012) find that the adoption of energy efficiency measures is mainly driven by profitability and that a significant limiting constraint is a firm´s financial resources. Götz (2018) and Xu and Kim (2021) also find that financial constraints are negatively correlated with firms' pollution abatement measures. Instead, financially constrained firms increase the likelihood of a firm polluting by 3% – 3.5% (Xu and Kim, 2021). Based on the discussion, we expect that the more finance constrained a firm is, the fewer the mitigation measures it will pursue.

5. Methodology

5.1. Logistic regression estimation

To capture corporate strategies to tackle climate change and policy-related impacts, we have taken into account the characterization framework of energy-efficiency investments with selected attributes based on Trianni et al (2014). As firms' business decisions are influenced by a wide range of factors, including market demand, competition and environmental regulations, it is difficult to distinguish between mitigation measures that are only driven by climate change impacts and those that are the results of other factors. In order to distinguish between the mitigation measures chosen we split them into capital intensive and non-capital intensive. For example, investments related to support processes, e.g., ventilation or lighting, have lower initial costs and may be adopted on an operational level, whereas investments related to production processes are capital-intensive and therefore more often subject to strategic decision making (Thollander and Ottosson, 2010).

We start our analysis of the link between credit constraints, green management practices and the type of green investment by using a multinomial logistic regression model. The probability, $Pr_{j,i}$, of firm *i* choosing a type of green investment *j* among J types of green investment is:

$$Pr(Y_i = j) = \frac{e^{\left(\beta_0+\beta_{1,j}CreditConstrained_i+\beta_{2,j}GreenMgmt_i+\gamma_j' X_i+\mu_r+\vartheta_s+\varepsilon_i\right)}}{\sum_{k=1}^{J} e^{\left(\beta_0+\beta_{1,k}CreditConstrained_i+\beta_{2,k}GreenMgmt_i+\gamma_k' X_i+\mu_r+\vartheta_s+\varepsilon_i\right)}}, \qquad (1)$$

where Y_i is firm *i*'s choice of the type of green investment *j*: no green investment; capital-intensive green investment only; non-capital-intensive green investment only; and both capital- and non-capital-intensive green investment. Our main explanatory variables of interest are $CreditConstrained$, an indicator for whether the firm is credit constrained or not, and $GreenMgmt$, a z-score measuring the quality of green management practices. The vector $\boldsymbol{X_i}$ comprises three types of control variables. First, we use variables on the credit market conditions in the vicinity of each firm. This is measured using characteristics of the bank branches that fall within a 15km radius of a firm, in particular, the number of branches and the average amount of 2007 assets held by banks owning those branches. Second, we include other locality characteristics, such as the population size class. We take the city or town where a firm is located as the relevant unit. μ_r and ϑ_s are region and sector fixed effects, where regions correspond to NUTS 1 regions or equivalent. Third, we include include firm characteristics, such as the log of firm age and the log of firm age squared (as proxies for the vintage of machinery and equipment), exporter status, percentage of employees with a university degree, stock exchange listing, sole proprietorship, and whether the firm has audited financial accounts. Further information on regions and sectors used in the analysis can be found in the Appendix, Tables A.2 and A.3 respectively.

The scope of corporate strategy is measured by the total number of mitigation measures. Hence, this first dependent variable can take integers between zero and ten (see Figure 7). Here, we combine two to four different investments and five or more different green investments into one category each because the percentage of firms that engage in five, six, seven, and so on, investments is relatively low (even more so in MENA, see Figure 7), making the model harder to estimate. To analyze the link between credit constraints, green management practices and the number of different green investments, we use ordered logistic regression, where Y_i is firm *i*'s choice of the number of different green investments *m*: none; one; two to four; five or more different green investments. We also look at none; one; two; three; four; five or more different green investments. While it could be argued that we are dealing with a continuous outcome variable in this case – that is, that the difference between one or two green investments is the same as the difference between four or five green investments – there are numerous combinations of the ten different types of green investments the firms were asked about in the survey which would likely violate this assumption. Moreover, we group cases with over five different green investments into one category because the percentage of firms that undertake more than five green investments is relatively low (see Figure 7). In ordered logistical regression, an underlying score is estimated as a linear function of the independent variables and a set of cut-points. The probability of firm *i* choosing a particular category of different green investments among M categories of green investment is within the range of the cut-points estimated for the outcome:

$$Pr(Y_i = m) = Pr\begin{pmatrix}\kappa_{m-1} < \beta_0 + \beta_1 CreditConstrained_i + \beta_2 GreenMgmt_i \\ +\boldsymbol{\gamma}'\boldsymbol{X_i} + \mu_r + \vartheta_s + \varepsilon_i \leq \kappa_m\end{pmatrix}, \quad (2)$$

where Y_i is firm *i*'s choice of the number of green investments *m*, and $\kappa_1, \kappa_2, \ldots, \kappa_{M-1}$ are the cut-points ($m = 1,2, \ldots, M$).

We are interested not only in the link between credit constraints, green management practices and the type of green investment in our sample of (mostly) developing countries in Europe and Central Asia as well as MENA, but also in whether – and how – this link might differ depending on the region, given the differences in their progress in reducing emissions as well as policy choices regarding primary energy supply and fossil fuel subsidies, among other things. We thus estimate versions of equations (1) and (2), where we allow the estimated coefficients on our main explanatory variables of interest as well as all firm-level covariates, the number of branches, and the average amount of 2007 assets held by banks owning those branches to vary by region. The parameters in all models are estimated by using maximum likelihood, and standard errors are clustered on locality.

5.2. Logistic regression instrumental variables estimation

Past (green) investments could influence credit constraints or green management practices. If the firm has successfully completed an investment project recently, banks might view its new green investment project, either capital- or non-capital-intensive, more favorably. Alternatively, they might consider that the firm could overstretch and hence take a less favorable view. The banks might also view new green investment projects with several different measures less favorably. On the side of green management practices, investment in several measures, such as air pollution control, energy management, machinery and equipment upgrades, could facilitate the adoption of green management practices such as environmental monitoring or target setting. To deal with such concerns, we use an IV strategy, in line with the one used in De Haas et al (2022). Specifically, we assume that a firm's local environment provides a source of exogenous variation that affects the firm's decision about the type and number of green investments only via financing or the quality of green management.

When it comes to credit constraints, the international evidence shows that due to agency costs, small and medium-sized enterprises (majority of our sample) can only access nearby banks (Degryse and Ongena, 2005, Agarwal and Hauswald, 2010).[4] We can use the variation in those banks' regulatory (Tier 1) capital ratio as a plausibly exogenous driver of firms' financing constraints. Tier 1 capital ratio relates a bank's core equity capital (shareholders' equity and disclosed reserves) to its risk-weighted assets. During and after the global financial crisis, as well as after the 2011 regulatory stress tests by the European Banking Authority, many banks had to improve their Tier 1 capital ratio within a short period of time. Because raising additional equity was costly due to the difficult situation in the global capital markets, many banks deleveraged by shrinking their risk-weighted assets, including through cuts in lending (Gropp et al, 2019).

The first credit constraints instrument captures the fact that the intensity of deleveraging varied significantly across banks, even those within the same country. Firms that were surrounded by branches of banks that had to boost their Tier 1 capital ratio more during the crisis, found it more difficult to access bank credit; therefore, we expect a positive relationship between the increase in local banks' average Tier 1 capital ratio and the likelihood that nearby firms were credit constrained. To create the instrument $\Delta Tier1$, we combine the information on the geographic coordinates of both firms and the bank branches that surround them, and $\Delta Tier1$ measures the change in average Tier 1 capital ration over the period 2007 (just before the global financial crisis) to 2014 (after both the global financial crisis and the subsequent Eurozone crisis) for all banks in a firm's vicinity, where the latter is defined as a circle with a 15km radius.

The second credit constraints instrument is motivated by credit constraints being determined by local credit market conditions. This instrument is an average credit constraints indicator of firms within a 15km radius, excluding those from a firm's own sector $s(i)$.[5] This is similar to the "leave-one-out" strategy pursued in "jack-knife" approaches (Angrist et al, 1999), and is calculated as follows:[6]

$$CreditConstrainedL1O_{isc} = \frac{1}{N}\sum_{j\in[s(j)\neq s(i)\&d(i,j)\leq 15km]} CreditConstrained_j, \qquad (3)$$

where $d(i,j)$ is the distance between firms i and j.

The green management instrument is motivated by green management being determined by the local diffusion of management practices. It is unlikely, though, that firms learn from every other firm in their vicinity; they are more likely to learn from larger firms only. We divide the firms in deciles based on the number of permanent, full-time employees and then calculate average green management z-score of firms within a 15km radius in deciles above the firm's own decile. This implies that firms in the top decile in such a radius do not have any firms in the vicinity based on

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[4] The median Belgian SME borrower in Degryse and Ongena (2005) and the median US SME borrower in Agarwal and Hauswald (2010) were located 2.5km and 4.2km, respectively, from the lending bank branch.

[5] Sectors used can be found in Table A.3 in the Appendix.

[6] Similar approaches have been used in a number of other studies, including Fisman and Svensson (2007), Aterido et al (2011), and Commander and Svejnar (2011).

which we can calculate such average green management z-score; in such cases, we set this average to 0 and define an indicator variable equal to 1. The green management instrument is thus calculated as follows:

$$GreenMgmtLLD_{isc} = \begin{cases} \frac{1}{N}\sum_{j\in[D_l(j)>D_l(i)\ \&d(i,j)\leq 15km]} GreenMgmt_j \\ 0\ if\ \left[N_{D_l(j)} = 0\ \&d(i,j) \leq 15km\right] \end{cases}, \quad (4)$$

where $D_l(j)$ is firm *j*'s decile based on number of permanent, full-time employees and $N_{D_l(j)}$ is the number of firms in deciles above firm i's own decile.

Our two stage logistic regression framework with instrumental variables thus comprises the first-stage equations

$$\Xi_{isc} = \delta_0 + \delta_1 CreditConstrainedL10_{isc} + \delta_2 \Delta Tier1_{isc} + \delta_3 GreenMgmtLLD_{isc}$$
$$+\boldsymbol{\gamma}\hat{}' \boldsymbol{X\_i} + \xi\_r + \zeta\_s + \epsilon\_isc, \quad (5)$$

for $\Xi \in \{CreditConstrained, GreenMgmt\}$; and the second-stage equations are:

$$Pr(Y_i = j) = \frac{e^{\left(\beta_0+\beta_{1,j}Credit\widehat{Constrained}_i+\beta_{2,j}Gree\widehat{nM}gmt_i+\gamma_j' X_i+\mu_r+\vartheta_s+\varepsilon_i\right)}}{\sum_{k=1}^{J} e^{\left(\beta_0+\beta_{1,k}Credit\widehat{Constrained}_i+\beta_{2,k}Gree\widehat{nM}gmt_i+\gamma_k' X_i+\mu_r+\vartheta_s+\varepsilon_i\right)}}, \quad (6)$$

for the multinomial logistic regression model where Y_i is firm *i*'s choice of the type of green investment *j*: no green investment; capital-intensive green investment only; non-capital-intensive green investment only; and both capital- and non-capital-intensive green investment; and

$$Pr(Y_i = m) = Pr\begin{pmatrix} \kappa_{m-1} < \beta_0 + \beta_1 Credit\widehat{Constrained}_i + \beta_2 Gre\widehat{enM}gmt_i \\ +\boldsymbol{\gamma}'\boldsymbol{X_i} + \mu_r + \vartheta_s + \varepsilon_i \leq \kappa_m \end{pmatrix}, \quad (7)$$

for the ordered logistic regression model where Y_i is firm *i*'s choice of the number of green investments *m*, and $\kappa_1, \kappa_2, \ldots, \kappa_{M-1}$ are the cut-points ($m = 1,2, \ldots, M$). We estimate the first stage using ordinary least squares, and then use the predicted values in the second stage logistic regressions. The parameters in the second stage are estimated by using maximum likelihood, and standard errors are bootstrapped and clustered on locality.

6. Results

6.1. Logistic regression estimates

6.1.1. Type of green investment

Green management quality affects the type of green investment a firm makes. Table 2 presents the average marginal effect estimates of the association between credit constraints, green management quality, and type of green investment, based on multinomial logistic regressions with the type of green investment as a dependent variable. All regressions include locality-level credit market controls, region and sector fixed effects, and use locality-clustered standard errors. Table A.5 in the Appendix shows that the estimates are broadly robust to the inclusion of firm-level controls.

Panel A contains the average marginal effect estimates for the overall sample. A unit increase in the quality of green management practices, equivalent to moving from the 10th to 50th percentile of the distribution of the quality of green management practices, matters for selecting each type of green investment. It is associated with a 21.3 percentage points lower probability of making no green investments and 3.5 percentage points lower probability of making capital-intensive green investments only. At the same time, it is associated with 1.8 percentage points higher probability of making non-capital-intensive green investments and a whopping 23 percentage points higher probability of making both types of green investments. Thus, better green management practices are positively correlated with firms' green investments, congruent with our stated hypothesis 1, which suggests that such practices overcome the information barriers to mitigation measures and induce firms to take action. In addition, higher-quality green management practices are positively associated with non-capital-intensive green investments, which is also in line with hypothesis 1 that firms pursuing mitigation measures will focus on investments in non-capital-intensive processes. As suggested by the literature, this can be due to the potential higher returns associated with supporting non-capital-intensive processes, ease of implementation and its relatively lower capital spending requirements compared to investments targeting capital-intensive production activities.

Credit constraints can hinder green investment. Panel A of Table 2 also indicates that being credit constrained is associated with a 2.2 percentage points higher probability of making no green investment and a 3.3 percentage points lower probability of making both capital- and non-capital-intensive green investment. Average marginal effects of being credit constrained show no statistically significant impact on either capital-intensive or non-capital-intensive investments only. While credit constraints affect whether firms make a green investment, contrary to our hypothesis 3, there is no difference between the impact credit constraints have on capital-intensive versus non-capital investments in the overall sample. This could be because we do not know the actual capital intensity of each green investment the company reported. Investment in green energy generation on site, for example, could mean that the firm bought one solar panel and installed it on its roof (non-capital-intensive green investment) but it could also mean that the firm built a hydroelectric power plant (capital-intensive green investment).

The magnitude of the effect of credit constraints and green management quality on the type of green investment varies by region. Estimates in Panel B indicate that while credit constraints matter for some types of green investment by firms in ECA, they are marginally relevant only for making both capital and non-capital intensive green investment in MENA. In MENA, green management quality plays a more important role for any type of green investment. A unit increase in the quality of green management in the MENA region is associated with a 28.1 percentage points decrease in the likelihood of making no green investment and a 7.2 percentage points decrease in the likelihood of making capital-intensive green investments only. It is associated with a 9.7 percentage points increase in the likelihood of making non-capital-intensive green investments only and 25.6 percentage points increase in making both capital- and non-capital-intensive green investments. The magnitude of these associations is larger in MENA than in ECA, and the magnitude differences are statistically significantly different from each other at a 5% level of significance. The estimates broadly confirm our hypothesis 1, but not hypothesis 3.

Table 2: Multinomial logistic regression for type of green investment (average marginal effects)

	No green investment	Capital-intensive green investment only	Non-capital intensive green investment only	Both capital- and non-capital-intensive green investment
	Panel A: Overall sample			
Credit constraints	0.022*	0.001	0.009	-0.033***
	(0.009)	(0.007)	(0.006)	(0.009)
Green management	-0.213***	-0.035***	0.018***	0.230***
	(0.011)	(0.007)	(0.004)	(0.007)
	Panel B: Allow all coefficients to vary by region			
Credit constraints ECA	0.027**	-0.009	0.013	-0.031**
	(0.009)	(0.007)	(0.007)	(0.011)
Credit constraints MENA	0.002	0.038	-0.006	-0.035*
	(0.026)	(0.020)	(0.017)	(0.015)
Green management ECA	-0.194***	-0.038***	0.004	0.228***
	(0.011)	(0.006)	(0.004)	(0.007)
Green management MENA	-0.281***	-0.072*	0.097***	0.256***
	(0.036)	(0.032)	(0.011)	(0.018)
Observations	17,902			
Clusters	3,022			

Note: This table shows the average marginal effect estimates of credit constraints and green management on the type of green investment, based on multinomial logistic regression with the type of green investment as a dependent variable. Regression controls for locality-level credit market controls (log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius) ; population size class; and region and sector fixed effects. In Panel B, estimated coefficients for all firm-level covariates as well as log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius are allowed to vary by region. Locality-clustered standard errors in parentheses. ***, **, * - statistically significant at 1%, 5%, and 10%, respectively.

Source: Enterprise Surveys and authors' calculations.

6.1.2. Number of different green investments

Credit constraints and green management quality also affect the number of different green investments a firm makes. Table 3 presents the average marginal effect estimates of the association between credit constraints, green management quality, and the number of different green investments, based on the ordered logit regressions with the number of green investments as a dependent variable. We combine the number of different green investments into the following four categories: no green investments; one green investment; two to four different green investments; and five or more different green investments.[7] All regressions include locality-level credit market controls, and region and sector fixed effects.[8] Overall, firms are more likely to invest in more green measures if they have higher quality green management practices and experience fewer financial constraints. Average marginal effect estimates in Panel A indicate that a unit increase in the quality of green management practices is associated with a 19.6 and 2.4 percentage points lower probability of making no or only one green investment, as well as a 7.6 and 14.5 percentage points higher probability of making two to four, or five or more different green investments, respectively. In other words, the better the quality of green management, the more likely the firm is to make a higher number of green investments, congruent with hypothesis 2. Better quality green management practices can provide better access to information about climate needs and investment in climate-related measures, necessary to address asymmetric information and prompt firms to adopt a mitigation strategy. Similar to Kalantzis and Revoltella (2019), the magnitude of the effect indicated in this study is rather substantial (almost 15 percentage points) between such management practices and a firm adopting over five green investments.

In contrast, being credit constrained is associated with a 3.1 and 0.4 percentage points higher probability of making either no green investments or one green investment, respectively. It is also associated with a 1.2 and 2.3 percentage points lower probability of making two to four, or five or more different green investments, respectively. These results align with hypothesis 4, whereby the more credit constrained the firm, the fewer the mitigation measures it will pursue. As suggested in the literature, financial constraints can hinder green investment as it limits the capability of the firm to undertake the necessary capital requirements associated with the mitigation measures.

In MENA, green management quality appears to be more important for the firms' decision to make green investments (and the number of different green investments) than credit constraints; the estimates are consistent with our hypothesis 2, but not with hypothesis 4. Estimates in Panel B indicate that compared with firms in ECA, firms in MENA appear to be less sensitive to credit constraints when deciding on the number of different green investments to make – none of the

[7] Table A.7 shows that the estimates are robust to using six categories of the number of green investments: no green investment; one green investment; two different geen investments; three different green investments; four different green investments; and five or more different green investments. The estimates confirm hypotheses 2 and 4 for the overall sample and ECA, as well as hypothesis 2 for MENA.

[8] The estimates are broadly robust to the inclusion of firm-level controls; see Table A.6.

estimated average marginal effects is statistically significant. In both regions, the number of green investments firms make seems to depend more on the quality of green management practices. In the ECA region, the pattern looks similar to the one in Panel A. A unit increase in the quality of green management practices increases in magnitude with the number of different green investments. It is associated with an 18.2 and 3.5 percentage points decrease in the likelihood of making no or one green investments, respectively, and a 6.1 and 15.6 percentage points increase in the likelihood of making two to four, or five or more different green investments, respectively. On the other hand, in the MENA region, a unit increase in the quality of green management practices is associated with a 26.3 percentage points decrease in the likelihood of making no green investments. Meanwhile, it is associated with a 2.7 percentage points increase in the likelihood of making one green investment, 14.2 percentage points increase in the likelihood of making two to four different green investments, and a 9.3 percentage points increase in the likelihood of making five or more different green investments. In other words, it appears that the decision of how many different types of green investments to make depends on some other factor besides the quality of green management practices, which serves as more of a threshold.

Table 3: Ordered logistic regression for the number of different green investments (average marginal effects)

Variables	No green investment	One	Two to four	Five or more
	Panel A: Overall sample			
Credit constraints	0.031***	0.004***	-0.012***	-0.023***
	(0.006)	(0.001)	(0.002)	(0.004)
Green management	-0.196***	-0.024***	0.076***	0.144***
	(0.004)	(0.001)	(0.002)	(0.002)
	Panel B: Allow all coefficients to vary by region			
Credit constraints ECA	0.035***	0.006***	-0.012***	-0.028***
	(0.006)	(0.001)	(0.002)	(0.005)
Credit constraints MENA	0.009	-0.001	-0.005	-0.003
	(0.017)	(0.002)	(0.009)	(0.006)
Green management ECA	-0.182***	-0.035***	0.061***	0.156***
	(0.004)	(0.001)	(0.002)	(0.003)
Green management MENA	-0.263***	0.027***	0.142***	0.093***
	(0.011)	(0.003)	(0.006)	(0.004)
Observations	17,902			
Clusters	3,022			

Note: This table shows the average marginal effect estimates of credit constraints and green management on the number of green investments, based on ordered logistic regression with the categories based on the number of green investments as a dependent variable. Regression controls for the locality-level credit market controls (log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius); population size class; and region and sector fixed effects. In Panel B, estimated coefficients for all firm-level covariates as well as log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius are allowed to vary by region. Locality-clustered standard errors in parentheses. ***, **, * - statistically significant at 1%, 5%, and 10%, respectively.

Source: Enterprise Surveys and authors' calculations.

6.2. Logistic regression instrumental variables estimates

As discussed in the methodology section, a firm's investment decisions can influence its credit constraints and green management practices. In this subsection, we take a logistic IV regression, with three instruments for our two variables of interest.

Table 4 shows the results of the first stage. We regress each firm's credit constraint indicator and green management score against the three instruments in columns 1 and 2, respectively. In Panel A, coefficients are not allowed to vary by region, while in Panel B they do so. The estimates confirm that firms are more likely to be credit constrained in the overall sample as well as in ECA and MENA separately if firms in their vicinity from other sectors are also credit constrained. In MENA, firms are more likely to be credit constrained if the banks in their vicinity had to increase their Tier 1 capital ratio between 2007 and 2014, and had to deleverage and reduce their risky assets. In column 2, the green management score is positively correlated with the local green management quality overall, and much more strongly for MENA than for ECA.

Table 4: First stage IV regressions

	Credit constrained (indicator)	Green management (z-score)
	[1]	[2]
	Panel A: Overall sample	
Local credit constraints	0.268***	0.046
	(0.033)	(0.081)
Change in local average Tier 1 ratio (% points)	0.002	0.000
	(0.001)	(0.003)
Local green management	-0.015*	0.241***
	(0.006)	(0.039)
	Panel B: Allow all coefficients to vary by region	
Local credit constraints	0.259***	0.108
	(0.034)	(0.084)
Local credit constraints x MENA	0.314**	-0.396
	(0.102)	(0.214)
Change in local average Tier 1 ratio (% points)	0.002	-0.001
	(0.001)	(0.003)

Change in local average Tier 1 ratio (% points) x MENA	0.031*	0.090
	(0.014)	(0.055)
Local green management	-0.009	0.233***
	(0.006)	(0.041)
Local green management x MENA	-0.057**	0.304***
	(0.020)	(0.075)
MENA	0.951	0.153
	(1.053)	(2.036)
Observations	17,902	17,902
Clusters	3,022	3,022

Note: This table shows the first stage regressions corresponding to Tables 5 and 6. Regression controls for locality-level credit market controls (log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius); an indicator for no firms in other sectors in a 15km radius with data on credit constraints; an indicator for no firms in a 15km radius in higher deciles with data on green management; population size class; and region and sector fixed effects. Locality-clustered bootstrapped standard errors in parentheses. ***, **, * - statistically significant at 1%, 5%, and 10%, respectively.

Source: Enterprise Surveys and authors' calculations.

6.2.1. Type of green investment

The second stage average marginal effect estimates in Table 5, Panel A show that once we account for potential endogeneity of credit constraints and green management, the only significant estimates are found for both capital- and non-capital intensive green investment category. A unit increase in the quality of green management practices, equivalent to moving from the 10th to 50th percentile of the distribution of the quality of green management practices, is associated with a whopping 42.6 percentage points higher probability of making both capital- and non-capital-intensive green investment. This is almost twice the size of the estimate in Panel A of Table 2 that does not account for endogeneity. Our hypothesis 1 is thus only partly confirmed in this setting.

Overall average marginal effect estimates also indicate that being credit constrained leads to a 30.9 percentage points lower probability of making both capital- and non-capital-intensive green investment, although the estimate is statistically significant only at 10% level of significance.

Estimates in Panel B show that the overall average marginal effect estimates mask differences at the regional level. They indicate that credit constraints matter for some types of green investment by firms in ECA (at least at 10% level of significance): being credit constrained leads to a 29.7 percentage points higher probability of making no investment and a 15.2 percentage points higher probability of making non-capital-intensive investment only. However, credit constraints do not play a role in MENA firms' decisions about the type of green investment. In MENA, green management quality plays a more important role for either no green investment or both capital- and non-capital-intensive green investment. A unit increase in the quality of green management in the MENA region leads to a 46 percentage points decrease in the likelihood of making no green investment, compared with 28.4 percentage points decrease in ECA. The same increase in the quality of green management leads to a 36.2 percentage points increase in the likelihood of making both capital- and non-capital-intensive green investments in MENA, but a 41.6 percentage points increase in ECA – though the magnitude differences are not statistically different from each other at 5% level of significance. In ECA, a unit increase in the quality of green management is also associated with a 5.4 and 7.8 percentage points decrease in the likelihood of making capital-intensive and non-capital-intensive green investment, respectively. The estimates marginally confirm our hypothesis 1, but not hypothesis 3.

Table 5: Multinomial logistic IV regression for type of green investment (average marginal effects)

	No green investment	Capital-intensive green investment only	Non-capital intensive green investment only	Both capital- and non-capital-intensive green investment
	Panel A: Overall sample			
Credit constraints	0.268	-0.056	0.097	-0.309*
	(0.224)	(0.073)	(0.190)	(0.134)
Green management	-0.351	-0.024	-0.050	0.426***
	(0.260)	(0.079)	(0.169)	(0.057)
	Panel B: Allow all coefficients to vary by region			
Credit constraints ECA	0.297*	-0.074	0.152*	-0.376**
	(0.117)	(0.076)	(0.075)	(0.135)
Credit constraints MENA	0.229	0.306	-0.178	-0.357
	(0.262)	(0.178)	(0.206)	(0.188)
Green management ECA	-0.284***	-0.054*	-0.078**	0.416***
	(0.041)	(0.021)	(0.024)	(0.044)
Green management MENA	-0.460***	0.092	0.006	0.362***
	(0.070)	(0.054)	(0.040)	(0.060)
Observations	17,902			
Clusters	3,022			

Note: This table shows the average marginal effect estimates of credit constraints and green management on the type of green investment, based on multinomial IV logistic regression with the type of green investment as a dependent variable. Regression controls for locality-level credit market controls (log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius); indicators for no firms in other sectors in a 15km radius with data on credit constraints and green management; population size class; and region and sector fixed effects. In Panel B, estimated coefficients for all firm-level covariates as well as log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius are allowed to vary by region. Table 4 provides the first stage of the IV regressions. Locality-clustered bootstrapped standard errors in parentheses. ***, **, * - statistically significant at 1%, 5%, and 10%, respectively.

Source: Enterprise Surveys and authors' calculations.

To some extent, lack of more significant results could be because we do not know the actual capital intensity of each green investment the company reported. Investment in green energy generation on site, for example, could mean that the firm bought one solar panel and installed it on its roof (not particularly capital-intensive green investment) but it could also mean that the firm has built a solar power plant with thousands of solar panels (capital-intensive green investment).

6.2.2. Number of different green investments

Turning to the number of different green investments, Table 6 presents the average marginal effect estimates of the association between credit constraints, green management quality, and the number of different green investments, based on the ordered logistic IV regressions with the number of green investments as a dependent variable.[9]

Average marginal effect estimates in Panel A indicate that a unit increase in the quality of green management practices leads to a 35.2 and 5.7 percentage points lower probability of making no or only one green investment, as well as a 10.3, and 30.6 percentage points higher probability of making two to four, or five or more different green investments, respectively. This confirms our hypothesis 2. Better quality green management practices can provide better access to information about climate needs and investment in climate-related measures, necessary to address asymmetric information and prompt firms to adopt a mitigation strategy. In contrast, being credit constrained leads to a 26.5 and 4.3 percentage points higher probability of making either no green investments or one green investment, respectively. It also leads to a 7.8, and 23.3 percentage points lower probability of making two to four, or five or more different green investments, respectively. As was the case with the estimates not taking into account endogeneity in Table 4, these results align with hypothesis 4, whereby the more credit constrained the firm, the fewer mitigation measures it will pursue.

Panel B confirms hypotheses 2 and 4 for firms in the ECA region. For firms in the MENA region, however, the average marginal effects estimates for both credit constraints and green management are lower for the five or more different green investments than for the two to four green investments. They indicate that compared with firms in ECA, firms in MENA are much more sensitive to credit constraints if they do not make any green investment or if they make two to four different green investments (with the estimates statistically significant at 10% level of significance). Being credit constrained leads to a 20.3 percentage points decrease in the likelihood of making two to four different green investments, compared to a 6.5 percentage points decrease in ECA, but to an 18.6 percentage points decrease in the likelihood of making five or

[9] Table A.8 contains the equivalent estimates for the number of green investments variable with 6 categories.

more different green investments.[10] In ECA, the number of green investments firms make seems to depend more on the quality of green management practices than on credit constraints. In the MENA region, they appear to be closer in terms of magnitude: a unit increase in the quality of green management practices leads to a 39.8 percentage points decrease in the likelihood of making no green investments, while being credit constrained leads to a 41.5 percentage points decrease. Meanwhile, a unit increase in the quality of green management practices leads to a 19.5 and 17.9 percentage points increase in the likelihood of making two to four green and five or more different green investments, respectively. In other words, it appears that in MENA, the decision of how many different types of green investments to make depends on both credit constraints and the quality of green management practices, once the estimates account for endogeneity.

Table 6: Ordered logistic IV regression for the number of different green investments (average marginal effects)

	No green investment	One	Two to four	Five or more
	Panel A: Overall sample			
Credit constraints	0.265*	0.043*	-0.078*	-0.230*
	(0.117)	(0.020)	(0.039)	(0.100)
Green management	-0.352***	-0.057***	0.103***	0.306***
	(0.043)	(0.012)	(0.025)	(0.040)
	Panel B: Allow all coefficients to vary by region			
Credit constraints ECA	0.283**	0.066**	-0.065*	-0.285**
	(0.108)	(0.025)	(0.026)	(0.108)
Credit constraints MENA	0.415*	-0.025	-0.203*	-0.186*
	(0.206)	(0.014)	(0.101)	(0.092)
Green management ECA	-0.313***	-0.073***	0.072***	0.315***
	(0.037)	(0.009)	(0.009)	(0.037)
Green management MENA	-0.398***	0.024***	0.195***	0.179***
	(0.054)	(0.006)	(0.025)	(0.025)
Observations	17,902			
Clusters	3,022			

Note: This table shows the average marginal effect estimates of credit constraints and green management on the number of green investments, based on ordered logistic IV regression with the categories based on the number of green investments as a dependent variable. Regression controls for the locality-level credit market controls (log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius); indicators for no firms in other sectors in a 15km radius with data on credit constraints and

[10] The difference between the two average marginal effect estimates for the MENA region is not statistically significant. Estimates in Table A.8 indicate that none of the credit constraints average marginal effect estimates for MENA is statistically significant if the two to four different green investments category is split up into two, three, and four different green investments.

green management; population size class; and region and sector fixed effects. In Panel B, estimated coefficients for all firm-level covariates as well as log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius are allowed to vary by region. Table 4 provides the first stage of the IV regressions. Locality-clustered bootstrapped standard errors in parentheses. ***, **, * - statistically significant at 1%, 5%, and 10%, respectively.

Source: Enterprise Surveys and authors' calculations.

Taken together, these estimates suggest that policy measures that ease access to bank credit specifically for green investment might not suffice to see a substantial increase in green investments. This appears to be the case particularly for MENA and may be relevant for other countries at a similar level of development and climate change awareness. Governments and development banks should also consider measures that could strengthen green management practices. These may include disseminating information on best green management practices, requirements to measure and report environmental impacts or credit lines contingent on the adoption of better green management practices by firms.

7. Conclusions

For the analysis of firms' investment strategies, researchers have predominantly observed and described the role of various determinants, including information barriers and financial constraints in investment strategies in developed countries (Thollander et al, 2007; Fleitera et al, 2012; Kalantzis and Revoltella, 2019). Building upon previous research, this paper develops a new framework of firms' mitigation measures. Using unique data from the joint EBRD-EIB-WBG Enterprise Surveys, it empirically examines the determinants of the mitigation scope (i.e. the total number of mitigation measures) and the number of measures that firms take to follow certain strategic preferences of firms' investment areas. We specifically analyze factors that other researchers had previously suggested as possible determinants for firms' investment strategies (De Haas et al, 2022; Kalantzis and Revoltella, 2019). Methodologically, we apply an IV logistic regression model in addition to the logistic regression model in our econometric analysis.

In line with our priors, we find that better green management practices positively impact the transition strategy of firms to a sustainable future. Moreover, the magnitude of this impact increases with the number of measures implemented. This result implies that more aware firms about climate change impacts and the various existing measures that tackle them are the ones to engage the most in mitigation measures. This relationship is exponential and positive and suggests that firms with the best management practices overcome information barriers and adopt more mitigation measures.

Our econometric analysis also shows that firms' access to finance is an important determinant for adopting measures, especially for capital-investment measures, such as those in production processes. Specifically, the more financially constrained firms are, the less likely they pursue many mitigation measures to reduce energy costs and their carbon footprint. Once again, the exponential relationship is evident, implying that the impact of financial constraints on the investment strategy of firms is higher for the lower and upper range of measures that could be implemented.

Based on the above, the key findings are that financial constraints and information barriers not only influence the transition strategy of firms, but also the *number* of measures that they implement along the different strategic areas, namely support and production processes. The econometric results further show that the impact of these factors and their importance in firms' transition strategies are influenced by the location where firms operate. For example, in the MENA region, green management quality appears to be more important for the firms' decision to make green investments (and the number of different green investments to make) than credit constraints. Although access to finance is essential for investing in green, mainly because green investments compete with other core-business activities, information appears to play a greater role in the investment decision-making process and the selection of mitigation measures in this geographical setting.

This has important implications. Climate change will continue to have significant effects on business activities requiring firms in various industries and regions to adapt appropriately at a local level. Policy makers should guide this process to enable an effective and cost-efficient business model transformation because some mitigation measures will require investment decisions with long planning and amortization times (Stern, 2007). In this respect, our findings are valuable as they explain how governments can support this transformation process. Governments could increase the scope of firms' business model transformation by influencing awareness of possible climate change effects. If perceptions of climate change are not aligned across sectors, counties and various actors, the effectiveness of the policy response is jeopardized and climate action is stalled (Kalantzis et al, 2021). This could, for example, include intensively addressing the topic or providing research and information such as improved climate forecasting (Scott and McBoyle, 2007). Governments and development banks should also consider measures that could strengthen green management practices. This may include disseminating information on best green management practices, requirements to measure and report environmental impacts or credit lines contingent on firms' adopting better green management practices.

Governments also need to understand the reasons behind limited energy transformation among less informed firms, as reflected by their green management practices for target-setting purposes. Such firms are the most static in adjusting their business models, albeit the urgency to do so. Once more information is sought, governments can determine in which situations support for transformation makes economic sense and target such efforts into specific groups. It may be, for example, that transformation is no longer economically viable for highly brown sectors, e.g. coal power plants, mining etc. After such an assessment, governments can provide financial support (e.g. tax breaks on mitigation investments, subsidies) or capability building (e.g. technical support, skills training) for targeted firms who are able to transition. This would subsequently increase the uptake of mitigation strategies to minimize climate change risks. Support can also target specific mitigation measures, such as those related to production processes that can help reduce the financial losses from more stringent climate policies at a national and international level, thereby lowering the risk of financial default.

Moreover, governments could attempt to bring firms' adjustments in line with their desired direction at the local or regional level. If, for example, governments seek to motivate firms to build their business model around more environmentally-friendly actions rather than protecting them by maintaining environmentally harmful subsidies, they would have to lower the dependency of firms, e.g. by incentivizing new business development activities. These examples show how governments could consider the active support of firms' mitigation efforts on a broader level and rethink the future of entire regions or industries affected by climate change.

We should note that in our study, we investigated the role of information barriers and financial constraints in the green investment strategies of firms. Nonetheless, it is important to acknowledge that other factors may influence investment decisions in this regard. Thus, future studies could further investigate the reasons for implementing green measures after accounting for unexpected behavior between variables. In particular, it would be interesting to run an instrumental variable approach – despite the difficulty in finding good instrumental variables - to observe the magnitude and direction of the causation of financial constraints and information barriers, which is needed for designing better climate policies. Another future avenue for research would be to investigate whether the impact of these two factors differs across sectors and size of firms.

8. References

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Appendix

Table A.1: Variable definitions and data sources

Variable name	Variable definition	Source
Type of green investment	Categorical variable: 0 if no green investment; 1 if capital-intensive green investment only; 2 if non-capital-intensive green investment only; and 3 if both capital and non-capital intensive green investment. Machinery and equipment upgrades; vehicle upgrades; green energy generation on site; and waste minimization, recycling and waste management are classified as capital-intensive green investment. Heating and cooling improvements; energy management; water management; air pollution control measures; improvements to lighting systems; and other pollution control measures are classified as non-capital-intensive green investment.	ES
Number of green investments (6 categories)	0 if no green investment; 1 if one green investment; 2 if two green investments; 3 if three green investments; 4 if four green investments; and 5 if five or more green investments. Green investments are machinery and equipment upgrades; vehicle upgrades; green energy generation on site; waste minimization, recycling and waste management; heating and cooling improvements; energy management; water management; air pollution control measures; improvements to lighting systems; and other pollution control measures.	ES
Number of green investments (4 categories)	0 if no green investment; 1 if one green investment; 2 if two to four green investments; 3 if five or more green investments.	ES
Green investment	1 if firm adopted at least one of the following measures over the last three years: heating and cooling improvements, more climate-friendly energy generation on site, machinery and equipment upgrades, energy management, waste minimization, recycling and waste management, air pollution and control measures, water management, upgrade of vehicles, improvements to lighting systems, other pollution control measures; 0 otherwise	ES
Credit constrainted	1 if firm needed a loan and was discouraged from applying or rejected when it applied; 0 otherwise (including no need for credit or satisfied demand for credit)	ES
Green management	Z-score based on four areas of green management practices: strategic objectives related to the environment and climate change, manager with explicit mandate to deal with green issues, environmental targets, monitoring.	ES
Exporter	1 if firm directly exported at least 10% of its sales in the last complete fiscal year; 0 otherwise	ES
Employees with a university degree (%)	Percentage of employees with a completed university degree	ES

Publicly listed	1 if firm is a shareholding firm with shares traded in the stock market; 0 otherwise	ES
Sole proprietor	1 if firm is a sole proprietorship; 0 otherwise	ES
Audited	1 if firm had its annual financial statements checked and certified by an external auditor; 0 otherwise	ES
Firm age	Log of firm age (from when it was registered)	ES
No. bank branches	Number of bank branches within a 15km radius around the firm	BEPS II and ES
Local banks' average asset size in 2007 (log)	Average asset size of banks with branches within a 15km radius around the firm, weighted by the number of bank branches, logged	BEPS II, Orbis, and ES
Locality size	Variable based on the number of inhabitants in the firm's locality; categories: city with population over 1 million; over 250,000 to 1 million inhabitants; 50,000 to 250,000 inhabitants; fewer than 50,000 inhabitants	ES, verified with official sources
Leave-one-out mean credit constraints	Credit constraints instrument obtained by averaging the credit constraints of other firms in a 15km radius around the firm and excluding firms in the same sector	ES
Change in local average Tier 1 ratio (% points)	Difference between the average Tier 1 ratio of banks with branches within a 15km radius of the firm in 2014 (weighted by the number of bank branches) and the average Tier 1 ratio of banks with branches within a 15km radius of the firm in 2007 (weighted by the number of bank branches).	BEPS II, Orbis, and ES
Leave-one-out mean green management	Green management instrument obtained by averaging the green management of firms in higher size deciles in a 15km radius around the firm	ES

Source: ES refers to the EBRD-WBG-EIB Enterprise Surveys, BEPS II refers to the second round of the Banking Environment and Performance Survey and Orbis refers to Bureau van Dijk's Orbis database.

Table A.2: ES stratification regions and NUTS 1 regions

	BEEPS stratification regions	**NUTS 1 regions**	**Notes**
Albania	Central Albania	Entire country	BEEPS stratification regions correspond to NUTS 2.
	Northern Albania		
	Southern Albania		
Armenia	Gyumri (Shirak)	Entire country	Based on official regions. Not covered: Aragatsotn, Ararat, Armavir, Gegharkunik, Kotayk, Syunik, Tavush, Vayots Dzor
	Vanadzor (Lori)		
	Yerevan		
Azerbaijan	Baku and Absheron	Baku, Absheron and Center	Based on official economic regions. Not covered: Nagorno Karabakh, Kalbajar-Lachin, Nakhchivan (disputed/landlocked).
	Center (Aran, Daglig-Shirvan, Quba-Khachmaz, Lankaran)		
	West (Ganja-Qazakh, Shaki-Zaqatala)	West	

Belarus	Minsk	Minsk and Minskaya	Based on official economic regions. Not covered: Nagorno Karabakh, Kalbajar-Lachin, Nakhchivan (disputed/landlocked).
	Minskaya		
	Brestskaya, Grodnenskaya	Rest of the country	
	Gomelskaya, Mogilevskaya		
	Vitebskaya		
Bosnia and Herz.	Bosnia and Hercegovina (Bosna, Herzegovina-Neretva, West Herzegovina)	Entire country	Based on official administrative regions. Not covered: Aragatsotn, Ararat, Armavir, Gegharkunik, Kotayk, Syunik, Tavush, Vayots Dzor.
	Republika Srpska and Distrikt Brcko		
	Sarajevo		
Bulgaria	Severen tsentralen	Northern and Eastern Bulgaria	BEEPS stratification regions correspond to NUTS 2.
	Severoiztochen		
	Severozapaden		
	Yugoiztochen		
	Yugozapaden	South-Western and South-Central Bulgaria	
	Yuzhen tsentralen		
Croatia	Jadranska Hrvatska	Entire country	BEEPS stratification regions correspond to NUTS 2.
	Kontinentalna Hrvatska		
Czech Rep.	Central (Prague & Central Bohemia)	Entire country	BEEPS stratification regions combine NUTS 2 regions.
	East (Central Moravia and Moravian-Silesian)		
	North (Severozapad and Severovychod)		
	South (Jihozapad and Jihovychod)		
Egypt	Greater Cairo (Cairo, Giza, Qalyubia)	Greater Cairo	BEEPS stratification regions combine governorates. Not covered: Red Sea, New Valley, Matrouh, North Sinai, South Sinai.
	Middle and East Delta (Damietta, Dakahlia, Al Sharqia, Kafr al Sheikh, Al Gharbia, Monoufia)	Middle and East Delta	
	Northern Upper Egypt (Beni Suef, Fayoum, Minya, Assuit)	Northern Upper Egypt	
	Southern Upper Egypt (Souhag, Qena, Aswan, Al Aqsar)	Southern Upper Egypt	
	Suez Region (Port Said, Suez, Ismaili)	Suez Region	
	West Delta (Alexandria, Beheira)	West Delta	
Estonia	Laane-Eesti, Kesk-Eesti ja Kirde-Eesti	Entire country	BEEPS stratification regions combine NUTS 3 regions.
	Louna-Eesti		
	Pohja-Eesti		

Georgia	Center (Imereti, Shida Kartli, Samtskhe-Javakheti, Mtskheta-Mtianeti, Racha-Lechkhumi and Kvemo Svaneti)	Entire country	BEEPS stratification regions combine official regions. Not covered: South Osetia, Abkhazia.
	East (Kakheti, Kvemo Kartli)		
	North and West (Adjara, Guria, Samegrelo, Zemo Svaneti)		
	Tbilisi		
Hungary	Central Hungary	Central Hungary	BEEPS stratification regions correspond to NUTS 2, with Budapest and Pest combined into NUTS 1.
	Central Transdanubia	Transdanubia	
	Western Transdanubia		
	Southern Trandanubia		
	Northern Great Plain	Great Plain and North	
	Northern Hungary		
	Southern Great Plain		
Jordan	Amman	Amman	BEEPS stratification regions combine governorates. South has less than 3 million inhabitants, but it doesn't make sense to combine it with other regions.
	Irbid	North and Central	
	North and Central (Ajloun, Balqa, Jerash, Madaba, Mafraq)		
	Zarqa		
	South (Aqaba, Karak, Ma'an, Tafilah)	South (Aqaba, Karak, Ma'an, Tafilah)	
Kazakhstan	Akmola region	North and Central Kazakhstan	BEEPS stratification regions are based on official regions.
	Astana		
	Kostanay, North Kazakhstan and Pavlodar		
	East Kazakhstan		
	Karaganda		
	Almaty	Almaty region and city	
	Almaty region		
	Aktobe region	West and South Kazakhstan	
	Atyrau		
	Mangystau and West Kazakhstan		
	Kyzylorda, South Kazakhstan, Jambyl		
Kyrgyz Rep.	Bishkek	Entire country	BEEPS stratification regions combine official regions.
	Chui, Jalalabad, Issyk-Kul		
	Talas, Naryn, Osh, Batken		
Latvia	Kurzeme & Zemgale	Entire country	
	Riga & Pieriga		

	Vidzeme & Latgale		BEEPS stratification regions combine NUTS 3 regions.
Lithuania	Kaunus & Klaipeda	Entire country	BEEPS stratification regions combine NUTS 3 regions.
	Rest of the country (Tauragė, Telšiai, Panevėžys, Šiauliai, Utena, Alytus, Marijampolė)		
	Vilnius		
Moldova	Center (Chisinau, Anenii Noi, Causeni, Calarasi, Criuleni, Hincesti, Ialoveni, Leova, Nisporeni, Orhei, Straseni, Ungheni, Telenesti)	Entire country	BEEPS stratification regions are close to administrative regions, with a few exceptions.
	North (Balti, Briceni, Donduseni, Drochia, Edinet, Falesti, Floresti, Glodeni, Rezina, Riscani, Singerei, Ocnita, Soroca, Soldanesti)		
	South (Gaugazia, Comrat, Cahul, Cantemir, Cimislia, Taraclia, Bender, Tiraspol, Basarabeasca, Dubasari, Stefan Voda)		
Mongolia	Central & East Mongolia	Entire country	BEEPS stratification regions combine provinces.
	Khangai & West Mongolia		
	Ulaanbaatar		
Morocco	Béni Mellal-Khénifra and Drâa-Tafilalet	Béni Mellal-Khénifra and Drâa-Tafilalet	BEEPS stratification regions are based on official regions. Not covered: Guelmim-Oued Noun, Laayoune-Sakia El Hamra, and Dakhla-Oued Ed-Dahab.
	Casablanca-Settat	Casablanca-Settat	
	Fès-Meknès	Fès-Meknès	
	Marrakech-Safi	Marrakech-Safi	
	Souss-Massa	Souss-Massa	
	Rabat-Salé-Kénitra	Rabat-Salé-Kénitra	
	Tanger-Tétouan-Al Hoceima	Tanger-Tétouan-Al Hoceima & Oriental	
	Oriental		
North Macedonia	Eastern Macedonia (Severoistocen, Istocen, Jugoistocen, Vardarski)	Entire country	BEEPS stratification regions combine NUTS 3 regions.
	Skopje		
	Western Macedonia (Poloski, Pelagoniski, Jugozapaden)		
Poland	Central	Central	BEEPS stratification regions correspond to NUTS 1.
	Eastern	Eastern	
	Northern	Northern	

	Northwestern	Northwestern	
	Southern	Southern	
	Southwestern	Southwestern	
Romania	Nord-Vest	Macroregion one	BEEPS stratification regions correspond to NUTS 2.
	Centru		
	Nord-Est	Macroregion two	
	Sud-Est		
	Sud-Muntenia	Macroregion three	
	Buchuresti-Ilfov		
	Vest	Macroregion four	
	Sud-Vest Oltenia		
Russia	Central Federal District	Central Federal District	BEEPS stratification regions are federal districts. They all have a higher population than recommended for NUTS 1, but we cannot split them further.
	Far Eastern Federal District	Far Eastern Federal District	
	North-West Federal District	North-West Federal District	
	Siberian Federal District	Siberian Federal District	
	South (Southern Federal District and	South (Southern Federal District and	
	Ural Federal District	Ural Federal District	
	Volga Federal District	Volga Federal District	
Serbia	Belgrade	Serbia-North	BEEPS stratification regions are based on statistical regions. NUTS 1 regions are based on a proposal by the Government of Serbia.
	Vojvodina		
	South Serbia (Sumadija and Western Serbia, Southern and Eastern Serbia)	Serbia-South	
Slovak Rep.	Bratislava	Entire country	BEEPS stratification regions correspond to NUTS 2.
	Central Slovakia (Stredne Slovensko)		
	Eastern Slovakia (Vychodne Slovensko)		
	Western Slovakia (Zapadne Slovensko)		
Slovenia	Eastern Slovenija	Entire country	BEEPS stratification regions correspond to NUTS 2.
	Western Slovenija		
Tajikistan	Dushanbe	Region of Republican Subordination & Khatlon	BEEPS stratification regions are based on official provinces. Not covered: Gorno-Badakhshan Autonomous Province.
	Region of Republican Subordination & Khatlon		
	Sughd	Sughd	
Turkey	Aegean	Aegean	BEEPS stratification regions correspond to NUTS 1.
	Central Anatolia	Central Anatolia	
	Central East Anatolia	Central East Anatolia	

	East Black Sea	East Black Sea	
	East Marmara	East Marmara	
	Istanbul	Istanbul	
	Mediterranean	Mediterranean	
	Northeast Anatolia	Northeast Anatolia	
	Southeast Anatolia	Southeast Anatolia	
	West Anatolia	West Anatolia	
	West Black Sea	West Black Sea	
	West Marmara	West Marmara	
Ukraine	Cherkaska, Chernihivska	Cherkaska, Chernihivska, Vinnytska, Zhytomyrska	BEEPS stratification regions combine proposed NUTS3 regions (in parentheses). Not covered: Donetsk, Luhansk, Crimea.
	Vinnytska, Zhytomyrska		
	Dnipropetrovska, Kharkivska	Dnipropetrovska, Kharkivska	
	Khersonska, Mykolayivska, Odeska	Khersonska, Mykolayivska, Odeska	
	Kirovohradska, Poltavska	Kirovohradska, Poltavska, Sumska, Zaporizka	
	Sumska, Zaporizka		
	Kyiv	Kyiv	
	West (Chernivtsi, Ivano-Frankivsk, Khmelnytskyi, Lviv, Rivne, Ternopil, Volyn, Zakarpattia)	West	

Source: EBRD-EIB-WBG Enterprise Surveys and https://ec.europa.eu/eurostat/web/nuts/national-structures, https://interreg.eu/country/ukraine/ and https://en.wikipedia.org/wiki/NUTS_statistical_regions_of_Serbia (all accessed on 5 January 2022).

Table A.3: Mapping between 2-digit ISIC Rev. 3.1 sectors and sectors used in the analysis

	2-digit ISIC 3.1 sectors covered by ES/BEEPS	***Sectors used in the survey***
Manufacturing	Food (15)	15
	Tobacco (16)	
	Textiles (17)	17
	Garments (18)	18
	Leather (19)	
	Wood (20)	20
	Paper (21)	
	Publishing, printing, and recorded media (22)	
	Refined petroleum product (23)	24
	Chemicals (24)	
	Plastics & rubber (25)	25
	Non metallic mineral products (26)	26

	Basic metals (27)	28
	Fabricated metal products (28)	
	Machinery and equipment (29)	29
	Office, accounting and computing machinery (30)	30
	Electrical machinery (31)	
	Radio, television and communication equipment (32)	
	Precision instruments (33)	
	Motor vehicles, trailers and semi-trailers (34)	
	Other transport equipment (35)	
	Furniture (36)	36
	Recycling (37)	
Retail	Retail (52)	52
Other services	Construction (45)	45
	Services of motor vehicles (50)	51
	Wholesale (51)	
	Hotel and Restaurants (55)	55
	Land transport; transport via pipelines (60)	60
	Water transport (61)	
	Air transport (62)	
	Suppoting and auxiliary transport services (63)	
	Post and telecommunications (64)	
	IT (72)	72

Source: Enterprise Surveys and authors' calculations.

Table A.4: Sample breakdown

Countries	**Number of unique firms**
Albania	326
Armenia	526
Azerbaijan	178
Belarus	551
Bosnia and Herzegovina	258
Bulgaria	737
Croatia	304
Czech Republic	461
Egypt	2,354
Estonia	319
Georgia	504
Hungary	761
Jordan	526

Kazakhstan	1,254
Kyrgyz Republic	325
Latvia	299
Lithuania	324
Moldova	338
Mongolia	293
Morocco	504
North Macedonia	302
Poland	870
Romania	728
Russia	1,003
Serbia	278
Slovak Republic	417
Slovenia	373
Tajikistan	210
Turkey	1,430
Ukraine	1,149
Total	*17,902*

Source: Enterprise Surveys and authors' calculations.

Table A.5: Multinomial logistic regression for type of green investment, with firm-level controls (average marginal effects)

	No green investment	Capital-intensive green investment only	Non-capital intensive green investment only	Both capital- and non-capital-intensive green investment
	Panel A: Overall sample			
Credit constraints	0.020*	-0.001	0.007	-0.027**
	(0.009)	(0.007)	(0.006)	(0.009)
Green management	-0.202***	-0.032***	0.020***	0.213***
	(0.011)	(0.006)	(0.004)	(0.007)
	Panel B: Allow all coefficients to vary by region			
Credit constraints ECA	0.022*	-0.009	0.012	-0.024*
	(0.009)	(0.007)	(0.007)	(0.011)
Credit constraints MENA	0.009	0.033	-0.009	-0.033*
	(0.026)	(0.019)	(0.016)	(0.014)
Green management ECA	-0.183***	-0.035***	0.006	0.212***
	(0.011)	(0.006)	(0.004)	(0.008)
Green management MENA	-0.253***	-0.076*	0.100***	0.229***
	(0.035)	(0.030)	(0.011)	(0.017)
Observations	17,902			

Clusters	3,022

Note: This table shows the average marginal effect estimates of credit constraints and green management on the type of green investment, based on multinomial logistic regression with the type of green investment as a dependent variable. Regression controls for firm-level covariates (log firm age and its square, percentage of employees with a completed university degree, indicators for exporter status, listed firm, sole proprietorship, and audited financial accounts); locality-level credit market controls (log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius); population size class; and region and sector fixed effects. In Panel B, estimated coefficients for all firm-level covariates as well as log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius are allowed to vary by region. Locality-clustered standard errors in parentheses. ***, **, * - statistically significant at 1%, 5%, and 10%, respectively.

Source: Enterprise Surveys and authors' calculations.

Table A.6: Ordered logistic regression for the number of different green investments (average marginal effects)

	No green investment	One	Two to four	Five or more
	Panel A: Overall sample			
Credit constraints	0.026***	0.003***	-0.010***	-0.019***
	(0.006)	(0.001)	(0.002)	(0.004)
Green management	-0.183***	-0.022***	0.071***	0.134***
	(0.004)	(0.001)	(0.002)	(0.002)
	Panel B: Allow all coefficients to vary by region			
Credit constraints ECA	0.028***	0.005***	-0.010***	-0.023***
	(0.006)	(0.001)	(0.002)	(0.005)
Credit constraints MENA	0.013	-0.001	-0.007	-0.005
	(0.016)	(0.002)	(0.009)	(0.006)
Green management ECA	-0.169***	-0.032***	0.057***	0.144***
	(0.004)	(0.001)	(0.002)	(0.003)
Green management MENA	-0.237***	0.025***	0.127***	0.086***
	(0.011)	(0.003)	(0.006)	(0.004)
Observations	17,902			
Clusters	3,022			

Note: This table shows the average marginal effect estimates of credit constraints and green management on the number of green investments, based on ordered logistic regression with the categories based on the number of green investments as a dependent variable. Regression controls for firm-level covariates (log firm age and its square, percentage of employees with a completed university degree, indicators for exporter status, listed firm, sole proprietorship, and audited financial accounts); locality-level credit market controls (log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius); population size class; and region and sector fixed effects. In Panel B, estimated coefficients for all firm-level covariates as well as log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius are allowed to vary by region. Locality-clustered standard errors in parentheses. ***, **, * - statistically significant at 1%, 5%, and 10%, respectively.

Source: Enterprise Surveys and authors' calculations.

Table A.7: Ordered logistic regression for the number of different green investments (average marginal effects)

	No green investment	One	Two	Three	Four	Five or more
	Panel A: Overall sample					
Credit constraints	0.031***	0.004***	-0.001***	-0.005***	-0.006***	-0.023***
	(0.006)	(0.001)	(0.000)	(0.001)	(0.001)	(0.004)
Green management	-0.197***	-0.024***	0.009***	0.030***	0.037***	0.145***
	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
	Panel B: Allow all coefficients to vary by region					
Credit constraints ECA	0.035***	0.006***	-0.000	-0.005***	-0.007***	-0.028***
	(0.006)	(0.001)	(0.000)	(0.001)	(0.001)	(0.005)
Credit constraints MENA	0.014	-0.001	-0.003	-0.003	-0.002	-0.005
	(0.016)	(0.002)	(0.003)	(0.003)	(0.002)	(0.006)
Green management ECA	-0.182***	-0.035***	-0.001	0.025***	0.037***	0.157***
	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Green management MENA	-0.262***	0.027***	0.052***	0.051***	0.039***	0.093***
	(0.011)	(0.003)	(0.003)	(0.002)	(0.002)	(0.004)
Observations	17,902					
Clusters	3,022					

Note: This table shows the average marginal effect estimates of credit constraints and green management on the number of green investments, based on ordered logistic regression with the categories based on the number of green investments as a dependent variable. Regression controls for locality-level credit market controls (log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius); population size class; and region and sector fixed effects. In Panel B, estimated coefficients for all firm-level covariates as well as log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius are allowed to vary by region. Locality-clustered standard errors in parentheses. ***, **, * - statistically significant at 1%, 5%, and 10%, respectively.

Source: Enterprise Surveys and authors' calculations.

Table A.8: Ordered logistic IV regression for the number of different green investments (average marginal effects)

	No green investment	One	Two	Three	Four	Five or more
	Panel A: Overall sample					
Credit constraints	0.267*	0.044*	0.000	-0.031*	-0.048*	-0.233*
	(0.114)	(0.020)	(0.008)	(0.015)	(0.021)	(0.098)
Green management	-0.352***	-0.058***	-0.000	0.041***	0.063***	0.306***

	(0.042)	(0.012)	(0.011)	(0.009)	(0.007)	(0.040)
	Panel B: Allow all coefficients to vary by region					
Credit constraints ECA	0.294**	0.069**	0.015*	-0.028**	-0.055**	-0.296**
	(0.106)	(0.025)	(0.006)	(0.010)	(0.020)	(0.106)
Credit constraints MENA	0.356	-0.022	-0.055	-0.064	-0.056	-0.159
	(0.205)	(0.014)	(0.032)	(0.037)	(0.032)	(0.091)
Green management ECA	-0.314***	-0.074***	-0.016***	0.030***	0.058***	0.316***
	(0.036)	(0.009)	(0.003)	(0.004)	(0.007)	(0.037)
Green management MENA	-0.405***	0.025***	0.063***	0.073***	0.064***	0.181***
	(0.053)	(0.006)	(0.009)	(0.009)	(0.008)	(0.025)
Observations	17,902					
Clusters	3,022					

Note: This table shows the average marginal effect estimates of credit constraints and green management on the number of green investments, based on ordered logistic IV regression with the categories based on the number of green investments as a dependent variable. Regression controls for locality-level credit market controls (log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius); population size class; and region and sector fixed effects. In Panel B, estimated coefficients for all firm-level covariates as well as log local banks' average asset size in a 15km radius and the number of bank branches in a 15km radius are allowed to vary by region. Locality-clustered standard errors in parentheses. ***, **, * - statistically significant at 1%, 5%, and 10%, respectively.

Source: Enterprise Surveys and authors' calculations.