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Micro evidence from EIBIS

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Are EU firms climate-ready? Micro evidence from EIBIS

Fotios Kalantzis (EIB) and Sofia Dominguez (EIB, current affiliation UNCTAD)[1]

Abstract

This study uses unique firm-level data from EIBIS to identify EU firms' climate strategies and their associated factors. To do so, we initially run a clustering analysis that results in five distinct clusters in line with the literature and then investigate the role of various firms' characteristics in their adoption based on a multi-logit regression. Our findings show that almost half of the EU firms adopt either "wait-and-see" strategies or plan to invest in tackling climate change risks. More climate-friendly strategies appear to be positively associated with the awareness of climate-related risks, especially with firms that see the transition to a low-carbon future as an opportunity. Similarly, those strategies are followed by large firms that are innovative, face fewer credit constraints and operate in an environment where there is a strong push for climate actions from various stakeholders. These findings are valuable as they can guide policymakers on supporting firms' transformation to play their part, as an integral part of our society, in the road to a clean, affordable, and secure energy future.

Keywords: EIBIS, climate strategies, climate change risks, perception analysis, clustering analysis

1. Introduction

It is scientifically accepted that tackling the adverse effects of climate change requires radical reductions in GHG emissions globally and from all actors of our society. This consensus is increasingly being translated into political aspirations. For example, Europe has made significant efforts to support the transition to a low-carbon economy with the EU Green Deal and NextGenerationEU recovery package. However, a considerable investment gap still exists to shift to a carbon-neutral future by 2050. The European Commission estimates that the EU needs at least €350 billion in additional investments per year over this decade to meet its 2030 emissions reduction target (EC, 2021), which is an interim step for the 2050 objective. To put things into perspective, this is 11 per cent of EU gross fixed capital accumulation in 2021 (Eurostat, 2022a) and 2.5 per cent of GDP (Eurostat, 2022b). For government

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investment, which is estimated to be one-third of this amount (Alessi et al., 2019; EC, 2020) this means that it must increase by about 0.8% of GDP, which is a 25% increase of government investment in the EU. The remaining two-thirds of this investment should come from the private sector, which underlines the importance of private firms scaling up efforts for climate action.

This business-climate relationship has been an integral part of climate change discussions and motivated an increasing body of literature to investigate and identify firms' climate profiles based on their investment choices and the scope and level of carbon management activities in response to climate change (Lee, 2011). These typically include emission reduction commitments, process and product improvements, market and business developments, and external relationship development (ibid, 2011). Thus far, the literature has focused on solely identifying the potential strategic options of firms (e.g., Kolk and Pinkse, 2005). While these studies shed light on the identification of climate strategies and related management practices, the majority are descriptive and do not empirically test for different factors that may affect adopting a particular strategy. This further motivates our paper to present an empirical analysis of the potential factors affecting climate profiles, which is imperative to promote the necessary action to scale up firm efforts to address the negative impacts of climate change and its related policies.

Climate change and related policies are pressing, systemic issues that pose high risks to firms' business environments. On the one hand, the physical impacts of climate change can adversely affect firms' operations, causing disruptions in their production processes and supply chain. On the other hand, transition risks, which relate to policy developments and the regulatory framework, can increase the cost of businesses and lead to stranded assets. Being aware of the challenges associated with climate change is fundamental to prompt action and encourage firms to invest in climate measures to reduce the adverse outcomes of the climate crisis. Altogether, this has wide-reaching implications for firms, which are essential to close the investment gap for transitioning to a net-zero carbon economy and which also risk losing ground to more forward-looking competitors if they remain inert.

A number of studies have sought to examine the drivers behind climate investment choices, with a focus on the effects of perceived weather changes (e.g., Bryan et al. 2009; Hoffmann et al., 2009; Sullivan and White; 2019), access to finance (e.g., Girma et al., 2008; Bryan et al., 2009; Akiana, 2021), and to a lesser extent, stakeholder pressures (e.g., Damert et al., 2017; Yunus, 2017; Cadez et al., 2018). While this work has provided insight into some of the influencing factors and their corresponding mechanisms affecting climate investments, existing research does not address several issues. While there is a consensus that perceptions of climate-related risks can affect investment choices, most studies solely look at perceived weather changes and tend to overlook the impact of transition risks on economic actors. Besides physical climate risks, firms must also account for transition risks for an accurate climate risk assessment that better informs firms' investment decisions. Moreover, most studies that examine the effect of physical risks focus on the agricultural sector and farmers' investment behaviour. While we can draw parallels between the existing research on

households' and firms' investment choices, it is imperative to empirically examine this in other economic sectors to gauge their importance in a different context and allow other potential factors to be analysed. To this end, a better understanding of firms' behaviour, specifically regarding perceptions of climate-related risks and ongoing mitigation and adaptation investments, is needed to inform further policies promoting climate investments that can contribute to the energy transition.

Therefore, this paper first identifies firms' climate strategies based on clustering analysis and empirically examines how these firms' profiles vary alongside climate perceptions and firm-specific characteristics. We employ a multinominal logistic regression model to test for our hypotheses and expect that more sophisticated strategies[2] are used by:

I. Firms that acknowledge climate change risks
II. Firms that are optimistic about the future, their demand, access to finance conditions but have energy cost concerns,
III. Innovating firms,
IV. Firms that feel a push from various stakeholders, i.e., governments, citizens, and employees.

Our study contributes to the existing literature in several ways, policy, and practice. First, to the best of our knowledge, this is the first work that empirically identifies the profiles of EU firms based on their climate strategies and empirically examines how risk perceptions and other firm-specific characteristics affect these profiles and actions to tackle climate change. This addresses a gap in the literature and uses an innovative method to shed light on the topic in the European context. Second, understanding perceptions can guide policymakers to engage the private sector in playing their role to address climate change. Policymakers could seek to raise awareness of possible climate change effects by, for example, addressing the topic more extensively or better informing firms through improved climate forecasting. Examining the heterogeneity of effect across firms according to inter-alia, size, sector of operation can also identify areas for improvement and target setting. In this regard, it would also be beneficial to identify firms' vulnerability and limitations hindering climate investments from determining where and what type of support is needed.

This paper is organised as follows. Section 2 presents the literature review and the testing hypotheses. The data, variable measurement, and econometric model are briefly presented in Section 3. The multinomial logit regression results are reported in Section 4. Section 5 draws the conclusions and policy implications.

[2] In the paper, “sophisticated strategies” refer to climate profiles that incorporate at least two of the three identified climate-friendly criteria onto their practices. The indicators used to construct these profiles are discussed more extensively in section 2 and 3.

2. Literature review and testing hypotheses

2.1 Identifying climate profiles

Firms' climate investment choices and green practices belong to an overarching climate strategy inherent to businesses. With climate change being recognised as a topical issue affecting business, emerging literature has explored various corporate climate strategies in different contexts (e.g., Kolk and Pinkse, 2005, Weinhofer and Hoffmann, 2008; Lee, 2011). In their paper, Kolk and Pinkse (2005) examine the different strategies available to firms based on an analysis of FT500 companies. Using firm survey data on emission reduction targets, policies, activities and measurement, and their perceptions of climate change, they identify six profiles firms can adopt to address components related to climate change: "cautious planner, emerging planner", "internal explorer", "vertical explorer", "horizontal explorer" and "emissions trader" (ibid, 2005).

Other studies have followed a similar approach using clustering techniques and have identified akin corporate climate strategies. Weinhofer and Hoffmann (2008) employ a cluster analysis and identify six profiles using three variables measuring CO2 compensation, CO2 reduction and carbon independence. The resulting profiles were: "all-rounder", "compensator", "substituting compensator", "reducer", "substituting reducer", and" preserver". In their analysis, the authors find that larger companies and companies with higher CO2 emissions undertake a broader spectrum of activities without showing much preference for a specific climate strategy type, such as CO2 reduction. Based on a cluster analysis of 241 Korean firms, Lee (2011) also identifies six strategies using data on six different carbon management activities. The defined firm groups are: "wait-and-see observers", "cautious reducers", "product enhancer", "all-round enhancer", "emergent explorer" and "all-round explorer". While a significant relationship between a firm's climate strategy and its sector and size was found, no significant relationship between a climate strategy and firm performance was confirmed.

Following a similar line of thought, we opt for a clustering technique to identify different profiles. Choosing to invest in climate, planning to do so in the future and setting climate targets are indicators that communicate part of a firm's climate strategy. The clustering analysis allows us to partition firms into distinct groups based on their similarities across these indicators. This approach identifies five corporate climate strategies: "Wait-and-see observers", "Planners", "Cautious reducers", "Short-term explorers", and 'Forward-looking explorers", which are discussed extensively in Section 3.

Thus far, the literature has focused on identifying the potential strategic options of firms (e.g., Kolk and Pinkse, 2005) or looked at the relationship between climate strategies and financial performance (Lee, 2011). While these studies present valuable insight on the determination of climate strategies, the majority only provide a descriptive overview of firm profiles in a specific context. In this regard, there is a gap in empirically examining the influencing factors of climate strategies, which is fundamental to promote firm action to address the impact of climate change.

2.2 Determinants of climate investments and testing hypotheses

There is seemingly consensus that perceptions of climate risks are crucial to addressing climate change (Arnell and Delaney, 2006; Hoffmann et al., 2009; EIB, 2021, 2022). Focusing on individual perceptions, Weber (2011) finds that a lack of public risk perception can hinder climate change adaptation and mitigation efforts. Climate change requires collective action and individual awareness to induce environmentally responsible behaviour (Sullivan and White, 2019). From the firms' point of view, a firm will invest if the perceived benefits of the investment outweigh the associated costs (EIB, 2021). This cost-benefit analysis depends on the business' perception of climate risks. Firms that are more aware can appropriately assess the benefits of climate investments and price climate-related risks, which better informs their capital allocation decisions (EIB, 2021, 2022). Thus, awareness of the impact of climate change can influence climate investment and other strategic decisions. A firm must first acknowledge the threats imposed by climate change to take action; otherwise, they are unlikely to do so (Arnell and Delaney, 2006).

Hoffmann et al. (2009) empirically find that awareness of the impact of climate change has a positive effect on the scope of firms' adaptation strategies. Using survey data of climate change perceptions of ski lift operators in Switzerland, the authors (Hoffmann et al., 2009) find that the higher the level of awareness, the higher the number of climate-related measures adopted, which is significant at the 5% significance level. In a similar study using survey data, Bryan et al. (2009) find that Ethiopian and South African farmers that are more aware of extreme weather events are also more likely to adopt measures to respond to climate shocks. Using survey data on farmers' perceptions of different climatic changes in the area, the authors find a positive correlation between perceptions and adaptation measures, significant at the 1% level and robust to different specifications (ibid, 2009). Thus, it is expected that the greater the awareness of firms of climate-related risks, the more likely they are to adopt measures to reduce emissions.

The papers discussed thus far focus on perceptions of physical risk on adaptation strategies. Sullivan and White (2019), Hoffmann et al. (2009) and Byran et al. (2009) all employ variables based on specific weather pattern changes or weather events to measure individuals' or firms' perception of climate-related risks. Albeit important, firms face not only physical risks, but also transition risks, which are associated with society's response to climate change (EIB, 2021). Physical risks are more readily observable and thus easier to understand as they arise from exposure to severe weather events or significant changes in climatic patterns. On the other hand, transition risks are less evident, as they refer to the associated costs of shifting to a low-carbon economy, which relates to policy developments and increasing regulation on specific economic activities (EIB, 2021). This entails a comprehensive policy response from governments to achieve climate objectives and remain committed to international treaties. Due to their nature, transition risks can increase the cost of business and lead to stranded assets. Few studies investigate the effect of transition risks on climate action. However, as evidenced in the European Investment Bank's Investment Survey (2021), there is a positive

correlation between awareness of transition risks and climate investments, where firms that acknowledge such risks are more likely to invest in climate measures.

The key hypothesis that emerges from this discussion is that if firms are aware of the impact of climate change, they will be more likely to engage in climate strategies more extensively. Consequently, we expect that with increasing awareness, firms adopt more sophisticated climate strategies, which have a larger scope to address climate change.

Hypothesis 1: Firms that acknowledge climate risks are more likely to adopt more sophisticated climate strategies.

An influencing factor to climate investments decision choice is income and a firms' financial capability. While climate awareness is fundamental to prompt action, firms must also be able to undertake the costs necessary to adopt climate-related measures. In this regard, access to finance is important, as it facilitates the undertaking of costly investments for firms (Hubbard, 1998; Bryan et al., 2009; Akiana, 2021). Using a panel of 446,000 Chinese firms over six years, Girma et al. (2008) find that firms with good access to bank loans tend to innovate more, as it lowers the financial constraints that would otherwise prevent them from investing. Bryan et al. (2009) observe similar results in the agricultural sector and find that farmers with access to finance are 13% more likely to invest in measures to adapt to climate change, significant at the 1% level. Further studies examining the determinants of climate strategies in agriculture also indicate that access to credit markets and finance are positively correlated with the uptake of climate adaptation measures (Yesuf et al., 2008; Di Falco et al., 2011). By contrast, limited or no access to finance can hinder investments. In his study, Akiana (2021) finds that limited access to credit can deter the adoption of climate measures by farmers in the Congo. In line with the existing literature, the EIB Investment Survey (2022) reports that limited access to finance is an obstacle constraining investment, with about 55% of European firms citing it as a constraint, particularly in Southern Europe. In light of the above, we expect that access to finance is positively correlated with the uptake of more sophisticated climate strategies, where firms have invested in climate measures and set targets and further investment plans.

The EIB Investment Survey (2021, 2022) also recognises uncertainties about regulation and taxation, future technologies and climate change effects as significant obstacles for climate investments. Uncertainty can affect the cost-benefit evaluation of climate investments, which can impede the materialisation of an investment plan (Sandsmark and Vennemo, 2007; EIB, 2021, 2022). In their reports, the EIB (2021, 2022) highlight regulation uncertainty and taxation as particularly limiting, resulting in investment decisions to be postponed or abandoned, as firms opt for a "wait-and-see" approach rather than undertaking a costly action with uncertain consequences (Bloom et al., 2006). This compounds complexity to the monetary evaluation of climate investments, where benefits are typically underestimated and costs highlighted due to the long-term investment horizon associated with climate mitigation and adaptation measures (Sandsmark and Vennemo, 2007; EIB, 2021). In short, investment behaviour tends to become more cautious for firms that perceive uncertainty as an obstacle. This is consistent with several empirical studies (e.g. Bloom et al., 2006; Engau and Hoffmann,

2009). Thus, firms that face uncertainty about future conditions, including their demand, should have less sophisticated climate strategies due to their inertia to invest until they have the complete picture.

Another factor affecting the cost-benefit valuation of climate investments relates to energy costs. Energy-intensive firms may have a stronger incentive to adopt greener profiles and invest in energy efficiency and pollution abatement measures, particularly in countries and sectors with increasingly stringent policies. Indeed, firms in energy-intensive sectors, where energy costs are an important input in their production processes, may opt for green investments to increase productivity and reduce rising regulatory costs from heavy carbon pollution (Clarkson et al., 2015). Stucki (2019) confirms this in his paper, where he reports firms with high energy costs to have productivity increases associated with green investments when opting to invest. While this does not necessarily translate to higher investments in climate, it is an incentive that can positively affect a firm's climate profile. Thus, we expect that firms concerned about energy costs to have more sophisticated climate strategies.

In light of the discussion above, we expect that firms that 1) have adequate access to finance (do not perceive availability to finance as an obstacle), 2) are optimistic about the future (do not perceive uncertainty as an obstacle), and 3) have energy costs concerns adopt more sophisticated climate strategies.

Hypothesis 2: Firms that are optimistic about the future, their demand, access to finance conditions, but have energy cost concerns are more likely to adopt more sophisticated climate strategies.

Innovation can also play a role in a firms' investment decisions. Firms that engage in innovation and knowledge-intensive activities increasingly improve their inventive capacity of developing and incorporating new products and processes (Montresor and Vezzani, 2019). This showcases a firms' capacity to transform and remain competitive in the face of technological advancements and continuous change (EIB, 2022). Accordingly, the EIB (2022) finds that a lack of climate action is likely correlated with a weak capacity to transform. Innovation improves a firm's technological assets and competencies (Kolk and Pinkse, 2005), facilitating the adoption of more complex business strategies. While innovation itself does not translate into climate investments (Smithers and Blay-Palmer, 2001), innovative firms are more likely to uptake new developments and are thus more likely to adopt sophisticated climate strategies.

Hypothesis 3: Innovating firms are more likely to have more sophisticated climate strategies.

External influences can also be determinants of climate strategies (Christmann, 2004; Damert et al., 2017; Yunus, 2017; Cadez et al., 2018). Stakeholder theory posits that a firm's existence and competitiveness depend on the support of its stakeholders, and as a result, firms' strategies must be aligned with their expectations (Yunus, 2017). While there are several stakeholders at play, including customers, suppliers, investors, employees, financial

institutions, the media, the government, the public, among others, their level of influence will depend on the ability of the stakeholder to exert direct pressures upon polluting firms (Cadez et al., 2018). Therefore, it is perhaps unsurprising that regulators are deemed one of the most influential stakeholders given their power and capabilities to establish environmental regulations (Engau and Hoffmann et al., 2009; Yunus, 2017; Cadez et al., 2018). Indeed, stakeholder theory is often closely associated with the regulatory environment the firm operates in, with several studies (e.g., Kolk and Pinkse, 2007; Damert et al., 2017; and Yunus, 2017) reporting a positive relationship between climate regulation and corporate climate strategies. Based on a study of over 500 businesses in the chemical industry, Christmann (2004) reports that government pressure contributed to multinationals setting relatively high environmental performance standards. Similarly, Damert et al. (2017) find that regulatory pressure positively affects the uptake of corporate initiatives to reduce emissions.

In addition to the government, the public has become an increasingly important stakeholder in the case of climate change action (Kolk and Pinkse, 2007; Yunus, 2017; Cadez et al., 2018). While consumers and the general public do not have the coercive ability that regulators do, they can still exert pressure on firms through economic transactions (Cadez et al., 2018). There is also a reputational risk, which has become increasingly apparent with the rise of social awareness on climate change and green consumerism (Yunus, 2017). In her study, Yunus (2017) examines the drivers behind corporate carbon strategies, including the role of different stakeholder pressures in Australia. While the author does not find a statistically significant relationship between regulatory pressure and carbon management strategies, she does report a significant relationship between greener carbon strategies and secondary stakeholders, including the media and the public (ibid, 2017). Hjelmqvist (2020) also indicates a positive association between stakeholder pressure arising from citizens and the adoption of greener corporate climate strategies based on a qualitative study in Sweden. Accordingly, meeting expectations from key stakeholders, including the public, has become more of a baseline for Swedish companies to remain competitive (ibid, 2020).

Besides the "outside-in" effect exercised by stakeholders outside of the firm, existing literature also identifies internal stakeholder pressures as a potential driver for carbon management strategies (Damert et al., 2017; Yunus, 2017; Hjelmqvist, 2020). In the "inside-out" perspective, the locus of strategic responses to climate change is located inside a company and generally comprises management and non-management employees, who are associated with the success of firm strategies (Yunus, 2017). In general, staff dedicated to climate and ESG matters can improve information asymmetries about climate needs and related investments and, in turn, encourage climate investments. In their report, the EIB (2021) suggests a positive association between implementing measures to improve access to information about climate needs and investment in climate-related measures, including having dedicated climate staff members. Accordingly, 65% of firms that employed climate staff invested in climate measures, much higher than the 39% of firms that invested without a dedicated employee (2021). In her thesis, Hjelmqvist (2020) also explores this relationship and finds there is an inside-out push towards corporate environmental initiatives. Employees'

behaviours, communicated preferences and expertise may add to the firms' stakeholder orientation and influence their corporate social responsibility framework (ibid, 2020). Under this perspective, firms with dedicated climate staff are expected to adopt more sophisticated carbon strategies.

In line with previous research on stakeholder theory, we thus expect that firms that feel a push from relevant stakeholders have more sophisticated climate strategies. In the case of regulatory pressure and the public, this is considered an outside-in effect. Meanwhile, it is deemed an inside-out effect by the firm's internal staff.

Hypothesis 4: Firms that feel a push from various stakeholders, i.e., governments, citizens, and employees, are more likely to adopt more sophisticated climate strategies.

3. Data, variable measurement, and methodology

3.1 Data

The analysis in this paper is based on a sample of more than 12,500 firms for the year 2020. The data comes from the annual European Investment Bank Group Survey on Investment and Investment Finance (EIBIS). Conducted since 2016, EIBIS is an EU-wide survey that gathers qualitative and quantitative information on firms' investment activities and financing requirements. EIBIS uses a stratified sampling methodology and is designed to be representative at the EU and country-level and the sectoral and firm size levels. All surveyed firms are sampled from the Bureau van Dijk ORBIS database, and answers are matched with the firm's balance sheets and income statements. The main advantage of the dataset is that it provides unique information on firms' investments to tackle climate change-related risks and other variables that describe the energy profiles and financial positions of firms.

In particular, our analysis considered the information provided by the EIBIS related to investments already made to tackle the impact of weather events and deal with the reduction in carbon emissions, as well as planned investments over the next three years for the same purpose. We also use data on firms' perceptions of both climate change risks – physical and transition, the adoption of climate targets and other firm characteristics. This latter includes whether firms are financially constrained, engage in an exporting activity, operate in specific sectors, and are considered SMEs (small-medium enterprises) or large firms.

3.2 Dependent variable measurement

To investigate our main testing hypotheses, first, we construct a variable representing the climate strategies of the EU firms, considering the existing literature (Everitt et al., 2011). Since this is not directly observable, we employ a clustering technique based on investments made and plans to invest in tackling climate change risks, together with the presence of an

energy management system. Through clustering[3], we partition our data into distinct groups based on their similarities. This results in highly similar observations within each cluster and distinct groups being as dissimilar as possible (Kaufman and Rousseeuw, 1990). To calculate similarity among firms, we use Gower's (1971) dissimilarity coefficient extension by Kaufman and Rousseeuw (1990), which allows for mixed-type variables. We then implement a PAM algorithm (Kaufman and Rousseeuw, 1987), which uses a dissimilarity matrix composed of all the pairwise dissimilarity coefficients between observations and partitions the data in k different clusters. In our case, k was set equal to 7.

In clustering, it is essential to determine the number of clusters because it influences the results. Thus, various metrics exist to help choose the number of clusters to be extracted from the analysis. We use the elbow method, an internal validation metric that plots the explained variation as a function of the number of clusters. After calculating the elbow method for clusters ranging from 2 to 7 for the PAM algorithm, we see that in five clusters, the elbow of the curve is observed (Figure 1) which is also confirmed by the silhouette width metric. Figure 2 presents the t-distributed stochastic neighbourhood embedding, or t-SNE, which reduces the three variables in a two-dimensional visualisation of the resulting clusters.

Figure 1. Agglomerative clustering

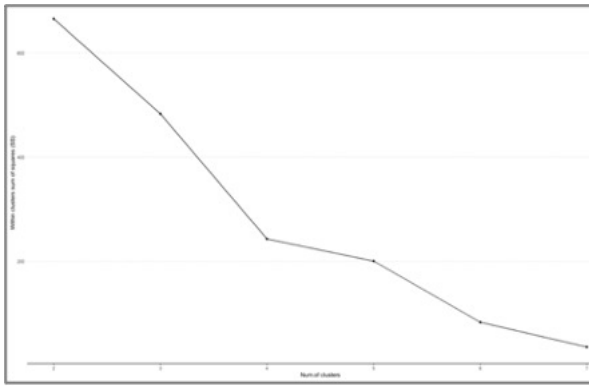
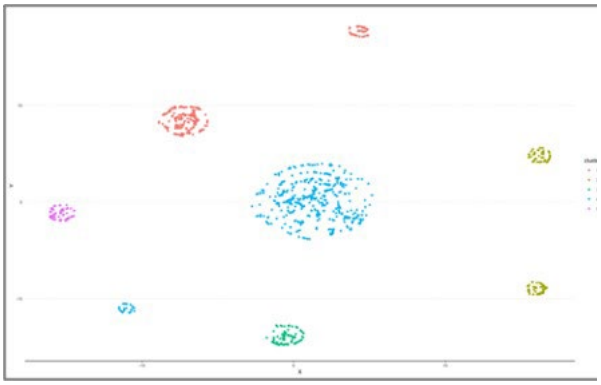


Figure 2. Clustering analysis approach



After running the algorithm in R and selecting the five clusters, we interpret the cluster by calculating their summary statistics (Table 1). Based on these results, we assign each cluster a name for our analysis, as seen in Table 1.

- Cluster 1 corresponds to **wait-and-see observers,** which are firms that remain passive in the face of climate change, and which have not invested in climate measures, do not have any plans to do so in the future and have not set climate targets.
- Cluster 2 corresponds to **planners,** which are firms that have not yet invested in climate measures but have plans to do so in the next three years, and to a minor extent, set climate targets – in this sample, 32% of planners set targets.

[3] Clustering refers to the process of grouping data into clusters, as a result the similarity between the data inside each cluster is maximized, and the similarity between different clusters is minimized.

- Cluster 3 corresponds to **cautious reducers,** which are firms that have invested in climate measures but do not have plans to continue these investments in the future.
- Cluster 4 corresponds to **short-term explorers,** which are firms that have set climate targets and invested in the past. They are perceived to be short-term thinkers because they do not have further plans to continue investing in climate measures in the future.
- Finally, cluster 5 corresponds to **forward-looking explorers,** which follow the most comprehensive strategy with a long-term vision. This group accounts for firms that fulfil the three criteria: they have invested in climate measures, have plans to continue in the future and have set climate targets.

The last two clusters encompass more sophisticated strategies, with firms incorporating at least two of the three more active criteria onto their practices.

Table 1. Identified clusters

Cluster No. / Name	**1**	**2**	**3**	**4**	**5**
	Wait-and-see observers	**Planners**	**Cautious reducers**	**Short-term explorers**	**Forward-looking explorers**
Climate targets	13%	32%	0%	100%	49%
Climate investments	0%	0%	100%	100%	100%
Climate plans	0%	100%	0%	0%	100%
Observations	4309	2038	1012	818	1338

3.3 Explanatory Variables

Table 2 presents the definition and descriptive statistics of the variables used in the subsequent empirical analysis. As most of the variables used are binary, only the unweighted and weighted means based on the value-added by firms are reported. The following discussion is based on weighted values at the country level. This table shows that most (58%) sampled firms perceive physical risks to impact their business. In contrast, fewer firms consider transition risks, with 15% reporting that it will adversely affect their business and 34% considering it positive. As it relates to investment barriers, half of the firms consider uncertainty as a constraint for investments. Low demand, energy costs concerns, and to a lesser extent, availability of finance are considered limitations for about a quarter of the sample. About 42% of firms are innovative. Regarding stakeholder pressures, about one-fifth

of firms have dedicated climate staff. Policy stringency is measured by an index covering the most recent developments in national climate policy frameworks, compiled by a comprehensive qualitative research study by Germanwatch (2019). Countries are ranked based on their climate policy performance. Higher scores indicate a better enabling environment for climate investment. Public pressure is measured by the average number of measures citizens partake in for increased climate action at the country level. Here, the EU average stands at 1.7.

Table 2. Descriptive statistics

Independent variables	Unweighted mean	Weighted mean*	Source
Perception of climate change risks			
Physical risks – Impact vs no impact	55%	58%	EIBIS 2020
Transition impact on demand – positive vs no impact	27%	34%	EIBIS 2020
Transition impact on demand – negative vs no impact	16%	15%	EIBIS 2020
Barriers to investment			
Low demand	23%	25%	EIBIS 2020
Energy cost concerns	20%	24%	EIBIS 2020
Availability of finance	20%	20%	EIBIS 2020
Uncertainty about the future	48%	50%	EIBIS 2020
Innovation			
Innovation	36%	42%	EIBIS 2020
Stakeholder pressure			
Policy stringency at the country level	56%	56%	Germanwatch 2019
Citizen action	1.7	1.7	Climate survey 2020
Climate staff	14%	22%	EIBIS 2020

Note: Weighted mean* represents EU figures weighted by value-added of firms at the country level.

Based on the clustering approach outlined above, the most prevalent climate strategies among European firms are wait-and-see observers and planners, representing 31% and 22% of the sample (see Figure 3). However, these results are mostly driven by Northern and Western Europe, which presents the lowest share of wait-and-see observers in the European

Union and exhibit the largest share of sophisticated strategies in the region. In practice, Central and Eastern Europe and Southern Europe present much higher shares of wait-and-see observers (43% and 36%, respectively). These regions also present the smallest share of sophisticated strategies, particularly Central and Eastern Europe, with 16% forward-looking explorers and 9% cautious reducers. This ultimately indicates regional differences in the adoption of climate strategies.

Figure 3. Firms' climate strategies (in %), by region

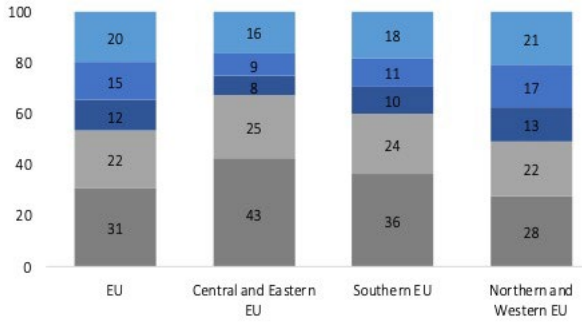


Figure 4. Firm's climate strategies (in %), by sector

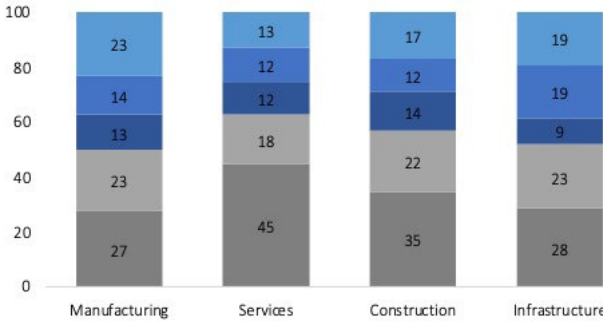
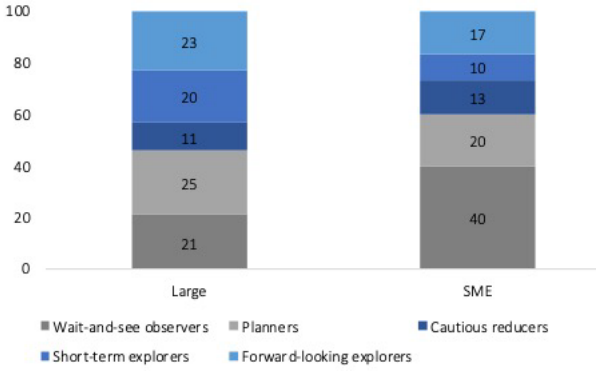


Figure 5. Firms' climate strategies (in %), by size

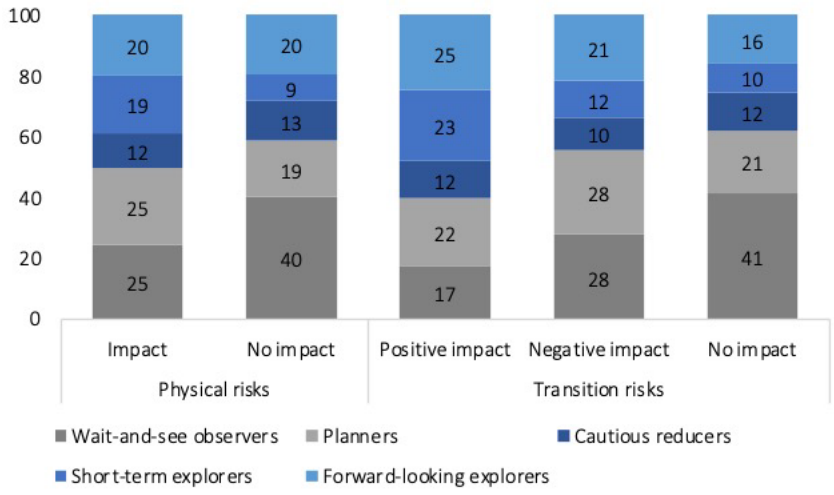


While wait-and-see observers are the most prevalent profile, there are also sectoral differences (Figure 4). Almost half (45%) of firms operating in services belong to this group, compared to a much lower 27% and 28% firms in manufacturing and infrastructure. Similarly, services see the smallest share of forward-looking explorers (13%), whereas it represents 23% and 19% of profiles in the manufacturing and infrastructure sectors, respectively. As it relates to size (Figure 5), SMEs engage less in climate strategies: 40% of SMEs are wait-and-see observers compared to 21% of large firms.

Our preliminary results show that most European firms adopt wait-and-see strategies more than any other type of strategy, which is consistent across regions and sectors. Regarding

climate perceptions, firms that are not aware of physical and transition risks overwhelmingly adopt wait-and-see profiles. According to Figure 6, about 25% of firms that acknowledge physical risks are wait-and-see observers. This figure rises to 40% for firms that do not perceive an impact from physical risks. The same applies to transition risks, where the gap is more pronounced. Firms that do not expect the transition to affect their business activities adopt less active profiles, with 41% being wait-and-see observers. Meanwhile, only 17% of firms that positively perceive the transition to affect their business are wait-and-see observers, and 48% adopt more sophisticated climate strategies (short-term and long-term explorers).

Figure 6. Firms' climate strategies, according to their perception of physical and transition risks



3.4 Methodology

This analysis identifies five corporate climate strategies among EU firms. After considering their characteristics, these strategies are classified as "wait-and-see observers", "planners", "cautious reducers", "short-term explorers", and "forward-looking explorers". These strategies are assumed to depend on a set of geographical and firm-specific characteristics, including the testing hypotheses set out in Section 2:

$$ClimateStrategy_i = \alpha + \beta Perceptions_i + \delta Barriers_i + \theta Inno_i + \rho StakeholderPressure + \varphi \boldsymbol{Z}_i + \varepsilon_i$$

where *ClimateStrategy* is the dependent variable representing the climate strategy of firm i, *Perceptions* represents the perceived physical and transition risks of firm i, *Barriers* represents four distinct variables measuring uncertainty about the future, demand, energy concerns and availability to finance, *Inno* is a dummy variable representing whether the firm innovates, and *StakeholderPressures* is comprised of three variables measuring policy stringency (to account for regulatory pressure), citizen action (to account for public pressures) and climate staff (to

account for employee pressures). ***Z*** is a vector of control variables at the firm level, including advanced management practices, exporting activities, profitability sector, size, age and region. ε represents the error term.

We employ a multinomial model for the econometric analysis, where the different strategies are analysed as alternatives without an implicit order. This model differs according to whether regressors vary across alternatives. Multinomial models are usually estimated by maximum likelihood. Thus, to the extent that models are nested, one can use standard likelihood ratio tests. When models are non-nested, one can use variant Akaike information criteria based on the fitted log-likelihood, with degrees of freedom adjustable for the number of parameters (Cameron and Trivedi, 2005). The estimation of the multinomial logit model is best carried out by utilising the maximum likelihood estimation technique (Greene, 2003). The maximum likelihood estimation technique gives parameter estimates that are asymptotically efficient, consistent, and normal, and the analogue of the regression t-test can be applied.

Let Pr represent the probability of a firm adopting a particular climate strategy, in our case, "wait and see strategy", such that the probability of not following this strategy is given as 1-Pr. Cognizant of the fact that we do not actually observe Pr, as Y is a latent variable, but instead, we observe the outcome Y = 1 if the firm follows an alternative j, say "forward-looking explorer", and Y = 0 if it does not, then we have the following model specification:

$$Pr(Y_i = j|x) = \frac{exp^{[X_i' \beta_j]}}{1 + exp^{[X_i' \beta_2]} + \cdots + exp^{[X_i' \beta_j]}} \; j = 1, 2, \ldots J$$

A positive β coefficient implies that firms attach positive utility to the corresponding characteristic. Here, X is a vector of independent variables, and β is a vector of their respective coefficients. As can be noted from equation 1, Pr ranges from 0 to 1 and is non-linearly related to the regressors and the parameters, thereby causing some estimation problems if the ordinary least squares (OLS) estimation technique is applied.

4. Results and discussion

Empirical results

Tables 3 and 4 summarise the empirical results concerning the potential influencing factors of climate strategies. We present two sets of results for each model: the coefficients of the multinomial logistic regression (Table 3) and the marginal effects (Table 4). In the tables below, model 1 includes explanatory variables: perceptions of climate-related risks, barriers to investment, stakeholders' pressure, and innovation with all controls and no regional effects, whereas model 2 incorporates regional effects[4].

[4] For the full set of results, please refer to the appendix.

Table 3. Logistic regression coefficients of climate strategies

	Outcome									
	(1)					(2)				
Variables	Wait and see observers	Planners	Cautious reducers	Short-term looking explorers	Forward-looking explorers	Wait and see observers	Planners	Cautious reducers	Short-term looking explorers	Forward-looking explorers
Physical Impact		0.499***	0.312***	0.559***	0.594***		0.509***	0.347***	0.601***	0.639***
		(0.0611)	(0.0771)	(0.0910)	(0.0744)		(0.0613)	(0.0776)	(0.0915)	(0.0750)
Transition impact, positive		0.764***	0.566***	1.075***	1.074***		0.740***	0.501***	1.037***	1.026***
		(0.0699)	(0.0895)	(0.0976)	(0.0817)		(0.0702)	(0.0900)	(0.0981)	(0.0822)
Transition impact, negative		0.457***	0.356***	0.490***	0.642***		0.444***	0.321***	0.473***	0.615***
		(0.0819)	(0.105)	(0.125)	(0.0994)		(0.0819)	(0.105)	(0.125)	(0.0996)
Demand concerns		-0.194***	-0.220**	-0.385***	-0.133		-0.170**	-0.152	-0.348***	-0.0716
		(0.0741)	(0.0952)	(0.112)	(0.0901)		(0.0744)	(0.0957)	(0.113)	(0.0905)
Energy costs		0.303***	0.0242	0.181*	0.289***		0.336***	0.118	0.259**	0.414***
		(0.0733)	(0.0983)	(0.108)	(0.0892)		(0.0747)	(0.100)	(0.111)	(0.0912)
Availability of finance		0.0949	-0.187*	-0.331***	-0.302***		0.117	-0.130	-0.293**	-0.232**
		(0.0748)	(0.101)	(0.119)	(0.0983)		(0.0752)	(0.102)	(0.120)	(0.0988)
Uncertainty about the future		-0.146**	-0.0988	0.0546	-0.402***		-0.122*	-0.0456	0.0714	-0.328***
		(0.0644)	(0.0820)	(0.0932)	(0.0779)		(0.0652)	(0.0833)	(0.0943)	(0.0788)
Citizen pressure		1.267***	3.502***	2.524***	2.703***		0.708*	1.997***	1.574**	1.897***
		(0.359)	(0.481)	(0.558)	(0.452)		(0.386)	(0.531)	(0.612)	(0.507)
Policy stringency (Germanwatch)		-0.307**	-0.164	0.815***	-0.0103					
		(0.129)	(0.165)	(0.188)	(0.154)					
Climate staff		0.836***	-0.0434	1.894***	1.613***		0.808***	-0.123	1.832***	1.549***
		(0.0959)	(0.150)	(0.106)	(0.0960)		(0.0964)	(0.150)	(0.107)	(0.0969)
Innovation		0.297***	0.167**	0.149*	0.417***		0.290***	0.155**	0.151*	0.419***
		(0.0605)	(0.0777)	(0.0882)	(0.0723)		(0.0605)	(0.0778)	(0.0883)	(0.0725)
Low-income / Modernisation Fund										
Constant		-3.177***	-8.076***	-7.664***	-6.651***		-2.465***	-5.939***	-5.942***	-5.504***
		(0.610)	(0.840)	(0.975)	(0.780)		(0.657)	(0.919)	(1.052)	(0.871)
Observations	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region effects	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Standard errors in parantheses; *** p<0.01, **p<0.05, * p<0.1; controls variables include advanced management practices, exporting activities, profitability sector, size and age.

The coefficients in Table 3 show the effect of the explanatory variables on the marginal utility of the climate strategy under consideration relative to the reference, in our case, the "wait and see strategies". The statistical significance of a coefficient indicates the extent to which the corresponding explanatory variable affects the marginal utility of the relevant climate strategy relative to the base strategy, as defined above. Estimates with a negative sign imply the preference for the base strategy. To assess the simultaneous effect of the explanatory variables on the probabilities of the five distinct climate strategies, we calculate the marginal effects, which are presented in Table 4. The estimated parameters show the impact of the explanatory variables on the probability of undertaking the climate strategy under consideration.

The positive and highly significant coefficients on perceptions in Table 3 suggest the preference for the alternative strategies compared to the "wait and see" strategies. This implies that ceteris paribus, the more aware firms are of climate change risks, the more likely firms will be concerned about their impacts on their business activities. Hence, the more likely they will choose to go ahead with more sophisticated climate strategies.

Table 4. Marginal effects of climate strategies

	Marginal effects									
	(1)					(2)				
Variables	Wait and see observers	Planners	Cautious reducers	Short-term looking explorers	Forward-looking explorers	Wait and see observers	Planners	Cautious reducers	Short-term looking explorers	Forward-looking explorers
Physical Impact	-0.121***	0.0539***	0.00515	0.0201***	0.0422***	-0.128***	0.0530***	0.00734	0.0221***	0.0457***
	(0.0118)	(0.00983)	(0.00716)	(0.00540)	(0.00758)	(0.0119)	(0.00990)	(0.00715)	(0.00544)	(0.00754)
Transition impact, positive	-0.201***	0.0642***	0.00717	0.0452***	0.0848***	-0.193***	0.0650***	0.00270	0.0445***	0.0804***
	(0.0127)	(0.0118)	(0.00830)	(0.00729)	(0.0101)	(0.0129)	(0.0119)	(0.00820)	(0.00733)	(0.0100)
Transition impact, negative	-0.118***	0.0421***	0.00781	0.0152*	0.0527***	-0.113***	0.0424***	0.00531	0.0150*	0.0500***
	(0.0153)	(0.0144)	(0.0102)	(0.00865)	(0.0126)	(0.0154)	(0.0145)	(0.0100)	(0.00869)	(0.0125)
Demand concerns	0.0516***	-0.0191	-0.0118	-0.0179***	-0.00290	0.0408***	-0.0190	-0.00692	-0.0171***	0.00217
	(0.0147)	(0.0118)	(0.00850)	(0.00601)	(0.00943)	(0.0148)	(0.0119)	(0.00869)	(0.00612)	(0.00956)
Energy costs	-0.0566***	0.0425***	-0.0114	0.00362	0.0218**	-0.0743***	0.0403***	-0.00599	0.00619	0.0338***
	(0.0147)	(0.0126)	(0.00867)	(0.00671)	(0.00996)	(0.0148)	(0.0128)	(0.00903)	(0.00704)	(0.0105)
Availability of finance	0.0253*	0.0368***	-0.0141	-0.0178***	-0.0303***	0.0150	0.0369***	-0.0104	-0.0170***	-0.0245***
	(0.0153)	(0.0130)	(0.00890)	(0.00633)	(0.00921)	(0.0154)	(0.0131)	(0.00908)	(0.00646)	(0.00941)
Uncertainty about the future	0.0426***	-0.0122	-0.000513	0.0104*	-0.0404***	0.0323**	-0.0119	0.00285	0.0101*	-0.0333***
	(0.0127)	(0.0105)	(0.00766)	(0.00571)	(0.00807)	(0.0129)	(0.0107)	(0.00776)	(0.00581)	(0.00811)
Citizen pressure	-0.552***	0.0111	0.254***	0.0914***	0.195***	-0.338***	-0.00915	0.139***	0.0584	0.150***
	(0.0718)	(0.0593)	(0.0449)	(0.0343)	(0.0477)	(0.0776)	(0.0645)	(0.0501)	(0.0381)	(0.0538)
Policy stringency (Germanwatch)	0.0156	-0.0640***	-0.0144	0.0595***	0.00320					
	(0.0256)	(0.0211)	(0.0155)	(0.0114)	(0.0162)					
Climate staff	-0.250***	0.0268*	-0.0645***	0.127***	0.161***	-0.240***	0.0295**	-0.0670***	0.124***	0.153***
	(0.0150)	(0.0141)	(0.00801)	(0.0115)	(0.0136)	(0.0154)	(0.0143)	(0.00781)	(0.0116)	(0.0136)
Innovation	-0.0694***	0.0335***	0.00124	-0.000504	0.0352***	-0.0682***	0.0326***	0.000172	-0.000129	0.0355***
	(0.0119)	(0.01000)	(0.00725)	(0.00535)	(0.00784)	(0.0119)	(0.0100)	(0.00722)	(0.00539)	(0.00780)
Constant										
Observations	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region effects	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Standard errors in parantheses; *** p<0.01, **p<0.05, * p<0.1; controls variables include advanced management practices, exporting activities, profitability sector, size, and age.

The marginal effects bring out some interesting points (Table 4). The econometric analysis confirms the descriptive results by indicating that firms that are more aware of the risks of climate change are more likely to have more sophisticated climate strategies (i.e., forward-looking, and short-term explorers). For example, we observe that firms that feel a climate change impact and see the energy transition with a positive view are about 4 and 8 percentage points (pp.) more likely to adopt forward-looking strategies. Interestingly, firms

that view the transition as an opportunity are also more likely to be forward-looking and short-term explorers and invest in climate than those that view the transition negatively and those that only acknowledge physical risks. By contrast, firms that do not perceive risks from climate change or do not see the energy transition as an opportunity are 12 and 20 pp. more likely to adopt wait-and-see strategies. Thus, hypothesis 1 is supported, and firms that acknowledge climate risks are more likely to adopt more sophisticated climate strategies. In addition, the results suggest that this effect is the most pronounced for firms that perceive the energy transition as an opportunity.

The econometric analysis also shows intuitive results corresponding to the variables measuring barriers to investment. Our results indicate that concerns over demand, availability of finance, uncertainty and energy costs play a role in the uptake of climate strategies, as they affect the valuation assessment of investments. Regarding demand concerns, Table 4 reports highly significant and positive coefficients for wait-and-see strategies in both specifications. Accordingly, firms that are concerned about demand are more likely to adopt a wait-and-see approach. By contrast, firms experiencing demand concerns are less likely to adopt short-term looking strategies. We find similar results with respect to uncertainty. Here, we observe that firms that perceive uncertainty as an obstacle are 4 pp. less likely to be forward-looking explorers and are 4 pp. more likely to opt for a wait-and-see approach.

The coefficients on the presence of financial constraints (availability of finance) are negative and highly relevant for more sophisticated strategies in Table 4, indicating that lack of financial resources possibly restrict firms' climate strategy. Ceteris paribus, not financially constrained firms are more likely to choose forward-looking strategies. In comparison, financial resources appear not to affect the cautious reducers. This suggests that the availability of funds affect more long-term investment strategies than short-run ones.

By contrast, firms experiencing energy costs concerns are more likely to favour strategies other than wait-and-see observers, in specific planners and forward-looking explorers. When looking at the marginal effects, it seems that energy-intensive firms are about 6 pp. less likely to adopt wait-and-see strategies, and instead are 2 pp and 4 pp more likely to become forward-looking explorers and planners, respectively. This is in line with the literature and the notion that firms with significant energy costs are more strongly incentivised to adopt more climate-friendly profiles and engage in climate investments for improved productivity and maintaining their competitiveness (Kalantzis and Niczyporuk, 2022).

Overall, hypothesis 2 is partially supported. Firms that perceive access to finance, uncertainty and demand as obstacles are more likely to adopt less sophisticated climate strategies and adhere to a wait-and-see approach. Meanwhile, firms with high energy costs are less inclined to be wait-and-see observers.

The coefficients on innovation are highly significant in Table 3, and their positive signs suggest a lower preference for the wait and see strategy, as opposed to other strategies. According to the marginal effects (Table 4), the probability of adopting a forward-looking or a planner profile is positively and significantly affected by 3.5 pp and 3.3 pp, respectively. The opposite

(6.9 pp) holds for wait-and-see strategies, whose coefficient is negative. Congruent with the literature on innovation and transformative capacity, these results confirm that firms with innovative activities follow more active climate strategies. Therefore, hypothesis 3 is supported.

The results also suggest that there are pressures arising from climate staff, citizens, and to a lesser extent, regulators towards more sophisticated climate strategies. For example, firms with dedicated climate staff are less likely to adopt a wait-and-see approach by 2.5 pp. At the same time, they are simultaneously more likely to adopt more sophisticated climate strategies. The magnitude of effect also increases in size with the complexity of the profile, i.e., firms with climate staff are 12 pp and 16 pp more likely to adopt short-term and forward-looking profiles, indicating the existence of an inside out push. As it relates to outside-in pressures, firms that face public pressure are also less likely to be wait-and-see observers and more likely to adopt more sophisticated climate strategies. Albeit a smaller magnitude of effect, the same applies to firms with stringent climate environments, where the more rigid the regulatory framework, the more likely firms adopt short-term looking strategies. However, it is worth noting that we do not find statistically significant coefficients for wait-and-see observers and forward-looking explorers. Thus, while evidence supports an outside-in push for citizens to adopt more sophisticated strategies, our results partially support hypothesis 4 when considering regulatory pressures.

Regional effects are captured by dummy variables region and country. The results, shown in the appendix, show that firms in Northern and Western European countries are more likely to favour more active climate profiles, while firms in central Eastern Europe are the least likely to do so. This regional difference possibly reflects differences in the stringency of climate policies.

Turning now to industry-specific factors, the results suggest that firms with an important cost input are more encouraged to adopt more active climate profiles. For example, firms in the infrastructure and manufacturing sectors are more likely to be forward-looking explorers than firms operating in services and construction. Ceteris paribus, firms that operate in the construction sector are more likely to follow wait-and-see strategies than any other sector. Similarly, we observe that SMEs are more likely to adopt a wait-and-see profile than a forward-looking one.

5. Conclusions and policy implications

Existing research has increasingly focused on identifying and describing the different corporate climate strategies based on qualitative studies on the scope of carbon management activities and initiatives by the firm (e.g., Kolk and Pinkse, 2005, Weinhofer and Hoffmann, 2008; Lee, 2011). At the same time, several studies have examined factors influencing climate investments, with a focus on physical climate perceptions (e.g., Bryan et al. 2009; Hoffmann et al., 2009; Sullivan and White; 2019), financial constraints (e.g., Girma et al., 2008; Bryan et al., 2009; Akiana, 2021) and stakeholder pressures. Building upon previous research, we

combine these two streams of literature to first identify firms' climate strategies based on a clustering analysis and then investigate the associated characteristics of the identified climate profiles with a multinomial logit model. To this end, we use unique data from the EIB Investment Survey on European firms for the year 2020.

Our clustering analysis indicates that five types of climate strategies are employed by EU firms: "wait-and-see observers", "planners", "cautious reducers", "short-term explorers", and "forward-looking explorers". In line with our priors, our evidence suggests that climate risk perceptions are positively correlated with adopting more sophisticated climate strategies, e.g., short-term, and forward-looking explorers. This effect is particularly large for those firms that view the transition as an opportunity. This produces new evidence on the role of transition risks' perceptions in climate strategies. Thus far, literature showed that firms that face physical risks, as reflected by extreme weather events, are incentivised to follow climate-friendly strategies. Our study confirms this relationship and additionally shows that firms that acknowledge transition risks and especially opportunities that arise from the transition to a low-carbon future are even more likely to proceed with more sophisticated climate profiles. Not only does this shed light on the importance of transition risks, but also underlines the need of firms to incorporate transition risks in their decision-making.

Our econometric analysis also shows that the various climate strategies are closely related to the country and sector that firms operate in and their size. First, we find that firms in countries where there is a strong push for climate action either by the government or by its citizens tend to adopt more climate-friendly strategies. Likewise, large, and energy-intensive firms that operate in the manufacturing and infrastructure sectors appear to implement more sophisticated strategies than SMEs and firms operating in the services and construction sectors. Innovation is also correlated with more sophisticated climate strategies.

As it relates to investment barriers, the analysis confirms that concerns over demand, availability of finance, uncertainty and energy costs play a role in the uptake of climate strategies, as they affect the valuation assessment of investments. Accordingly, firms that are financially constrained, and are uncertain about the future and demand are less likely to adopt climate-friendly strategies. The same applies to those with no energy costs concerns. Overall, the empirical evidence from the EU firms is generally consistent with the existing literature on the choice of climate strategies.

Our findings are valuable as they can guide policymakers to support firms' transformation processes in the transition. First, it allows policymakers to understand some of the drivers and potential influencing factors behind more sophisticated climate strategies, which can be used to further incentivize firms. Based on the results on climate perceptions, 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, countries and various actors, the effectiveness of the policy response is in danger, and climate action is stalled (Kalantzis et al., 2021). Potential support could, for example, include intensively addressing the topic or providing research and information such as improved climate forecasting (Scott and McBoyle, 2007).

Understanding the factors associated with climate strategies can also guide policymakers to determine areas of potential support. 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; otherwise, they will lose ground from more forward-looking competitors. In this context, although the benefits from convincing large firms to engage in mitigating activities are greater for the overall climate objectives, there is a higher scope to intervene in SMEs. Our results suggest that SMEs are less informed than large firms, as reflected by green management practices and low adaptation shares. Policymakers should investigate the reasons behind these and identify in which situations support makes economic sense. This support could then be targeted to enhance a firm's ability to adapt in the form of financial support (e.g., tax breaks on mitigation investments, subsidies) or capability building (e.g., technical support, skills training) to mitigate climate change risks.

The latter might be particularly important for small firms and those operating in less energy-intensive sectors, which might not have the additional physical and human capital to implement more climate-friendly strategies. These firms seem to pursue mainly low hanging fruit actions (such as replacing lightbulbs) as part of their investment strategies. The reality is that most SMEs do not have the resources on their own to pursue significant, lasting energy efficiency changes to their business. They do not have specialist energy efficiency departments or managers, do not have the spare capital to invest in the infrastructure needed to maximize energy savings, and simply do not have the time it takes to implement changes to their businesses while they are struggling with the day-to-day tasks required to keep afloat.

There is a large scope for policymakers to disseminate the benefits of implementing more climate-friendly strategies. Exchange of good practices, communication packages and training programs are being implemented in different EU members. These, along with other forms of support could act as a win-win strategy for both firms and the EU. For firms, increased investment in climate could lead to reduced energy cost savings. This would subsequently contribute to closing the investment gap to reach the 2030 climate objectives and ensure their achievement.

In our study, we should note that we investigated the different climate strategies of firms and the role of various factors influencing the adoption of these profiles. Nonetheless, it is important to acknowledge that our study reports correlation and not causality. Understanding what truly drives climate actions at the firm level may help European and national policymakers design policies that are more compatible with firms' incentives and more cost-effective to implement. This study can thus be improved by addressing the endogenous variable problem, enabling us to address questions such as, "Does the fact that larger firms are more likely to take climate actions reflect unmeasured selection or economies of scale?" Although difficult, more data should be collected to illuminate the effects of national policy preferences, perceived local climate and sector vulnerability and national interest groups. In further studies, it is essential in the next step to analyse specific climate actions taken by firms to see why some have been able to move beyond political rhetoric to

concrete actions. Finally, important policy implications can be gleaned by exploring the potential effects of more aggressive sectorial policies on firms' climate actions.

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Appendices

Table A.1. Full set of results, logistic regression coefficients of the determinants of climate strategies

	Outcome														
	(1)					(2)					(3)				
Variables	Wait and see observers	Planners	Cautious reducers	Short-term looking explorers	Forward-looking explorers	Wait and see observers	Planners	Cautious reducers	Short-term looking explorers	Forward-looking explorers	Wait and see observers	Planners	Cautious reducers	Short-term looking explorers	Forward-looking explorers
Physical Impact		0.479***	0.271***	0.503***	0.575***		0.499***	0.312***	0.559***	0.594***		0.509***	0.347***	0.601***	0.639***
		(0.0595)	(0.0753)	(0.0878)	(0.0721)		(0.0611)	(0.0771)	(0.0910)	(0.0744)		(0.0613)	(0.0776)	(0.0915)	(0.0750)
Transition impact, positive		0.756***	0.566***	1.046***	1.042***		0.764***	0.566***	1.075***	1.074***		0.740***	0.501***	1.037***	1.026***
		(0.0684)	(0.0877)	(0.0944)	(0.0792)		(0.0699)	(0.0895)	(0.0976)	(0.0817)		(0.0702)	(0.0900)	(0.0981)	(0.0822)
Transition impact, negative		0.462***	0.381***	0.486***	0.639***		0.457***	0.356***	0.490***	0.642***		0.444***	0.321***	0.473***	0.615***
		(0.0802)	(0.103)	(0.121)	(0.0969)		(0.0819)	(0.105)	(0.125)	(0.0994)		(0.0819)	(0.105)	(0.125)	(0.0996)
Demand concerns		-0.187***	-0.236**	-0.334***	-0.117		-0.194***	-0.220**	-0.385***	-0.133		-0.170**	-0.152	-0.348***	-0.0716
		(0.0725)	(0.0942)	(0.108)	(0.0877)		(0.0741)	(0.0952)	(0.112)	(0.0901)		(0.0744)	(0.0957)	(0.113)	(0.0905)
Energy costs		0.344***	0.0806	0.274***	0.335***		0.303***	0.0242	0.181*	0.289***		0.336***	0.118	0.259**	0.414***
		(0.0715)	(0.0961)	(0.104)	(0.0867)		(0.0733)	(0.0983)	(0.108)	(0.0892)		(0.0747)	(0.100)	(0.111)	(0.0912)
Availability of finance		0.0537	-0.238**	-0.396***	-0.394***		0.0949	-0.187*	-0.331***	-0.302***		0.117	-0.130	-0.293**	-0.232**
		(0.0725)	(0.0986)	(0.115)	(0.0951)		(0.0748)	(0.101)	(0.119)	(0.0983)		(0.0752)	(0.102)	(0.120)	(0.0988)
Uncertainty about the future		-0.141**	-0.0989	0.0382	-0.426***		-0.146**	-0.0988	0.0546	-0.402***		-0.122*	-0.0456	0.0714	-0.328***
		(0.0630)	(0.0804)	(0.0903)	(0.0757)		(0.0644)	(0.0820)	(0.0932)	(0.0779)		(0.0652)	(0.0833)	(0.0943)	(0.0788)
Citizen pressure		1.233***	3.682***	2.267***	2.721***		1.267***	3.502***	2.524***	2.703***		0.708*	1.997***	1.574**	1.897***
		(0.347)	(0.468)	(0.536)	(0.435)		(0.359)	(0.481)	(0.558)	(0.452)		(0.386)	(0.531)	(0.612)	(0.507)
Policy stringency (Germanwatch)		-0.329***	-0.228	0.743***	-0.0740		-0.307**	-0.164	0.815***	-0.0103					
		(0.127)	(0.162)	(0.182)	(0.150)		(0.129)	(0.165)	(0.188)	(0.154)					
Climate staff		0.917***	0.0373	2.083***	1.750***		0.836***	-0.0434	1.894***	1.613***		0.808***	-0.123	1.832***	1.549***
		(0.0931)	(0.145)	(0.101)	(0.0925)		(0.0959)	(0.150)	(0.106)	(0.0960)		(0.0964)	(0.150)	(0.107)	(0.0969)
Innovation		0.337***	0.212***	0.304***	0.508***		0.297***	0.167**	0.149*	0.417***		0.290***	0.155**	0.151*	0.419***
		(0.0582)	(0.0747)	(0.0837)	(0.0689)		(0.0605)	(0.0777)	(0.0882)	(0.0723)		(0.0605)	(0.0778)	(0.0883)	(0.0725)
Constant		-3.402***	-7.898***	-7.078***	-6.769***		-3.177***	-8.076***	-7.664***	-6.651***		-2.465***	-5.939***	-5.942***	-5.504***
		(0.563)	(0.769)	(0.886)	(0.714)		(0.610)	(0.840)	(0.975)	(0.780)		(0.657)	(0.919)	(1.052)	(0.871)
Observations	8,929	8,929	8,929	8,929	8,929	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686
Controls	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region effects	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.2. Full set of results, marginal effects of the determinants of climate strategies

	Marginal effects														
	(1)					(2)					(3)				
Variables	Wait and see observers	Planners	Cautious reducers	Short-term looking explorers	Forward-looking explorers	Wait and see observers	Planners	Cautious reducers	Short-term looking explorers	Forward-looking explorers	Wait and see observers	Planners	Cautious reducers	Short-term looking explorers	Forward-looking explorers
Physical Impact	-0.114***	0.0512***	0.00217	0.0188***	0.0422***	-0.121***	0.0539***	0.00515	0.0201***	0.0422***	-0.128***	0.0530***	0.00734	0.0221***	0.0457***
	(0.0114)	(0.00945)	(0.00698)	(0.00565)	(0.00746)	(0.0118)	(0.00983)	(0.00716)	(0.00540)	(0.00758)	(0.0119)	(0.00990)	(0.00715)	(0.00544)	(0.00754)
Transition impact, positive	-0.199***	0.0623***	0.00785	0.0469***	0.0817***	-0.201***	0.0642***	0.00717	0.0452***	0.0848***	-0.193***	0.0650***	0.00270	0.0445***	0.0804***
	(0.0123)	(0.0114)	(0.00810)	(0.00750)	(0.00984)	(0.0127)	(0.0118)	(0.00830)	(0.00729)	(0.0101)	(0.0129)	(0.0119)	(0.00820)	(0.00733)	(0.0100)
Transition impact, negative	-0.119***	0.0412***	0.0101	0.0157*	0.0521***	-0.118***	0.0421***	0.00781	0.0152*	0.0527***	-0.113***	0.0424***	0.00531	0.0150*	0.0500***
	(0.0149)	(0.0139)	(0.0101)	(0.00903)	(0.0125)	(0.0153)	(0.0144)	(0.0102)	(0.00865)	(0.0126)	(0.0154)	(0.0145)	(0.0100)	(0.00869)	(0.0125)
Demand concerns	0.0495***	-0.0181	-0.0138*	-0.0162**	-0.00140	0.0516***	-0.0191	-0.0118	-0.0179***	-0.00290	0.0408***	-0.0190	-0.00692	-0.0171***	0.00217
	(0.0143)	(0.0114)	(0.00828)	(0.00642)	(0.00937)	(0.0147)	(0.0118)	(0.00850)	(0.00601)	(0.00943)	(0.0148)	(0.0119)	(0.00869)	(0.00612)	(0.00956)
Energy costs	-0.0691***	0.0443***	-0.00859	0.00887	0.0245**	-0.0566***	0.0425***	-0.0114	0.00362	0.0218**	-0.0743***	0.0403***	-0.00599	0.00619	0.0338***
	(0.0141)	(0.0121)	(0.00853)	(0.00721)	(0.00990)	(0.0147)	(0.0126)	(0.00867)	(0.00671)	(0.00996)	(0.0148)	(0.0128)	(0.00903)	(0.00704)	(0.0105)
Availability of finance	0.0407***	0.0338***	-0.0158*	-0.0214***	-0.0373***	0.0253*	0.0368***	-0.0141	-0.0178***	-0.0303***	0.0150	0.0369***	-0.0104	-0.0170***	-0.0245***
	(0.0148)	(0.0124)	(0.00852)	(0.00647)	(0.00878)	(0.0153)	(0.0130)	(0.00890)	(0.00633)	(0.00921)	(0.0154)	(0.0131)	(0.00908)	(0.00646)	(0.00941)
Uncertainty about the future	0.0438***	-0.0101	-0.000211	0.0103*	-0.0437***	0.0426***	-0.0122	-0.000513	0.0104*	-0.0404***	0.0323**	-0.0119	0.00285	0.0101*	-0.0333***
	(0.0124)	(0.0101)	(0.00746)	(0.00598)	(0.00796)	(0.0127)	(0.0105)	(0.00766)	(0.00571)	(0.00807)	(0.0129)	(0.0107)	(0.00776)	(0.00581)	(0.00811)
Citizen pressure	-0.552***	0.00204	0.271***	0.0791**	0.200***	-0.552***	0.0111	0.254***	0.0914***	0.195***	-0.338***	-0.00915	0.139***	0.0584	0.150***
	(0.0689)	(0.0566)	(0.0433)	(0.0356)	(0.0467)	(0.0718)	(0.0593)	(0.0449)	(0.0343)	(0.0477)	(0.0776)	(0.0645)	(0.0501)	(0.0381)	(0.0538)
Policy stringency (Germanwatch)	0.0244	-0.0630***	-0.0192	0.0604***	-0.00267	0.0156	-0.0640***	-0.0144	0.0595***	0.00320					
	(0.0248)	(0.0204)	(0.0151)	(0.0119)	(0.0160)	(0.0256)	(0.0211)	(0.0155)	(0.0114)	(0.0162)					
Climate staff	-0.276***	0.0199	-0.0653***	0.152***	0.169***	-0.250***	0.0268*	-0.0645***	0.127***	0.161***	-0.240***	0.0295**	-0.0670***	0.124***	0.153***
	(0.0137)	(0.0131)	(0.00751)	(0.0119)	(0.0132)	(0.0150)	(0.0141)	(0.00801)	(0.0115)	(0.0136)	(0.0154)	(0.0143)	(0.00781)	(0.0116)	(0.0136)
Innovation	-0.0861***	0.0329***	0.00189	0.00832	0.0430***	-0.0694***	0.0335***	0.00124	-0.000504	0.0352***	-0.0682***	0.0326***	0.000172	-0.000129	0.0355***
	(0.0113)	(0.00946)	(0.00692)	(0.00558)	(0.00762)	(0.0119)	(0.01000)	(0.00725)	(0.00535)	(0.00784)	(0.0119)	(0.0100)	(0.00722)	(0.00539)	(0.00780)
Constant															
Observations	8,929	8,929	8,929	8,929	8,929	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686	8,686
Controls	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region effects	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

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