

The Importance of Climate Risks for Institutional Investors

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ABSTRACT

According to our survey regarding climate-risk perceptions, institutional investors believe these risks have financial implications for their portfolio firms and that the risks have already begun to materialize, particularly regulatory risks. Many of the investors, especially the long-term, larger and ESG-oriented investors, consider risk management and engagement, rather than divestment, to be the better approach for addressing climate risks. Although the investors believe that some equity valuations do not fully reflect climate risks, their perceived overvaluations are not large. In addition, a widespread view exists that climate-risk disclosure needs improvement.

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Climate risks, that is, the exposure to risks related to climate change, potentially have large effects on corporations, transmitting those risks to their institutional investor owners and correspondingly, affecting the outcomes for the institutional investors' clients, shareholders, or pension beneficiaries. Among others, academicians and policy makers argue that climate risks can adversely affect the values of assets managed by institutional investors, especially long-term institutions.¹ These risks pose severe problems because market participants, including institutional investors, find them difficult to price and hedge, possibly because of their systematic nature, a lack of disclosure by portfolio firms, challenges in finding suitable hedging instruments, and the fact that the primary types of climate risks (physical, regulatory and technological) have different characteristics but are not independent.² In addition, although many focus on the negative influences of climate change, it can also provide potential investment opportunities.

Institutional investors increasingly address issues related to climate risks, including joining together in organizations such as Climate Action 100, the Portfolio Decarbonization Project, the Global Investor Coalition on Climate Change, and CDP. For example, CDP, which collects data on how firms manage risks related to climate change, has support from investors representing over \$100 trillion in assets under management. In addition, some investors focus on divestments to mitigate their climate risks. For example, a number of university endowments and foundations have excluded fossil fuel companies to combat climate change. Given their prominent position as large shareholders, institutional investors are also increasingly viewed as catalysts driving firms to reduce emissions and to prepare for a low-carbon economy (Andersson, Bolton, and Samama 2016b; OECD 2017).

Despite the importance of climate change, there is little systematic knowledge on the role of climate risks for institutional investors. The goal of this paper is to use a global survey of a broad base of

¹ See, for example, Andersson, Bolton, and Samama (2016a), Bansal, Kiku, and Ochoa (2017), Daniel, Litterman, and Wagner (2017), Giglio et al. (2018), European Commission (2018), and Carney (2015).

² See Barnett, Brock, and Hansen (2018) for the challenges to price uncertainty induced by climate change. Engle et al. (2018) and Andersson, Bolton, and Samama (2016a) discuss strategies to hedge climate risks.

institutional investors to elicit these investors' views and actions related to climate risks. Our 439 respondents should be knowledgeable about the role of climate risks for their institutions, as one-third hold executive level positions in their institutions. Further, the sample includes 48 respondents from institutions with more than \$100bn in assets under management.³ This sizeable representation of very large investors is useful, because such institutions could have particularly strong influences on their portfolio firms' climate policies. The respondents' institutions are located throughout the world, which allows us to provide a global perspective on the role of climate risks.

Our survey addresses five key areas: the role of climate risks in investment decisions; climate-risk management; shareholder engagement related to climate risks; the implications of climate risks for asset pricing; and investors' views on firms' climate-risk disclosures. With regard to the first set of questions focused on the importance of climate risks, we find that our respondents deem traditional financial risks to be the most important risks they face, followed by operating, governance, and social risks. Climate risks and environmental risks are ranked fifth and sixth, respectively. However, this low relative rank does not imply that climate risks are considered as financially immaterial. The investors responding to our survey believe that climate risks have significant financial implications for portfolio firms.⁴ This concern is also reflected in the investors' climate expectations: the vast majority expect a rise in global temperature by the end of this century, and four in ten even predict an increase that exceeds the Paris two-degree target (UNFCCC 2015). These expectations reflect the possibility of very negative effects on financial assets (Dietz et al. 2016).

We also evaluate the investors' views on the horizons over which they expect climate risks to materialize financially. A major challenge to investors can be the uncertainty of the time horizon (Barnett, Brock, and Hansen 2018; Andersson, Bolton, and Samama 2016a). Even with this potential uncertainty,

³ In total only 133 institutions managed assets exceeding \$100bn by the end of 2016 (Willis Towers Watson 2017).

⁴ Using archival data, a number of recent papers address the financial materiality of climate risk for asset values (Baldauf, Garlappi, and Yannelis 2018; Bernstein, Gustafson, and Lewis 2018; Flammer 2018; Giglio et al., 2018; Murfin and Spiegel 2018) and firm performance (Addoum, Ng, and Ortiz-Bobea 2018).

according to our respondents, climate risks are not viewed as a theme of the distant future. Fewer than 10% believe that climate risks will materialize only in ten years or beyond, while 50% state that risks related to climate regulation have already started to materialize.

Considerations of climate risks can arise from both financial and nonfinancial motivations. Purely financial motivations include how climate risks can affect returns and risks. For example, Bénabou and Tirole (2010) put forward the view of “doing well by doing good,” under which investors take a long-term view regarding climate risks and maximize inter-temporal profits. In addition, some argue that climate change results in the stranding of assets, which will lower investors’ portfolio values (Litterman 2013). Others maintain that numerous investors consider climate risks primarily because of more nonfinancial motives. Examples include the preferences of their clients or those of their investment managers (Riedl and Smeets 2017; Hong and Kostovetsky 2012). Some have also put forth regulatory requirements (FIR 2016), peer pressure, or moral obligations. Importantly, our survey shows that no single motivation explains why investors incorporate climate risks into their decisions. Agreement is strongest for three motives: the protection of the investors’ reputations, their moral/ethical considerations, and their legal/fiduciary duties, two of which (protection of reputation and legal/financial duties) have both financial and nonfinancial implications. The next highest-frequency motivations are more purely financial: the ideas that incorporating climate risks into the investment process improves investment returns and reduces portfolio risks.

The second and third key areas of the survey focus on implementation aspects, in particular, risk management and shareholder engagement. A survey is useful to study these topics as many implementation approaches are difficult to detect using archival methods, because they are generally unobservable to the researcher, for example, scenario analyses, hedging activities, and behind-the-scenes engagement practices. Only a small percentage of our investors (7%) have taken no approach to manage

climate risks during the five years preceding the survey.⁵ While large variation exists in the risk-management approaches used, the investors indicate two techniques to be their major approaches: analyses of carbon footprints and stranded asset risks, employed by 38% and 35% of the respondents, respectively. Some of the respondents take these approaches one step further by attempting to reduce their portfolios' carbon footprints (29%) or stranded asset risks (23%). (The flipside of these numbers is that most of the respondents do not use either of these basic approaches to evaluate and manage climate exposures.) A number of investors also use other forms of climate-risk management such as incorporating climate risk into their valuation models (26%) or hedging against climate risk (25%). From the list of 12 possible approaches, the least frequently used tool is the divestment of portfolio firms, which is employed by 20% of the investors. The large heterogeneity across investors suggests that the industry is still in the process of finding the most effective ways to manage climate risks.

Our cross-sectional analyses indicate that institutions more concerned about the financial costs of climate risks use a wider range of tools to manage risks associated with climate change. Additionally, investors with longer horizons also engage in more climate-risk management: medium-term (long-term) investors use 0.9 (1.2) more approaches than short-term investors, a large number relative to the variable's median of three. Institutions with a higher fraction of holdings subject to ESG analysis also generally use a more diverse range of climate-risk-management approaches.

Institutional investors can also mitigate climate risks by engaging with their portfolio firms. Through survey questions we examine the investors' engagement strategies as well as their portfolio firms' responses. We find a generally high level of engagement by our respondent group: only 16% had not taken any actions over the past five years.⁶ The respondents typically use multiple channels to engage over

⁵ However, we note that respondents with more sophisticated tools would have been more likely to participate in the survey.

⁶ This percentage is comparable to the percentage in the McCahery, Sautner, and Starks (2016) survey on shareholder engagement, in which they find that only 19% of the respondents did not engage with their portfolio firms.

climate risks, as more than half of the sample had employed at least three engagement channels. Having discussions with management is cited as the most frequently used channel (43% of respondents used this approach, with 32% proposing specific actions to management on climate-risk issues). Close to 30% of the investors submitted shareholder proposals on climate-risk issues, and a similar fraction voted against management on proposals because of climate-risk concerns. These numbers are consistent with a recent trend of successful votes on climate shareholder proposals submitted to major oil and gas firms.⁷

Most firms responded to the investors' engagements, although a number of the firms simply acknowledged an issue rather than successfully resolving it. Successful engagements are reported by 25% of respondents. If portfolio firms did not respond to engagement or showed resistance, then the investors typically refrained from further actions rather than initiating more engagement, trying to hedge the climate-risk issue or divesting. In fact, divestment was the least used course of action when investors were dissatisfied with firm responses to their engagement (only 17% exited under such circumstances). This observation, together with the low prevalence of divestment for risk management, is interesting in light of the current debate about whether divestment or engagement is more effective in combating climate change, particularly given that divestment is the approach recommended by a number of activists and, as mentioned, followed by many university endowments and foundations.

Investors that are more concerned about the financial effects of climate risks, and those that expect them to materialize earlier, engage firms more intensively. Larger investors also engage firms along more dimensions, possibly because they have more resources to engage and larger firm holdings. The latter reduces free-rider concerns and implies stronger engagement incentives (Dimson, Karakaş, and Li 2018).

Recent theoretical and empirical research suggests that climate risks may be mispriced (Hong, Li, and Xu 2017; Bansal, Ochoa, and Kiku 2017; Daniel, Litterman, and Wagner 2017). To understand the extent

⁷ See "More Shareholder Proposals Spotlight Climate Change," *Wall Street Journal*, February 8, 2018.

to which this research corresponds to investors' perceptions, the survey's fourth section addresses the implications of climate risks for asset pricing. Understanding institutional investors' views is particularly relevant as they likely act as marginal investors, thereby affecting current and future equity prices. We elicit investors' beliefs regarding whether equity markets over- or underprice climate risks. To achieve more meaningful responses we employ a sector-level approach including both directions of mispricing, as climate risks may cause some sectors to be overvalued and others to be undervalued.

We find that the respondents believe that equity valuations do not fully reflect the risks from climate change, although the overvaluations are not perceived as being very large. Not surprisingly, the oil sector is considered as the most overvalued sector overall, followed by traditional car manufacturers and electric utilities. Yet, the misvaluation of these sectors relative to other sectors seems modest.⁸ We find little evidence for a systematic link between the perceived mispricing of climate risks and investor characteristics. Only two characteristics emerge as being relevant. Respondents with a larger share of their portfolios oriented to ESG standards generally see more underpricing of climate risks, and those that engage portfolio firms more intensively also believe that climate risks are more underpriced (which may explain their engagement activities). We also asked whether climate change causes assets in certain sectors to become stranded (Litterman 2013). We find the largest percentages of respondents (25% and 21%) consider this risk to be very high in the coal and unconventional oil producer sectors, respectively.

The last section of the survey focuses on climate-risk disclosure, which has the potential to facilitate the pricing and hedging of climate risks, and may discipline firm behavior. The majority of respondents, 51%, believe that climate-risk reporting is as important as financial reporting, and almost one-third considers it as more important. Many investors state that standardized and mandatory reporting on climate risk is necessary (Krueger, 2015). Our respondents also think that investors should put pressure on firms to

⁸ Nevertheless, even small adjustments can have a large impact in terms of asset values. A 5% market-capitalization correction among the world's ten largest oil firms would imply a \$65bn value loss, based on data from May 2018.

disclose more about climate risks, echoing recent investor initiatives at Exxon Mobil or Occidental Petroleum. Many respondents plan to engage firms to report according to the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), which—under the auspices of the G20 Financial Stability Board—recently published disclosure recommendations for firms and investors (TCFD 2017; Eccles and Krzus 2018). A widespread view also exists that current quantitative and qualitative disclosures are insufficiently precise or informative. Respondents provide indirect support for a French law that requires carbon reporting by institutional investors, as 60% plan to disclose the carbon footprints of their portfolios.

In terms of generalizability of our findings, we should note that our respondent group is likely biased toward investors with a relatively high awareness of climate risks, and possibly with higher credentials in climate-risk management. The reason is that such investors are probably more disposed to participate in a climate-risk survey. In addition, some of our responses were obtained at ESG conferences. Nevertheless, understanding the views and actions of such investors is particularly important, because they are more likely to shape corporate climate policies and to guide future practices of integrating climate issues into investment management.

Our paper contributes to a better understanding of the treatment of climate risks in financial markets. By designing our survey of institutional investors in order to analyze conceptual and empirical questions that are not directly testable through archival research, we contribute to several literatures. We contribute to a better understanding of the uncertainties of pricing of climate risk (e.g., Hong, Li, and Xu 2017; Bansal, Ochoa, and Kiku 2017; Daniel, Litterman, and Wagner 2017) through documenting the importance institutional investors place on climate risks, their forecasts of the probability of temperature changes, their assessments of the relative mispricing in the industrial sectors most exposed to climate risks, and how these attributes are related to investor characteristics. Additionally, we contribute to the literature on risk management, particularly the management of climate-risk exposure (e.g., Andersson,

Bolton, and Samama 2016a; Engle et al. 2018) by showing the extent to which institutional investors use various risk-management techniques and how investor characteristics can explain these behaviors. We contribute to the literature on shareholder engagements on environmental issues (e.g., Dimson, Karakaş, and Li 2015; Hoepner et al. 2018) through our analyses of which investors engage, the engagement channels they use to combat climate risk, and by providing evidence on how firms typically respond to such engagements. Finally, we contribute to the academic literature and debate on climate-risk disclosure (e.g., Eccles and Krzus 2018; Krueger 2015) by detailing institutional investors' views and actions on such disclosures. Overall, our analysis is particularly important because through our survey and cross-sectional analyses we are able to shed light on many investor perspectives and actions that are unobservable.

1. Methodology and Research Design

1.1 Survey Development

Our survey focuses on questions that are difficult to answer based on archival data. Whenever possible, we generated our questions on the basis of theories that make predictions about different aspects of climate risks. The survey instrument is provided in Internet Appendix B. We used an iterative process for developing the survey. As part of this process, we revised the survey based on the feedback from two referees. We also included the feedback from additional academics and practitioners. We then presented the survey instrument at a conference at Columbia University on November 30, 2017. After this event, we further revised the survey based on feedback by a discussant and conference participants. We also ran beta tests with practitioners to ensure the wording and questions are clear. At the end, we had a professional survey designer go over the wording, the ordering of the questions, and the length of the survey. We then programmed an online version with random orderings of response choices. An iterative process in designing a survey has been found to be beneficial (Krosnick and Presser 2010). Surveys are increasingly used in the finance literature, enabling better understandings of such topics as managers' choices in

corporate-finance issues (Graham and Harvey 2001), institutional investor activism (McCahery, Sautner, and Starks 2016), investor relations (Karolyi and Liao 2017), ESG investing (Amel-Zadeh and Serafeim 2018), and barriers to cross-border investing (Harvey et al. 2014).

1.2 Survey Delivery

We used both an online and a paper version of the survey that we distributed through four delivery channels. First, we personally distributed the paper version at four institutional investor conferences: the Sustainable Investment Conference in Frankfurt on November 9, 2017; the ICGN Paris Event on December 6-7, 2017; the Asset Management with Climate Risk Conference at Cass Business School in London on January 23, 2018; and the ICPM Conference in Toronto on June 10-12, 2018. We used the responses from Frankfurt and Paris as beta tests to further improve the design. As a result, some of the questions in the final survey were not included in these beta versions, and some beta questions were dropped eventually. We obtained a total of 72 responses from these four conferences.

Second, we distributed the survey to a list of investment professionals compiled by a survey service provider that manages a global panel of more than 5m registered participants. The panel contains detailed data on individuals' industries, job titles, and age to identify relevant panel subsamples. The service provider has several mechanisms in place to ensure the authenticity of the participants. Based on this panel we identified 1,018 individuals that work in senior functions at institutional investors.⁹ The provider then invited these panelists in March 2018 to participate in the online survey. To encourage participation the panelists received a small gift when filling in the survey (a voucher or donation to charity). We obtained 410 initial responses from this channel. To identify careless responses we applied a set of filters (Meade and Craig 2012). We excluded participants that took less than five minutes to complete the survey, and participants for which basic plausibility checks yielded logical inconsistencies in the responses (e.g.,

⁹ The survey was sent only to individuals aged between 25 and 65 and with the job titles listed in Table 1.

numbers in Question G4 not adding up to 100 as they should). We eliminated 90 responses in this process leaving 320 responses of good quality. These respondents took on average 15 minutes to complete the survey. As we explain further below, we performed internal validity checks on the responses to further verify data quality.

Third, in April 2018, we emailed invitations to participate in the survey to a list of institutional investors that cooperate with a major asset owner on climate-risk topics through CERES and IIGCC.¹⁰ The asset owner ranks among the world's largest investors and wrote a supporting letter on our behalf. We obtained 28 responses through this channel. The investor neither influenced the survey design nor the analysis of responses. It did not get access to the survey responses.

Fourth, we sent invitations to participate in the online survey to personal contacts of the authors who work at different institutional investors, yielding 19 additional responses. In total we received 439 responses across the four delivery channels.

1.3 Respondent Characteristics

We provide an overview of the characteristics for our survey respondents in Table 1. The respondents hold a variety of positions. The largest numbers of respondents are fund/portfolio managers (21%), followed by executive/managing directors (18%). About one-third works at the executive level in their institutions, such as CIO (11%), CEO (10%), or in related functions (10%). Remaining respondents include investment analysts/strategists (16%) and ESG/RI specialists (10%). (The small number of ESG/SRI specialists allows us to obtain a broad perspective on how climate-risks are treated in investment management.) Overall, these positions indicate that our respondents should be knowledgeable about the role of climate risks for their institutions.

¹⁰ CERES is a network of institutional investors with the goal to improve sustainability in areas including climate change, while IIGCC is another important forum for institutions to collaborate on climate-change issues.

Most respondents work for asset managers (23%) and banks (22%), followed by pension funds (17%), insurance companies (15%), and mutual funds (8%). The remaining 15% work for other institutions, including sovereign wealth funds, endowments or hedge funds. Our sample comprises a wide variety of investor sizes. It includes 19% of respondents that work for institutions with less than \$1bn in assets under management, 32% with assets between \$1bn and \$20bn, 23% with assets between \$20bn and \$50bn, and 16% with assets between \$50bn and \$100bn. A total of 48 respondents, or 11%, work for institutions with more than \$100bn in assets.

To understand whether systematic differences exist across investor horizons, we asked the respondents to report the typical holdings periods for their investments. Respondents could classify holding periods into short (less than six months), medium (six months to two years), long (two years to five years), and very long (more than five years). Only 5% of respondents' institutions typically hold investments for less than six months, 38% have medium holding periods, 38% have long holding periods, and the remaining 18% typically hold investments for more than five years (these respondents mostly work for banks, insurance firms, and pension funds). The headquarters of the institutions for which our respondents work are located in different world regions: 32% are in the United States, 17% in the United Kingdom and Ireland, 12% in Canada, 11% in Germany, 7% in Italy, 5% in Spain, and the rest in other parts of the world.

We also collected information on the institutions' investment structures. The average portfolio share that incorporates ESG aspects is 41%, the respondents' institutions invest on average 47% in equities (43% in fixed income), and an average of 38% of their assets are passively invested.¹¹ Finally, we asked which positions at their firms would be responsible for the implementation of climate risks in the investment process (they could indicate more than one). The results indicate that climate risks have

¹¹ Internet Appendix Figure 1 reports investors' portfolio holdings relative to a low-carbon benchmark (Question E4). Our investors seem to be relatively overweight in Financials, Information Technology, and Telecommunications. In unreported tests we find that long-term investors are more underweight in Energy. Relative portfolio holdings are largely unrelated to investor characteristics (not reported). One notable exception is that long-term investors are more underweight in the Energy sector.

become a topic with C-level responsibility at many investors: CIOs are responsible for implementing climate risks at 36%, and CEOs at 23%, of the institutions.

We are confident that in the vast majority of cases we have only one observation per institutional investor. The reason is that, in 87% of the observations, we have sufficient data to determine that none of the following identifying characteristics coincide: location, assets under management, institutional investor type, investor horizon, ESG share (+/-10% variation in the variable), equity share (+/-10%), and passive share (+/-10%). In 9% of the observations we cannot exclude the possibility that respondents work for the same institutional investors, as identifying observations coincide. However, the responses are sufficiently different among these respondents to discount that possibility with some degree of assurance. In the remaining observations we have insufficient information to determine whether characteristics coincide.

Internet Appendix Table 1 compares the respondents' characteristics across distribution channels. Most responses from our personal contacts were ESG specialists, while respondents linked to the asset owner were mostly executive/managing directors. Our conference channel yielded mostly asset managers or pension funds, partially because they were the demographics targeted by the conferences. The panel respondents and those related to the asset owner work in smaller institutions; the panel institutions further have shorter horizons. ESG portfolio shares are largest among the asset owner's partners, reflecting the nature of their cooperation.

1.4 Response Bias

Any survey faces the risk that respondents answer strategically or untruthfully. To mitigate this concern, we guaranteed anonymity and did not ask for names or employers. We emphasized that individual responses are treated confidentially. Based on conversations at the conferences, we learned that participants would not spend time on the survey if they intended to answer untruthfully.

We are unable to fully assess the potential response bias in our sample, such as how our responses would change if we had a random set of investors. However, we can provide some assessment of non-response bias by comparing characteristics of responding investors to those of the population at large, following for example Karolyi and Liao (2017). Internet Appendix Figure 2 shows that pension funds and banks are overrepresented in our sample, while it contains fewer mutual funds and asset managers. Our respondents are more likely to work for institutions in North America and Europe, compared to the universe of investors.

Overall, our respondent group is potentially biased toward investors with a relatively high awareness of climate risks, and with higher credentials in climate-risk management. This outcome is a result of the fact that such investors can be expected to be more disposed to participate in a climate survey, and it is perhaps also due to our delivery methods (especially the conference channel). We also have an oversampling of large investors. However, understanding the views and actions of investors with more sophisticated climate-risk policies and who are larger is particularly important because they are more likely to shape climate-related policies at portfolio companies, and also guide future policies and practices at institutional investors with less developed climate-risk credentials.

2. Climate Risks in the Investment Process

2.1 Expectations for Climate Change

For climate risks to be important in the investment process it is required that the investor believes that climate change represents a risk. Thus, we first examine whether investors view climate change itself as a significant future possibility by asking for their expectations regarding global temperature increases at

the end of the century.¹² We anchored expectations by referring to the two degrees Celsius target of the Paris Climate Accord and then requesting the respondents' own expectations.

Figure 1A reports the respondents' climate expectations and includes the results for the full sample and by world region. Across all respondents to this question, only 3% do not expect any temperature increase, 16% expect an increase by up to one degree, and 30% by up to two degrees. On the other hand, four in ten respondents expect a temperature rise that exceeds the Paris 2 degrees target, with 12% expecting an increase of more than three degrees. Illustrating the consequences of a temperature rise beyond three degrees, Thomas Buberl, CEO of insurer AXA is reported by Bloomberg to have expressed the view that *"If you go much further to 2020, 2030, we can clearly say that at a scenario between 3 and 4 degrees, it's not insurable anymore."*¹³ These expectations suggest that many of our respondents view very damaging climate scenarios to be likely. That is, these extreme expectations indicate that some of our respondents should have deep concerns about the effects of climate change on their portfolios.

Our survey indicates that extreme climate expectations are not confined to one region of the world as might be expected given differences in environmental sensitivities across regions such as between North America and Europe. Notably, similar proportions of respondents from these two regions expect temperature increases above two degrees. In addition, North American respondents have more pessimistic expectations when it comes to the most extreme scenario.

Because of the large uncertainty concerning climate change (Barnett, Brock, and Hansen 2018; Andersson, Bolton, and Samama 2016a), we asked the respondents to detail confidence in their expectations. Figure 1B illustrates their responses to this question. Overall, there exists a large degree of confidence in expectations about global warming given that 45% reported that they are relatively confident

¹² In a related survey, Weitzman (2001) asked economists about climate change to estimate discount rates for environmental projects.

¹³ See "Climate Change Could Make Your Basement Uninsurable in the Next Decade," *Bloomberg*, January 25, 2018.

in their expectations and another 34% are more or less confident. Only 21% lack confidence in their expectations. The figure also indicates heterogeneity in confidence levels across world regions, as the percentage of relatively confident respondents varies between 36% and 51%. Confidence levels are highest among North American respondents. Internet Appendix Table 2 shows that respondents that expect a stronger increase in temperatures also believe that climate change will have larger consequences for firms, which indicates internal validity across responses for some of the key climate variables we collected.

2.2 Importance of Climate Risks

Climate risks can potentially affect the values of assets managed by institutional investors, and recent asset pricing models highlight its importance as a long-run risk factor (Bansal, Ochoa, and Kiku 2017).¹⁴ However, it is unclear to what extent investors consider climate risks to be important in their investment decisions relative to other risks, and even whether they incorporate climate risks into those decisions. Understanding the importance of climate risks as perceived by investors is informative for a number of financial market participants, for example, for regulators setting capital requirements for banks or insurance firms.

In order to first establish a benchmark for the investors' portfolio risk considerations, we asked the survey participants to state the relative importance of six major risks. Respondents could rank these investment decision risks from one (most important risk) to six (least important) (Question A1). Figure 2A shows the percentage of respondents that rank a specified risk as most important as well as each risk's mean importance rank. As the figure illustrates, investors consider financial risks (e.g., earnings, leverage or payout policy) as most important, followed by operating risks (e.g., changes in demand), corporate governance risks, and social risks. Climate risks are ranked fifth, with other environmental risks placing sixth.

¹⁴ In addition, a number of studies have found that firms' environmental policies and actions can affect their cost of capital and market value, for example, Sharfman and Fernando (2008) or Chava (2014). Jagannathan, Ravikumar, and Sammon (2018) detail many of the risks to corporations and investors associated with climate change.

We found that 10% of the respondents consider climate risks as the most important risk. Overall, the ranking across risks appears in line with the focus on traditional investment risks in most of the finance literature and in typical business school curricula. It also reflects that most investors currently concentrate resources in the investment process on risks other than climate risks (Blackrock 2016).

The low relative ranking of climate risks does not imply that the effects of climate change are perceived as financially irrelevant. To understand expectations of the effects of climate risks for portfolio firms, we asked our participants to rate the financial materiality of three sources of climate risks: physical, regulatory, and technological risks (Question A2). Physical climate risks arise because some sectors and companies will face direct costs related to changes in the climate, such as extreme weather or a rise in sea levels. Regulatory risks arise from changes in policies and regulations implemented to combat climate change, such as carbon pricing or cap-and-trade schemes. These risks arise because of the unknowns with regard to the timing of any changes as well as their effects. Technological (or transition) risks arise because of climate-change related innovations that threaten incumbent firms (e.g., electric vehicles may disrupt traditional car manufacturers).

Respondents were asked to rate each of these climate risks on a scale of one (“not at all important”) to five (“very important”). Figure 2B shows that the respondents on average rate the financial consequences of all three risks between “important” and “fairly important.” The effects of regulatory and technological risks are seen as somewhat more important overall than those of physical risks (the differences are statistically significant at the 1% level).

The perception that climate risks matter financially conforms with evidence from studies that use archival data to examine the financial effects of physical climate risks. For example, Baldauf, Garlappi, and Yannelis (2018) and Bernstein, Gustafson, and Lewis (2018) provide evidence that expected sea-level rises affect real estate values. However, their conclusions are not universal as Murfin and Spiegel (2018) reach

the opposite conclusion with their analysis. Addoum, Ng, and Ortiz-Bobea (2018) determine that extreme temperatures affect firm performance, especially through revenues for firms in the consumer sectors. Additional papers examine how fund managers (Kumar, Shashwat, and Wermers 2018) and other investors (Choi, Gao, and Jiang 2018) react to physical climate-risk realizations. Similarly, Gibson Brandon and Krueger (2018) find that institutional investors' environmental policies change after extreme weather events. Further evidence regarding investor responses to climate risks lies in the fact that green bonds have become increasingly important in the financial markets (Baker et al. 2018; Flammer 2018; Tang and Zhang, 2018, Zerbib, 2018).

We expand this segment of the climate-finance literature by evaluating investors' expectations regarding the horizons over which climate risks are expected to materialize. A challenge to investors is that the horizon by which climate risks materialize is highly uncertain (Barnett, Brock, and Hansen 2018). Andersson, Bolton, and Samama (2016a) refer to this as the timing risk of mitigation policies. While it is usually assumed that physical climate risks materialize mostly over the longer term, regulatory risks can have a much shorter time frame. We use our survey to elicit investors' views on the time period over which they consider the climate risks will materialize financially (Question A3).

Figure 2C shows that the respondents believe that climate risks have already become important concerns. Very few respondents, less than 10%, believe that the three components of climate risk will have a delayed materialization of ten years or more. In fact, a majority of the sample agrees that regulatory risks are already important concerns. Fewer investors, but still more than 30%, believe that physical (and technological) risks are relevant now, consistent with the evidence in the research cited earlier. Overall, our numbers indicate that the institutional investor respondents consider climate risks to matter for their short-term as well as their long-term assets. Moreover, their answers are consistent with the arguments of Weitzman (2012) and Barro (2013) that climate change corresponds to disaster risk. As Giglio et al. (2018)

point out, climate change constitutes “*a rare event with potentially devastating consequences for the economy.*” Further, Ilhan, Sautner, and Vilkov (2018) provide evidence consistent with this view, documenting that carbon emissions increase tail risks elicited from two-year options.

The widespread perception that climate risks have begun to materialize raises the question of when, if at all, investors incorporate these risks into their investment processes. Figure 2D shows that more than half of the respondents that incorporate climate risks started to do so within the past five years. A total of 21% incorporated the risks in some form *more than ten years ago*.¹⁵

2.3 Climate-Risk Perceptions and Investor Characteristics

We next evaluate whether perceptions of climate risks vary in the cross-section of our sample investors. Temperature-augmented long-run risk models such as Bansal, Ochoa, and Kiku (2017) imply that climate risks should be a bigger concern for long-term investors, as they are more likely to bear the consequences of adverse climate-risk realizations. In addition, recent research suggests that long-term investors care more about ESG issues (Starks, Venkat, and Zhu 2018), and that environmental issues matter more for investment performance when institutions are long-term oriented (Gibson Brandon and Krueger 2018). These findings imply that long-term investors should be more concerned about climate risks than shorter-term investors. Related evidence comes from Shive and Forster (2018) who document a positive association between firm-level pollution and pressure from short-term investors.

The largest institutional investors—also referred to as universal owners—often own a slice of the world economy through their sizeable holdings. This leaves such investors more exposed to externalities from climate change, causing them to be potentially more concerned about climate risks. Much like the universal owners, other institutional investors with highly-diversified and more passively managed portfolios should also be more exposed to climate risks, as they have less scope to divest assets with large

¹⁵ It should be noted that this number could reflect a high awareness for climate risks among our respondents.

climate-risk exposure. Investors who incorporate ESG factors should also be more concerned about climate risks, given that they explicitly consider environmental risks in their investment processes.

Liang and Renneboog (2017) show that country origins are important determinants of social and environmental policies, as firms from civil-law countries have higher CSR scores than firms from common-law countries. Related evidence on the importance of geographical origins for investors' CSR preferences comes from Dyck et al. (2018). These empirical results imply that investors from Continental Europe (mostly civil law) care more about climate risks than those from North America or the United Kingdom and Ireland (common law).

To test these predictions, we run regressions that use proxies for the perceived importance of climate risks as dependent variables. Table 2 provides the results for the four proxies. The first regression in Column (1) bases the dependent variable on climate risk ranking, that is, each respondent's ranking of climate risks relative to other investment risks where the ranking can vary between one and six in order of ranking importance. In Columns (2) to (4) the dependent variables are based on the respondents' assessments of the materiality of each of the three primary types of climate risks, regulatory, physical, and technological risks. These variables range between one (not at all important) and five (very important). We include a set of independent variables to evaluate the predicted relationships between perceptions of climate risks and investor characteristics. *Medium horizon* (*Long horizon*) equals one if the typical holding period of an investor is between six months and two years (above two years). *Assets under management* takes values depending on the size of the assets, with one (less than \$1bn); two (between \$1bn and \$20bn); three (between \$20bn and \$50bn); four (between \$50bn and \$100bn); or five (more than \$100bn). *ESG share* is the percentage of the investor's portfolio reported as incorporating ESG issues, and *Passive share* is the fraction of the portfolio that is passively invested. We add dummy variables to capture the institutions' locations and type (omitted categories are a North American location and a pension fund).

Examining the coefficient on the investor-horizon variables in Column (1) of Table 2, we find that medium or long term investors do not differ from short-term investors in their perceptions of the importance of climate risks relative to other investment risks. Although investors seem to agree on the relative ranking of climate risks, differences do exist on the financial materiality of the three components of climate risk. Long-term investors find climate risks to be substantially more material than do other investors. Given that the average rankings (as shown in Figure 2B) of these risks are either 3.5 or 3.8, the estimated differences in rankings of around one-half for physical and technological risks are economically material. (The effect for regulatory risks is statistically insignificant.)

We find that large institutions consider physical risks in Column (3) as more financially material, which is consistent with the idea that such investors bear greater costs related to climate change. However, larger investors do not differ from other investors in their assessments of the importance of regulatory and technological risks. Contrary to our prediction, and somewhat surprisingly, European investors see a lower importance for the materiality of climate risks compared to their North American counterparts. As would be expected, institutions with a greater proportion of ESG investments regard physical and technological climate risk as more financially relevant than do other investors.

2.4 Motives for Incorporating Climate Risks

Investors' motivations for incorporating climate risks into their investment decisions can be financial, nonfinancial, or a combination of both. Financial motives include a quest for higher returns (possibly through mitigating the costs of climate change), or lower risks (e.g., lower portfolio and tail risk). Bénabou and Tirole (2010) argue that institutional investors take a long-term view regarding climate risks and seek to maximize inter-temporal profits. This view implies that incorporating climate risks into the investment process is beneficial, because of higher returns or lower risks. Gibson Brandon and Krueger (2018) and Hoepner et al. (2018) use archival data in support of this view, but our survey allows for a more

decisive answer regarding investor motivations through a direct question about the financial merits of incorporating climate risks.

Others argue that institutional investors consider climate risks primarily due to nonfinancial motivations. For example, consideration of climate risks may be a reflection of the investment managers' personal preferences or their perceived moral obligations. Hong and Kostovetsky (2012), for instance, show that political preferences of investment managers predict their investments in socially responsible stocks. A related view, labeled insider-initiated corporate philanthropy, posits that investment managers consider climate risks because it benefits them at the expense of their beneficiaries (Bénabou and Tirole 2010). Further rationales include a combination of financial and nonfinancial motivations, such as regulatory requirements, protecting their reputations, and peer pressure.

We evaluate the relative importance of these non-mutually exclusive motivations through a question (Question A4) in which respondents could indicate their agreement with different possible motives on a scale of one ("strongly disagree") to five ("strongly agree"). Figure 3 reports the percentage of respondents that "strongly agree" with each statement. The figure shows that no single motive strongly dominates over the others. Agreement is generally strongest for two motives: the protection of the investor's reputation (30% strongly agree to this motive) and moral/ethical reasons to consider climate risks (27.5%). Institutions also tend to agree with the motive of incorporating climate risks due to a legal obligation/fiduciary duty (27%). Purely financial motives also score relatively high, especially the idea that incorporating climate risks is beneficial to returns (25% strongly agree) and reducing portfolio risk (24%) or tail risk (21%).

In Table 3 we employ regressions to evaluate whether the investors' tendencies to agree with motives that are more financial or more nonfinancial are related to investor characteristics. To aggregate investor motives we create two indexes: *Financial motives* averages the responses on the three statements

about considering climate risks because of higher returns, lower portfolio risk, and lower tail risk; and *Nonfinancial motives* averages the responses to the remaining eight motives that include more nonfinancial aspects. We caution that this distinction is not clear-cut as some nonfinancial motives might have indirect financial benefits too (e.g., a higher climate-risk reputation may lead to larger fund inflows). Both indexes range between one and five, with larger numbers indicating stronger average agreement with the statements. The regressions contain the same independent variables as in Table 2 and additionally control for *Climate-risk materiality*, which averages the responses to the materiality of regulatory, physical, and technological climate risks.

The regressions show that respondents who expect greater material effects from climate change more strongly agree that climate risks should be incorporated due to both financial and nonfinancial motives. Larger investors tend to incorporate climate risks due to both reasons too (the effect is marginally insignificant for financial motives). Investors with a larger share of their portfolio aligned with ESG standards generally care more about climate risks because of financial motives, which confirms the common narrative among proponents of ESG factors that these factors are incorporated because they result in financial benefits.

3. Climate-Risk Management

3.1 Approaches to Climate-Risk Management

Managing climate risks provides challenges to institutional investors because of difficulties in pricing and hedging climate risks. Climate risks are difficult to hedge because of the uncertainties involved, their systematic nature, a lack of disclosure by portfolio firms, challenges in finding suitable hedging instruments, and the fact that the primary types of climate risks (physical, regulatory and technological) have different characteristics that are not independent in nature. In addition, there are few generally agreed upon methodologies as to how climate risks could be managed. Our survey collects information on

risk-management tools currently employed by investors, both before and after investments have been made, which allows us to evaluate current practices and to identify dimensions along which impediments may exist.

The academic literature on climate risk management at this point is still in early stages, but Andersson, Bolton, and Samama (2016a) and Engle et al. (2018) show that in principle investors can hedge climate risks, although others argue that they are difficult to hedge in practice (CISL, 2015). Another form of risk management would be to avoid problematic firms as pointed out theoretically by Heinkel, Kraus, and Zechner (2001) and empirically tested by Fernando, Sharfman, and Uysal (2017). Focusing on a more established mechanism, Dimson, Karakaş, and Li (2015) show that engagement on climate risks can enhance shareholder value. Through our survey we are able to evaluate whether a broad range of investors use risk-management techniques such as those described in these papers.

Question C1 is designed to determine which approaches the respondents' institutions had taken in the previous five years to incorporate climate risks into their investment processes. Figure 4A reports the percentage of respondents that employed a particular approach. Only a very small percentage (7%) of respondents had not taken any measures, which, as discussed earlier, may reflect our sample selection.¹⁶ The responses also indicate that investors employ a wide spectrum of approaches, and no single approach dominates. Figure 4B shows that, conditional on using risk management, the median investor focuses on three approaches.

The respondents indicate that their most frequently used risk-management techniques have been analyses of firms' carbon footprints and stranded asset risk, employed by 38% and 35% of the investors, respectively. Thirty-two percent of the respondents integrate ESG more generally into their investment

¹⁶ In terms of variation across distribution channels, the fraction of respondents without any risk-management approaches is zero among the asset owner's cooperation partners and among our personal contacts, while it is 8% in the panel and 7% among the conference participants. The latter number mitigates the concern that the conference participants are biased towards risk management, relative to other sample participants.

process, which could reflect pledges from the increasing number of investors signed up to initiatives such as the PRI. The flipside of these numbers is that they indicate two-thirds or more of investors currently do not use these basic approaches to manage climate risks. Several investors incorporated climate risks in some form prior to making investments, especially through screening (24%). This approach is consistent with the theoretical and empirical work of Heinkel, Kraus, and Zechner (2001), Barnea, Heinkel, and Kraus (2005), and Fernando, Sharfman, and Uysal (2017).

Regarding actions taken to manage climate risk after investments have been made, 29% (23%) of respondents strive to reduce the carbon footprint (stranded asset risk) of their portfolios, and 25% use some form of climate-risk hedging. The low percentage of investors who hedge climate risk may be in part a result of the difficulty in differentiating among the uncertainty components of risk, ambiguity and misspecification (Barnett, Brock, and Hansen 2018) as well as the further difficulties pointed out by Engle et al. (2018). Hedging against climate risk requires not only understanding the fundamentally long-lived risk of climate change, but also dealing with the difficulty of identifying shocks, the proper horizon, and which assets correlate with the outcomes, which overall results in the lack of existence of derivatives to engage in hedging for climate change. The authors suggest a short-term dynamic approach to protecting investor portfolios against the adverse effects of climate change.

The least frequently used approach is divestment, although there still exists a significant percentage (20%) of investors who take this approach. The relatively small number of investors who divest further informs the debate regarding whether divestment or engagement is the more effective method for reducing climate risk. We show below that our investors have a higher propensity to engage over climate risks than to avoid it by divesting. This is consistent with the stated views of the Harvard endowment: *“we maintain a strong presumption against divesting investment assets”* as the endowment is *“a resource, not*

*an instrument to impel social or political change.*¹⁷ The lack of use of divestment is consistent also with Bessembinder's (2017) analysis indicating significant costs to investors who divest fossil fuel companies. These costs include reduced diversification, ongoing compliance costs, and transaction costs. He estimates that the costs to endowments and pension funds from divestment would result in significant increases in tuition fees for students and reductions of 5 to 7% in monthly pension benefits.

3.2 Climate-Risk Management and Investor Characteristics

To better understand institutions' climate-risk management we develop a measure that reflects the spectrum of risk management techniques employed. Our composite "climate-risk-management index" sums the different approaches an investor has taken in the previous five years. This index construction, similar to the approaches taken in McCahery, Sautner, and Starks (2016) and Karolyi and Liao (2017), provides insights into the intensity of the investors' climate-risk management. In our survey we cover 13 possible risk-management techniques, implying that the index can vary between zero and 13. A caveat is that the index is designed to capture the extent to which investors used different types of risk-management tools, rather than the degree to which they used any one type. Thus, we are capturing the breadth of approaches rather than the depth.

Given the uncertainty regarding how to manage climate risks, we expect investors who are more concerned about the consequences of climate change to engage more intensively in climate-risk management by using a greater breadth of approaches. Similarly, investors who expect climate risks to materialize earlier should also engage in more risk-management techniques. Traditionally, economists and others have assumed that climate risks are likely to be more severe over the long term, which implies a prediction that long-term investors use a wider range of tools to manage these risks. In contrast, Giglio et al. (2018) argue that short-term cash flows are riskier because they bear the full brunt of a climate disaster

¹⁷ See Harvard University, *Fossil Fuel Divestment Statement*, October 3, 2013, Cambridge, Mass. A related discussion is provided in Shancke et al. (2014).

while long-term cash flows are less exposed because the economy can recover. Thus, whether the intensity of risk management is higher among long-term or short-term investors poses an empirical question. Given their role as universal investors, it is likely that large investors employ more risk management, as they are more exposed to climate externalities. Additionally, such investors should have more resources to develop and use risk-management tools. The role of the passive portfolio share is more ambiguous. Investors with high passive holdings may use more risk management as they cannot easily divest because of index-tracking or tracking-error considerations. However, the low-cost business model of passive investors may imply that they do not invest resources to actively manage climate risks.

We test these hypotheses through regression analyses, the results of which are provided in Table 4. The results partially support our hypotheses. We find that investors more concerned about the implications of climate risks use a more diverse set of risk-management tools (Column (1)) as expected, but as shown in Column (2) we find no difference between the risk-management intensity of investors who expect climate risks to materialize earlier versus those that expect them to materialize later. Column (3) shows that investors with longer horizons engage in a wider range of tools to manage climate risks. In fact, the estimates imply that investors with a medium (long) horizon use 0.9 (1.2) more approaches, a large number relative to the median of three approaches that we have found. This effect weakens once we control for additional investor characteristics in Column (5), but it remains sizeable as a medium-term (long-term) investor still uses about 20% (25%) more tools than the median investor. Consistent with our hypothesis, we also find in Column (4) that larger investors tend to manage climate risks more broadly. Across all specifications we find that ESG investors use more climate-risk tools for their investments, which is also reassuring from an internal (survey-data) consistency point of view.

3.3 Measurement and Evaluation of Climate Risks

Although a number of recommendations have been made regarding how investors should measure and evaluate the climate-risk exposure of their portfolios, to what extent institutional investors follow these recommendations remains unclear. For example, TCFD recommends that investors develop climate scenarios to assess their climate risks (TCFD 2017). David Swensen of the Yale Investments Office recommends that asset managers assess the carbon footprint of their investments and the effect of climate risks on returns (Litterman 2016). Further, not well understood is the extent of impediments in implementing approaches. We address these issues by asking investors which approaches (if any) they use to evaluate the consequences of climate risks for their portfolios (Question C5). The responses in Figure 5A document that 47% employ models to assess the impact of climate risk on expected returns, 47% measure the carbon footprint of their portfolio companies, and 39% use more sophisticated approaches such as climate scenarios and stress tests. Only 11% of the respondents do not attempt to evaluate the potential consequences of climate change through any of the approaches.

To understand impediments to evaluating the climate-risk exposures of their portfolios, we inquired which data sources, if any, investors use to measure the carbon footprints of portfolio firms (Question C6). The carbon footprint is a useful first step in quantifying exposure to climate risks as it captures greenhouse-gas emissions from business activities. Although a firm's carbon footprint may be unrelated to physical climate risks, it can be drawn on as a proxy for regulatory and technological risks (Ilhan, Sautner, and Vilkov 2018). Obtaining data on the carbon footprints of their portfolio firms is also important for investors that want to meet the TCFD recommendation to report these footprints to their own stakeholders. As Figure 5B illustrates, a large proportion (45%) of the respondents self-collect data on carbon footprints from corporate disclosures, while 32% use emissions data from MSCI and 27% from CDP. (MSCI, like many other third-party data providers, also sources some of its carbon data from CDP; the 27% indicating use of CDP data is therefore a lower bound on CDP's importance.) A number of investors do not

use any carbon-emissions data, either because they do not measure carbon footprints (17%) or because they consider the data unreliable (14%).

4. Shareholder Engagement on Climate Risks

We next assess how investors engage portfolio firms over climate risks, whether such engagements are usually effective, and what investors do when engagements are unsuccessful. The benefit of a survey is that many engagements take place behind the scenes, making it difficult to measure the effectiveness of engagement using archival data. We asked the participants in Question C2 which measures of direct engagement they have taken with portfolio firms over the previous five years.

Figure 6A presents evidence of a generally high level of engagement by our respondent group: only 16% had not taken any actions over the past five years. The respondents indicate that they used multiple channels to engage portfolio firms over climate risks. Discussions with management were most frequent, with 43% indicating that they had used the approach. The percentage compares with 63% of the respondents in the McCahery, Sautner, and Starks (2016) survey who used private discussions to engage management (they asked about engagement in general). The widespread use of private intervention over climate topics confirms the interpretation from their paper that many investors first engage firms through negotiations, and take public actions only once these private interventions failed. Figure 6A also indicates that many investors used these discussions to propose specific actions to management about the firm's climate policies.

Climate risks are increasingly a controversial topic at annual shareholder meetings. About one-third of the respondents submitted shareholder proposals on climate-risk issues, and a similar fraction voted against management proposals because of climate-risk concerns. These numbers are consistent with a recent trend of successful shareholder proposals at oil companies. A proposal at Exxon Mobil, for example,

asked management to disclose how climate risks affect the company in the future. Bauer, Moers, and Vihr (2015) provide additional evidence on engagement success with their finding that environmental and social proposals are more likely to be withdrawn, particularly if the sponsoring shareholder is an institutional investor. More confrontational engagements are also taking place: 20% state that they publicly criticized the management of portfolio firms over climate-risk issues, 19% voted against the re-election of directors because of their handling of climate risks, and 18% initiated legal measures over climate risks. Reflecting an increasing trend of climate-litigation risk, BP's CEO recently refused to disclose climate targets and to answer questions from activist investors because of the fear of legal actions.¹⁸

Figure 6B shows the distribution of the number of engagement channels used by the investors. The distribution is wide as a small percentage used all nine potential measures, although the median investor engaged through two channels only.¹⁹

An important question regarding engagement that is difficult to address using archival research is the degree to which the institutional investors in aggregate regard their climate-risk engagement as having been successful. The benefit of a survey is that it allows the direct measurement of whether engagement—especially when private—is successful. Thus, we asked in Question C3 how portfolio firms typically responded to engagement over climate risks. Targeted firms responded in most cases (71%) to the climate-risk engagement by their investors (Figure 7A), although the typical response was acknowledging an issue rather than successfully resolving it (Figure 7B). A successful completion of a typical engagement is reported by 25% of respondents, higher than the 10% of successful climate-change engagements in Dimson, Karakaş, and Li (2015). The deviation in success rates could have a variety of reasons. First, their sample period covers the years up to 2009, while climate engagements likely became more successful

¹⁸ See "Climate Change Warriors' Latest Weapon of Choice Is Litigation," *Bloomberg*, May 24, 2018. This article also documents that litigation against firms over climate change massively increased in the last few years.

¹⁹ Across our survey channels, there is a slightly higher propensity to engage along several dimension for our asset-owners' partners (median of three channels), followed by our personal contacts and the panel participants (two channels each). The median conference participant used one channel.

recently. Secondly, success might be defined differently by the institution studied in Dimson, Karakaş, and Li (2015), as compared to our investors.²⁰

Figure 7C further shows that if portfolio firms did not respond to an engagement or showed resistance, then investors usually gave up and did not take further actions (40%). Divestment is usually not the prime mechanism when being dissatisfied with portfolio firms' responses: only 17% indicate that they usually took the exit channel in such cases. The remaining investors either initiated the next level of engagement (21%) or tried to hedge the risk (23%). These numbers corroborate our prior result that climate risks usually do not trigger divestment, at least among most investors in our sample. Most of our investors' actions appear consistent with the view that divestment would reduce investor influence to improve climate policies. Further, Marcel Jeucken, managing director of responsible investment at PGGM states *"If we divest, other investors will buy the stock and nothing will change."*²¹

We next study the determinants of investors' intensity to engage over climate policies. As with our risk-management index, we create a variable that sums the different engagement channels used by an investor. Our survey covers nine intervention channels, implying that the index can vary between zero and nine. Larger numbers indicate a stronger tendency to engage along multiple channels.

Similar to our arguments for risk management, investors that are more concerned about climate risks, and those that expect the risks to materialize earlier, should engage more intensively. Investors with longer horizons should also have stronger engagement incentives, as they benefit more from improving climate policies. Larger investors have more resources and larger holdings in firms, reducing free-rider concerns and implying also stronger engagement incentives. For the reasons provided above, ESG and more passive investors should have stronger incentives to engage.

²⁰ The 25% matches the success rate that Dimson, Karakaş, and Li (2015) report for governance engagements and is close to the 28% that Hoepner et al. (2018) report for ESG engagements.

²¹ See "Special Report ESG: Carbon Risk, A changing climate," *IPE Magazine*, February 2015

We test these hypotheses regarding the relationships between intensity of engagements and investor characteristics through regression analyses. In Table 5 we report the results which show that the investors who consider the effects of climate change as more material, and those who expect climate risks to materialize earlier, engage firms more intensively. As predicted, larger investors also engage firms along more dimensions, although we have only weak evidence that long-term investors use more engagement channels. As expected, investors with a greater share of ESG-oriented investments in their portfolios use a wider variety of engagement channels.

5. Pricing of Climate Risks across Industries

A substantial amount of recent research suggests that climate risks can have a large impact on equity markets (see Hjort 2016 for a comprehensive review). For example, in Bansal, Ochoa, and Kiku (2017) rising temperatures negatively impact the economy by raising economic risk and reducing growth. Daniel, Litterman, and Wagner (2017) calibrate the price of climate risk and suggest potentially large deadweight costs from delaying climate-change mitigation. In a similar spirit, Litterman (2011) suggests that carbon emissions should be priced at high levels immediately, primarily due to the risk of catastrophic damages. In line with these approaches, Andersson, Bolton, and Samama (2016a) assume that markets overvalue carbon-intensive assets to derive hedging strategies. Empirical evidence exists as well. For example, Hong, Li, and Xu (2017) document that the exposure of food stocks to drought risks are incorrectly valued by markets. Similarly, Kumar, Xin and Zhang (2018) present evidence that firms' exposures to climate risk predict returns, suggesting that stock markets underweight climate risks. On the other hand, Bansal, Kiku, and Ochoa (2017) show that equity portfolios have negative exposures to long-run temperature fluctuations, which suggests that financial markets may be able to price climate risks at least to some extent. Jouvenot (2018) documents that manufacturing firms with better water management exhibit higher valuations during spells of drought.

We are able to contribute additional findings to this limited, and somewhat mixed, evidence through questioning our investors directly in order to understand the extent to which they believe that stock markets price climate risks correctly. To examine the investor beliefs on this issue, we asked the participants whether they believe that current equity valuations correctly reflect the risks and opportunities related to climate change (Question D1). As the exposure to climate risks likely varies across the economy, we asked for their beliefs across a range of important industries. This sector approach, with both directions of mispricing, is critical because the direction of mispricing is not known. The degree to which climate risks are not recognized in valuations could vary by sector with some sectors expected to be overvalued (e.g., the oil or coal sectors) and other sectors expected to be undervalued (e.g., the battery producers, water utilities). This approach is supported by the prior research that indicates climate risks are likely to vary across industries, depending on factors such as carbon emissions or stranded assets.²² As estimates about mispricing are uncertain, we take a Bayesian approach and allow respondents to indicate the confidence in their estimates (Question D2). This enables us to evaluate how results change once we put more weight on responses stated with higher confidence (some respondents may provide more informed estimates given their position or level of information).

Responses for each industry, reported in Table 6, can range between plus two (“valuation much too high”; underpricing) and minus two (“valuations much too low”; overpricing). Column (1) reports the mean score per industry and Column (2) standard deviations. Column (3) displays a measure of relative misvaluation, constructed as the mean industry score relative to the mean score across all industries. We report in Columns (4) and (5) the percentages that indicate valuation levels that are “much too high” or “much too low”. Finally, Column (6) reports the mean scores only for “relatively confident” respondents.

²² Krueger (2015) shows that firms in oil and gas, basic materials, and utilities have the highest greenhouse-gas emissions. Andersson, Bolton, and Samama (2016a) assume that mispricing is highest in carbon intensive sectors.

The table reveals two principal findings. First, a mean valuation score of zero would indicate a fair valuation. In contrast, we find the mean valuation scores to exceed zero for all of the industry sectors. Thus, the average respondent seems to believe that equity valuations do not fully reflect the risks from climate change. Rather the scores indicate that investors believe valuations are somewhat too high, which suggests an aggregate investor belief of climate-risk underpricing for the stock market as a whole. However, the responses for most sectors are around 0.4, indicating only modest overvaluations. Mispricing is slightly larger if we condition responses on participants with “relatively confident” assessments. At the same time, there is substantial uncertainty around the mean estimates, as standard deviations range between 0.9 and 1.1. Second, relative sector mispricing is largest among oil firms, traditional car manufacturers, and electric utilities. Yet, the magnitude of sector-level mispricing is surprisingly low: the misvaluation of the three most overpriced sectors is around 0.5 only, while the mean across all sectors is 0.38. These numbers either reflect a belief among most respondents that markets have already started to account for the relative pricing of climate risks, that greater mispricing exists but our investors do not recognize it, or that our question simply did not capture relative mispricing well. The first possibility is consistent with the conclusions of Griffin et. al. (2015) regarding their findings of limited negative stock market reactions to concerns about a carbon bubble and stranded assets for the largest oil and gas firms. The authors point out that investors could have not been as concerned because they considered alternatives such as carbon capture and sequestration and other technological advances, changes in government energy policies, whether oil and gas demand could actually be scaled back “within an economically meaningful horizon,” or the lack of investor information about firms’ positions.

We next examine in Table 7 whether responses to our mispricing question vary along investor characteristics. We create two indexes to capture the mispricing in aggregate. The first index, labelled *Climate-risk underpricing*, approximates an investor’s aggregate view about overvaluation by averaging *positive* mispricing scores (negative score are set to zero). The index ranges between plus two (strong

average overvaluation) and zero (no average overvaluation). The second index, *Climate-risk mispricing*, is non-directional and captures the general mispricing of climate risks by averaging the *absolute* values of all mispricing scores. We additionally report regressions that explain the underpricing of climate risks in the three industries that our investors believe are the most mispriced. We use the same independent variables as in previous tables, and add the risk-management and engagement indexes.

The regressions provide little evidence for a systematic link between mispricing and investor characteristics. Only two characteristics emerge as being relevant. First, investors with larger ESG shares generally view assets as being subject to more mispricing (especially underpricing), possibly a reason that such investors promote ESG factors to begin with. Second, investors that engage firms more intensively believe that climate risks are more underpriced, which may explain their engagement (although the effect is only marginally significant).

Many of those concerned about climate risk consider stranded assets to be a particularly significant risk for investors. Thus, we question our investors on the risk that climate change causes specific assets to become stranded (Question D3). Assets are “stranded” if firms are unable to recover their investment cost, implying a loss of value for investors (Carbon Tracker 2015). Figure 8A reports how institutional investors consider stranded asset risks for six industry subsectors selected based on prior research. McGlade and Ekins (2015), for example, estimate that a third of oil reserves, half of gas reserves and over 80% of coal reserves must remain unused until 2050 to meet the Paris target. For each industry subsector we report the percentage of respondents that consider stranded asset risks to be “very high”. We find that stranded asset risks are largest among coal producers, followed by unconventional oil producers (tar sands or fracking). Yet, even for the coal producers, which have the highest percentage of respondents believing that they face stranded asset risks, only 25% believe this risk is very high.

Thus far our analysis has mostly focused on downside risks associated with climate change. However, climate change is likely to generate winners as well. Understanding the associated opportunities would be important for investors allocating capital in the future. We asked respondents by means of an open question in which areas they see the biggest opportunities from climate change (Question D4). We classified the answers and report in Figure 8B the fifteen most frequent responses. The word cloud displays in larger font those responses that were more frequent. Our respondents identify opportunities mostly in renewable energy, but also in the areas of water (including water supplies and management), electric vehicles, and technology.

6. Climate-Risk Disclosure

In order to incorporate climate risk into their investment decisions, investors need sufficient information on firms' climate-risk exposures. Many regulators and investors argue that climate-risk disclosures are currently insufficient. For example, Mark Carney, Governor of the Bank of England, stated that more needs to be done *"to develop consistent, comparable, reliable and clear disclosure around the carbon intensity of different assets"* (Carney 2015). In a similar spirit, Anne Stausboll, former CEO of CalPERS, said that *"consistent and comparable corporate disclosure of material climate issues is critical [and that] investors require better climate disclosure in securities filings"* (Stausboll 2014). Further the evidence in Hong, Li, and Xu (2017) indicates that markets underreact to climate risks because of poor disclosure, suggesting that value exists in improving disclosure.

Beyond the question of how investors assess the sufficiency of climate-risk reporting is the question of how the investors consider the reporting on climate risk compared to reporting on financial information (Question B1). The results are illustrated in Figure 9A, which shows that 51% believe that climate-risk reporting is as important as financial reporting. Almost one-third even considers climate-risk reporting to be more important. This perceived importance stands in stark contrast to current practice.

To understand better the limitations and impediments to reporting on climate risks, we asked in Question B2 about the current disclosure practice. For example, we ask questions allowing exploration of the informativeness of qualitative disclosures (e.g., narratives of how climate change affects business models) as well as quantitative disclosures (e.g., emissions). We also collected views on whether disclosure should be more regulated and standardized. The responses in Figure 9B show that many investors believe that standardized and mandatory reporting on climate risk is necessary (27% strongly agree), and that there should be more standardization (27%). These numbers are consistent with recent initiatives that increase transparency. For example, in June 2017, TCFD released its recommendations on climate-related financial disclosures centered on the organization’s governance, strategy, risk management, as well as metrics and targets, thus, recommendations on reporting about climate risks that go beyond simply reporting emissions and including reporting on organizational governance or risk management surrounding climate risks. Several respondents also believe that investors should put pressure on firms to disclose more about climate risks (28% strongly agree), echoing the recent investor initiatives at Exxon Mobil discussed earlier. There also exists a widespread view that current quantitative and qualitative disclosures are insufficiently informative and precise, which could be one reason why climate risks are difficult to price or hedge.

Relatedly, we asked whether the investors engage or plan to engage portfolio companies to report in accordance with the TCFD recommendations (Question E5), especially given that several major investors announced that this will be a prime area for their engagement (Blackrock 2017). Figure 9C shows that this approach is shared widely, as 59% plan to engage firms on this topic. A new law implemented in France in 2016 requires carbon reporting also by institutional investors (Article 173), and this law is considered to be one of the most ambitious climate-risk regulations in the world.²³ Our international respondents provide

²³ See “France Gets Climate Risks Disclosures from Invest Firms,” *Wall Street Journal*, December 7, 2017. The law also requires investors to report on how they identify and manage climate risks.

support for the French approach, as 60% stated in Question B2 that they will disclose their own carbon footprint also (Figure 9D).

7. Conclusions

We survey institutional investors to gain a better understanding of whether, why, and how they consider climate risks in their investment decisions. In doing so, we are able to gather further insights into the theoretical constructs and previous archival research on climate risks in finance. We also hope that these findings help to generate additional theoretical and empirical research in the area.

We find that the survey respondents believe that climate risks have important financial implications for their portfolio firms, and the majority believes that climate risks, especially those related to regulation, have already started to materialize. There is no single motive that explains why the investors incorporate climate risks into their investment processes. The most common motives provided by the investors are to protect their reputations, moral/legal considerations, and the belief that climate risks affect returns.

Most of the respondents have taken at least first steps towards managing climate risks, although the two most basic approaches (analyses of carbon footprints and stranded asset risks) have been used by less than half of them. Divestment is the least frequently used approach overall. Investors with longer horizons generally use a wider range of tools to manage risks associated with climate change. When investors engage portfolio firms over climate risks they usually prefer private discussions with management. Larger investors generally engage firms along more dimensions.

The average respondent believes that equity valuations do not fully reflect the risks from climate change. Overvaluations are considered to be largest among oil firms, followed by traditional car manufacturers, and electric utilities, although the magnitudes of the overvaluations seem to be modest. The majority of respondents believe that climate-risk reporting is as important as financial reporting, and

almost one-third even consider it to be more important. Many investors believe that standardized and mandatory reporting on climate risks is necessary, and that there should be more standardization.

Overall, our evidence indicates that investors consider climate risks as important investment risks, and that investors are already incorporating these risks into their investment processes. Despite this, many investors still do not use basic tools to identify and manage climate risks. In general, the Long-term and larger investors appear better prepared for the transition to a low-carbon economy.

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Figure 1: Institutional Investor Climate-Change Expectations

Figure 1A provides respondents' expectations for the global temperature rise by the end of this century. We report results for the full sample and by region. Regions include North America (United States and Canada), Continental Europe, United Kingdom and Ireland), and Rest of World. We anchored expectations by referring in our question to the two degrees Celsius target of the 2016 Paris Climate Accord. Respondents were asked to state their own climate expectations, and to provide us with a confidence level for their assessment. Figure 1B provides responses on the confidence level, again reported for the full sample and by region.

Figure 1A: Climate-change expectations

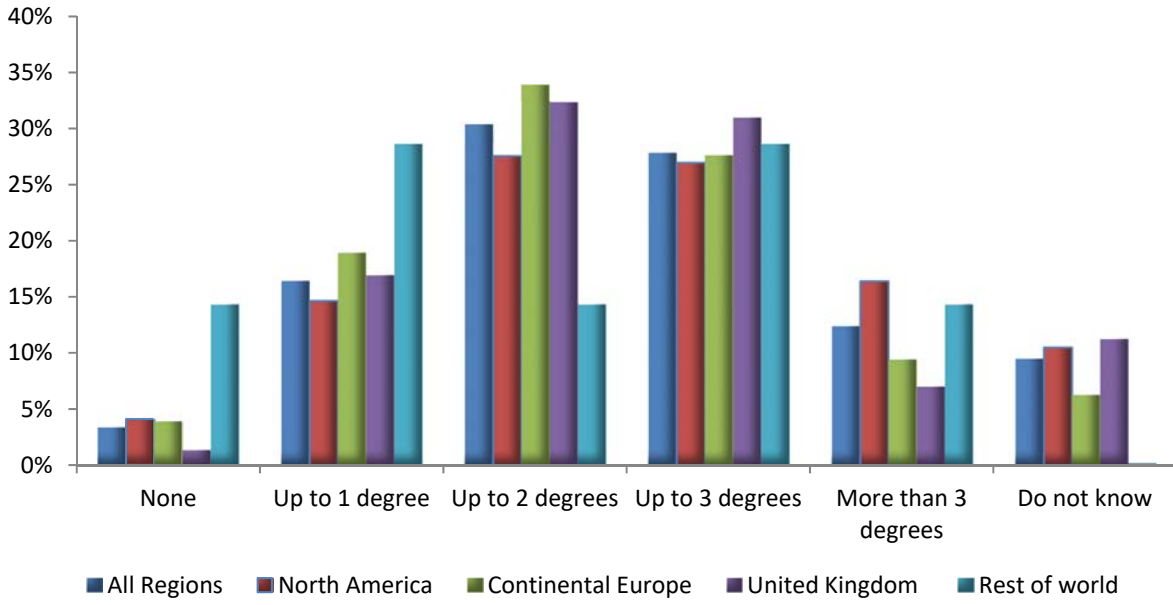


Figure 1B: Confidence in climate-change expectations

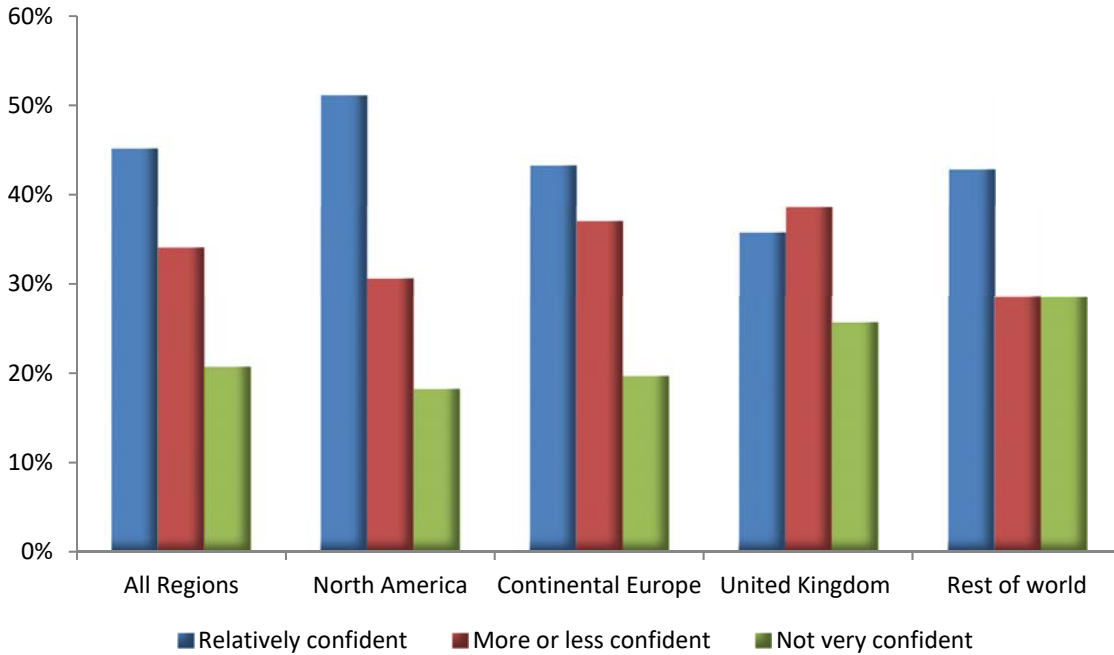


Figure 2: Investor Perceived Importance of Climate Risks

Figure 2A reports the respondents' rankings of six major investment risks. We asked respondents to rank the six risks from one to six, where one is the most important risk and six the least important risk. The bars represent the percentages of respondents that rank a risk as the most important risk (# 1 risk) when making investment decisions. We also report the mean response, calculated as the average rank across respondents. Smaller average rank numbers indicate that a risk is considered more important. Figure 2B reports the respondents' ratings of the financial materiality of different components of climate risk with respect to their portfolio firms (regulatory, physical and technological). The responses can vary between one (not at all important) and five (very important). Larger numbers indicate that a risk is more financially material. Figure 2C reports the time horizons over which the respondents expect different climate risks to materialize financially. Figure 2D reports the number of years since the respondents' institutions first started to incorporate climate risk into their investment processes.

Figure 2A: Most important investment risks
Percentage of respondents that rank each risk as most important

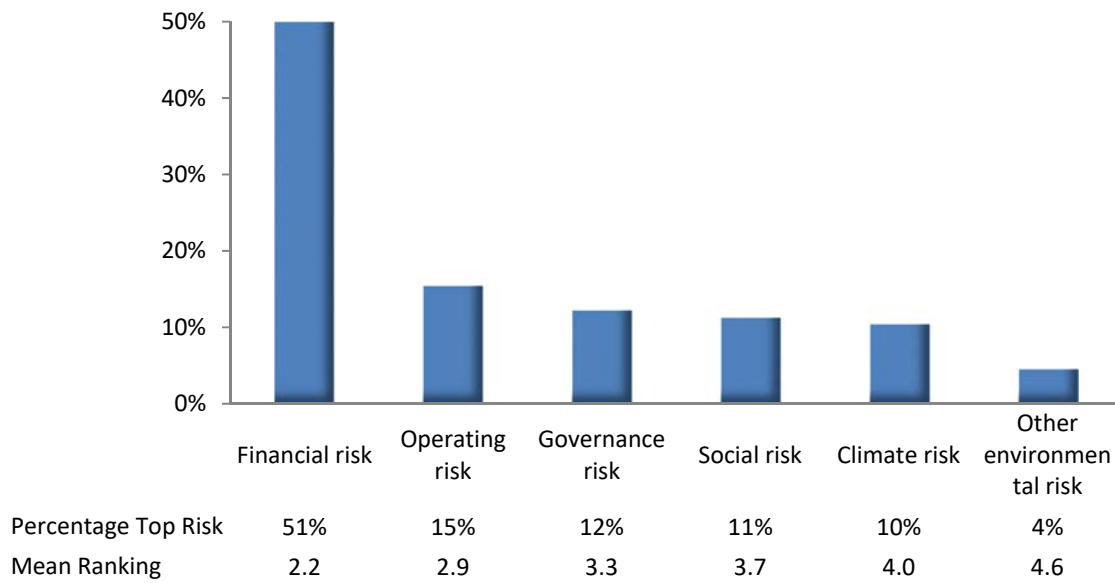


Figure 2B: Financial materiality of climate risks
(1= Not at all important, 5= Very important)

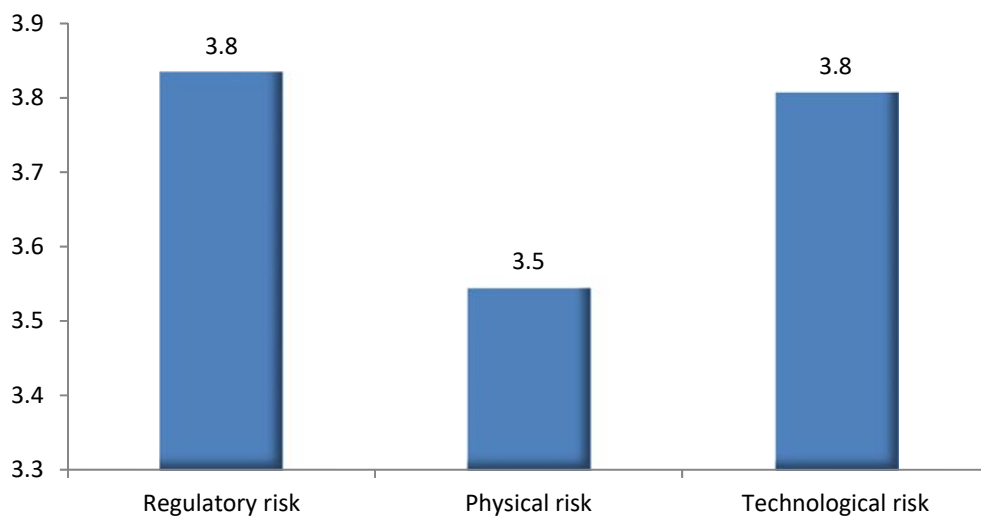


Figure 2 (continued)

Figure 2C: Climate-risk horizon
Over what time horizons, if any, do you expect these risks to materialize?

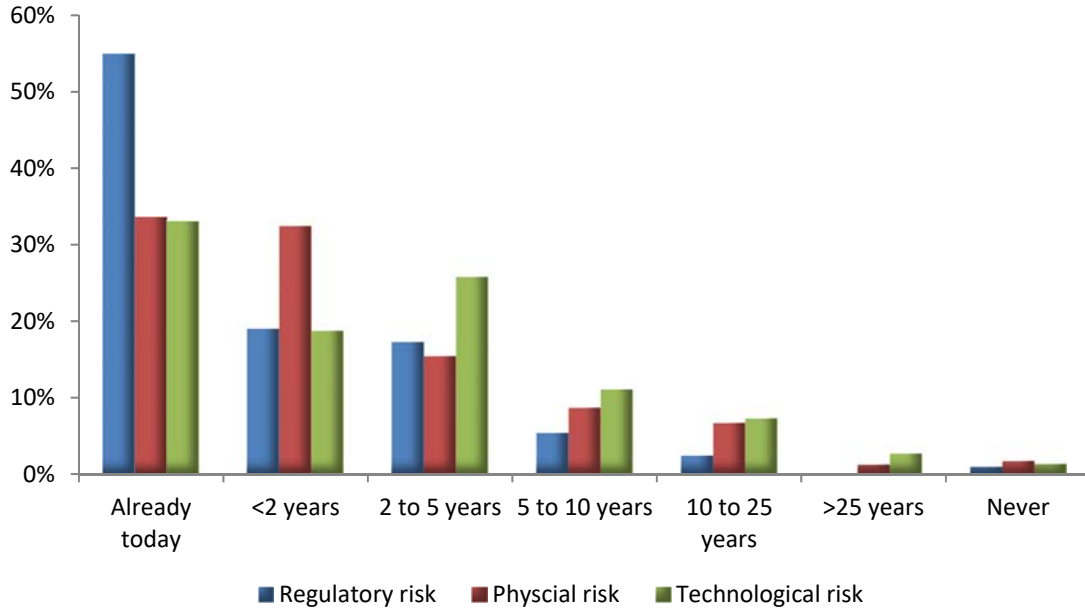


Figure 2D: Climate risks in the investment process
When did you start to incorporate climate risk into your investment process? (number of years ago)

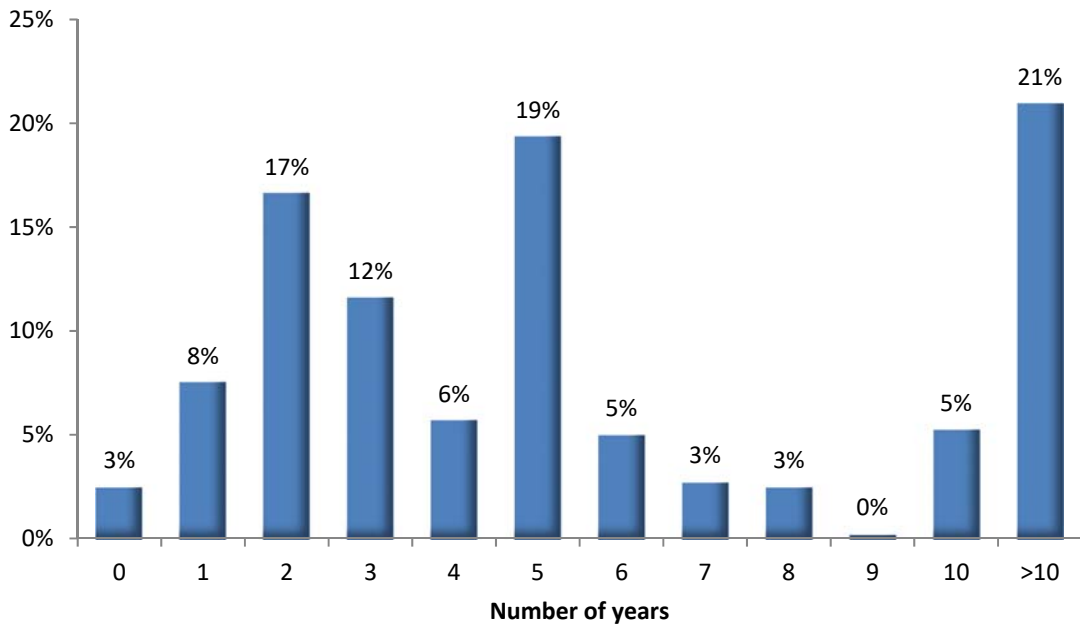


Figure 3: Motivations to Incorporate Climate Risks into Investment Process

This figure provides the percentages of respondents that “strongly agree” with different statements on their motivations to incorporate climate risks into their investment processes. Respondents could indicate their agreement to different statements on a scale of one (“strongly disagree”) through five (“strongly agree”). We rank results based on their relative frequency. Responses were not mutually exclusive.

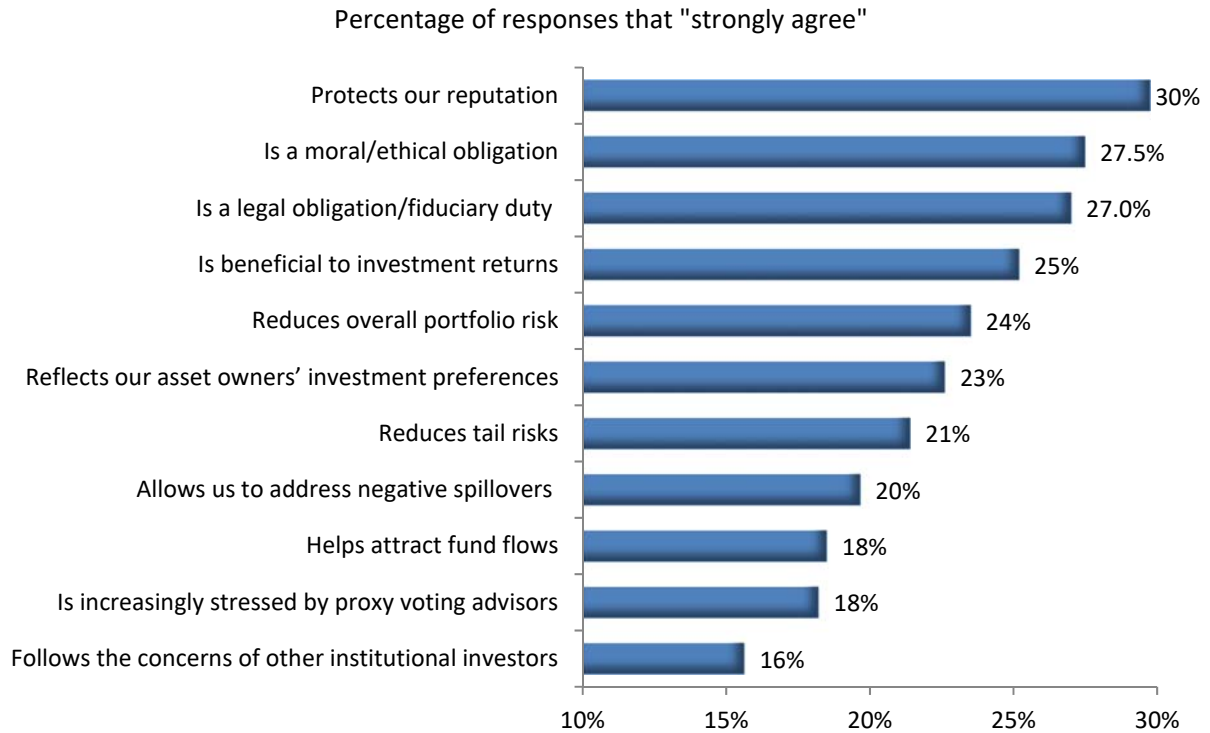


Figure 4: Climate-Risk Management

Figure 4A reports the percentage of respondents that took a particular measure to manage climate risks. We rank results based on their relative frequency. Responses were not mutually exclusive. Figure 4B reports the distribution of the number of alternative risk-management approaches that were taken.

Figure 4A: Which approach have you taken in the past five years to incorporate climate-risk management in your investment process?

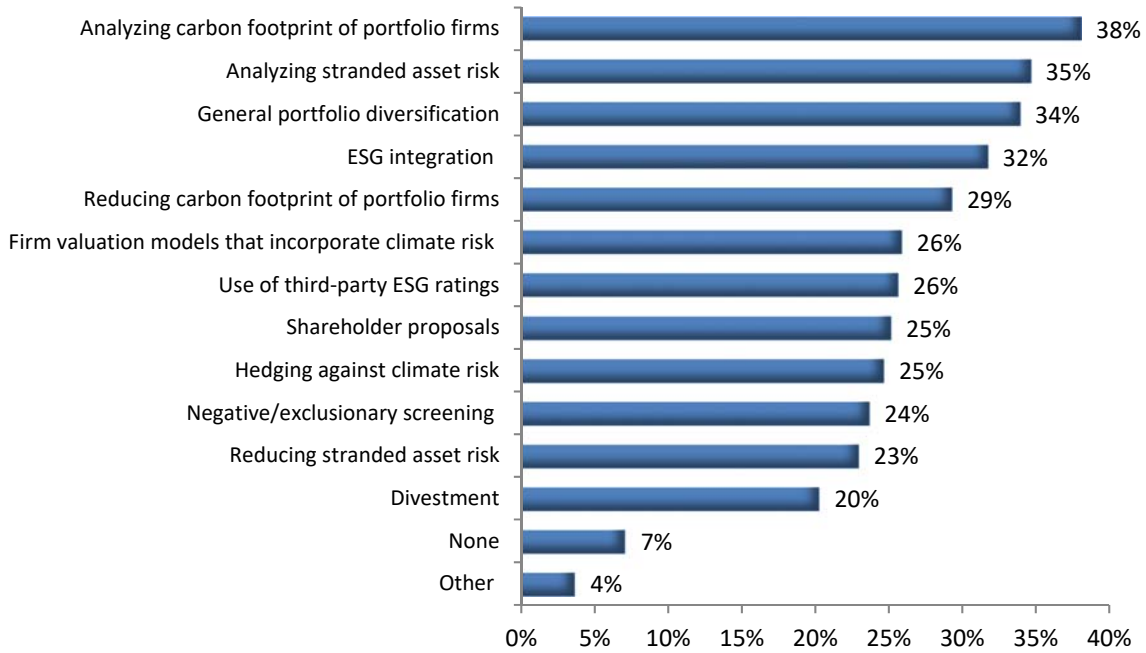


Figure 4B: Number of risk-management approaches taken by investors in the past five years

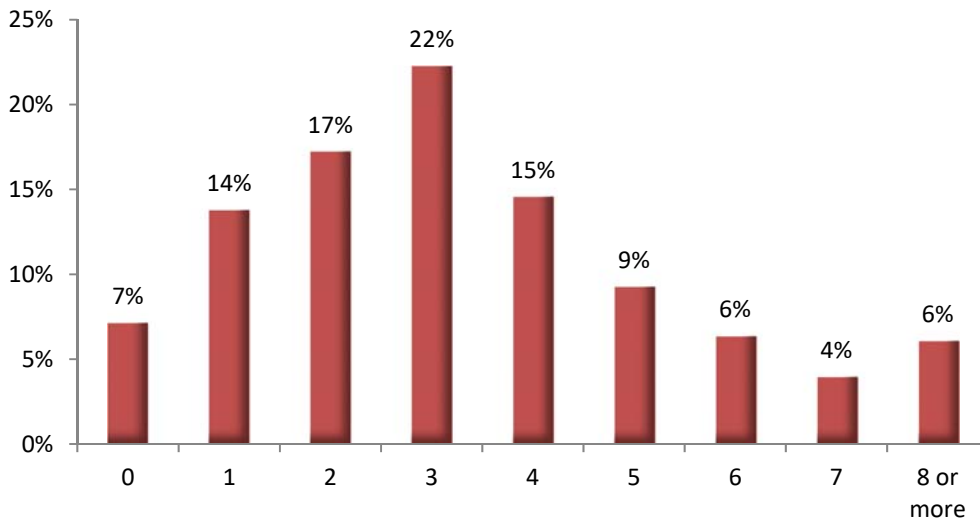


Figure 5: Evaluation and Measurement of Climate Risks

Figure 5A reports the approaches that the investors used to evaluate the consequences of climate risks for their portfolios. Responses were not mutually exclusive. Figure 5B reports the data sources that the investors used to measure the carbon footprint of their portfolio companies. Responses were not mutually exclusive.

Figure 5A: Which of the following approaches, if any, do you use to evaluate the consequences of climate risk for your portfolio?

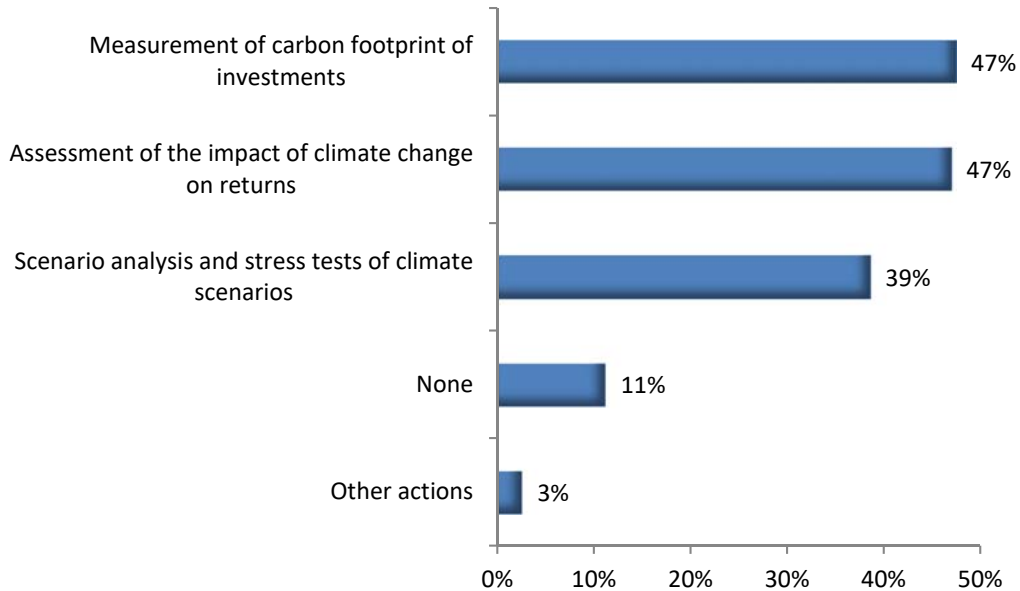


Figure 5B: What data sources, if any, do you use to measure the carbon footprint of portfolio companies?

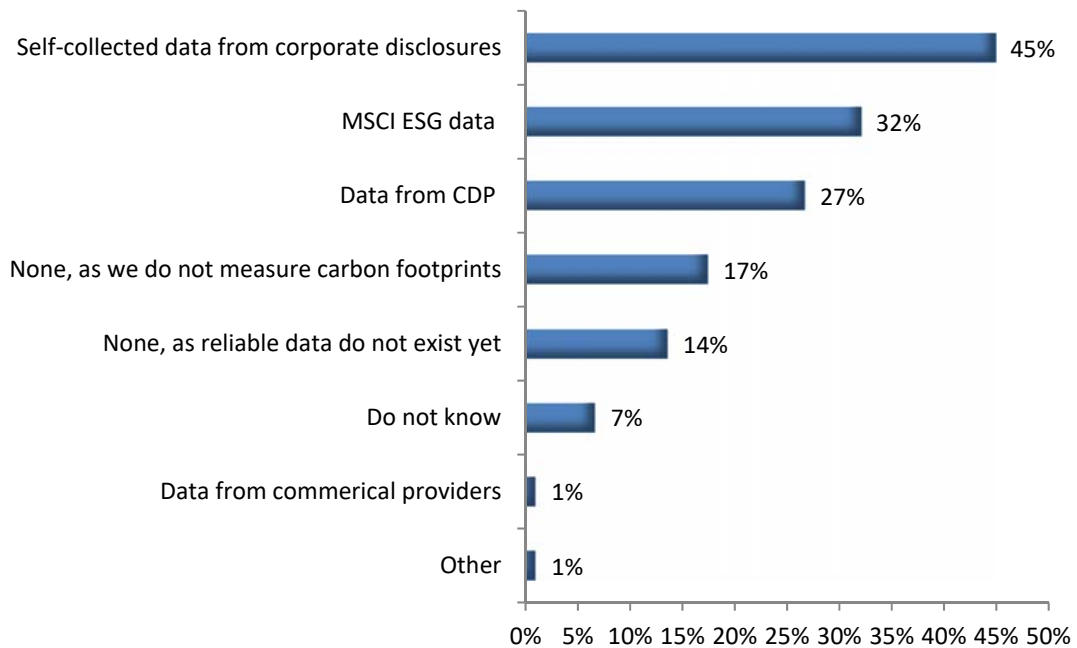


Figure 6: Climate-Risk Engagement

Figure 6A reports the percentage of respondents that took a particular measure to engage portfolio firms over climate-risk issues in the past five years. We rank results based on their relative frequency. Responses were not mutually exclusive. Figure 6B reports the distribution of the number of engagement channels that were used.

Figure 6A: What measures of direct engagement over climate-risk issues have you taken in the past five years with any of your portfolio companies?

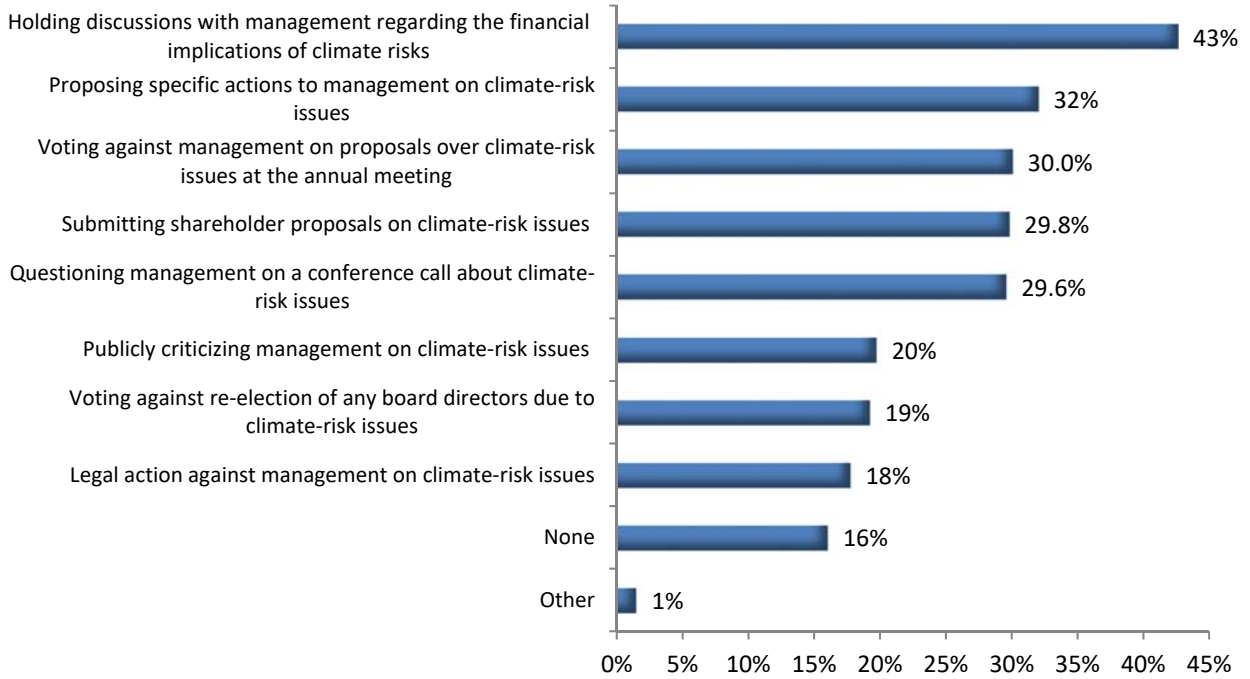


Figure 6B: Number of engagement channels taken by investors in past five years

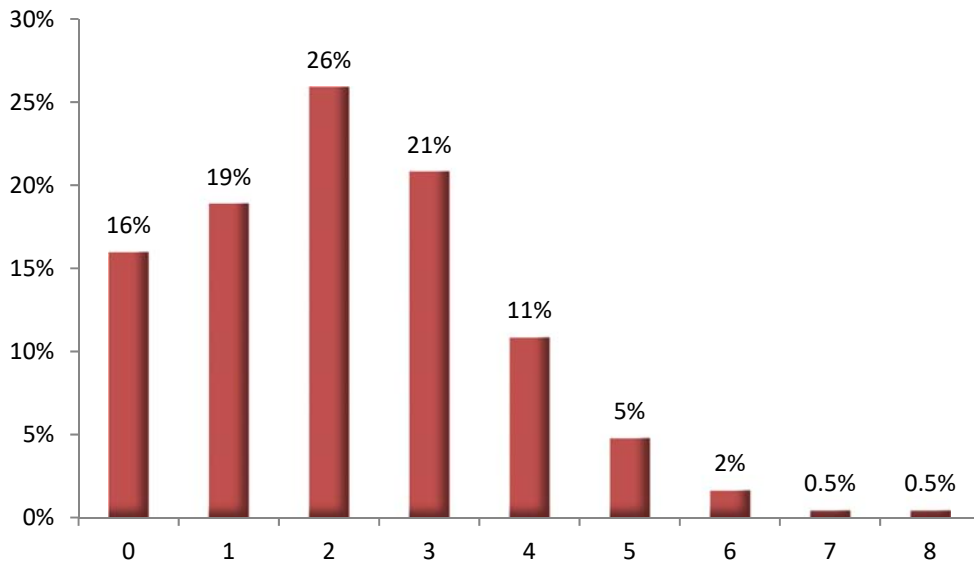


Figure 7: Responses to Climate-Risk Engagement

Figure 7A reports whether the management of portfolio companies typically responded to the investor’s engagement over climate-risk issues. Figure 7B reports the portfolio companies’ typical responses to such engagements. Figure 7C reports the investors’ responses if the portfolio companies either did not respond to the engagement (see Figure 7A) or showed resistance (see Figure 7B).

Figure 7A: If you have directly engaged portfolio companies over climate-risk issues in the past five years, how has the management of the portfolio firm typically responded?

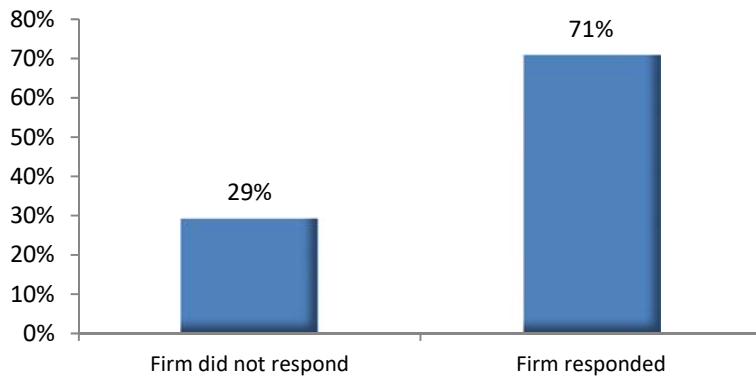


Figure 7B: What was the typical firm response?

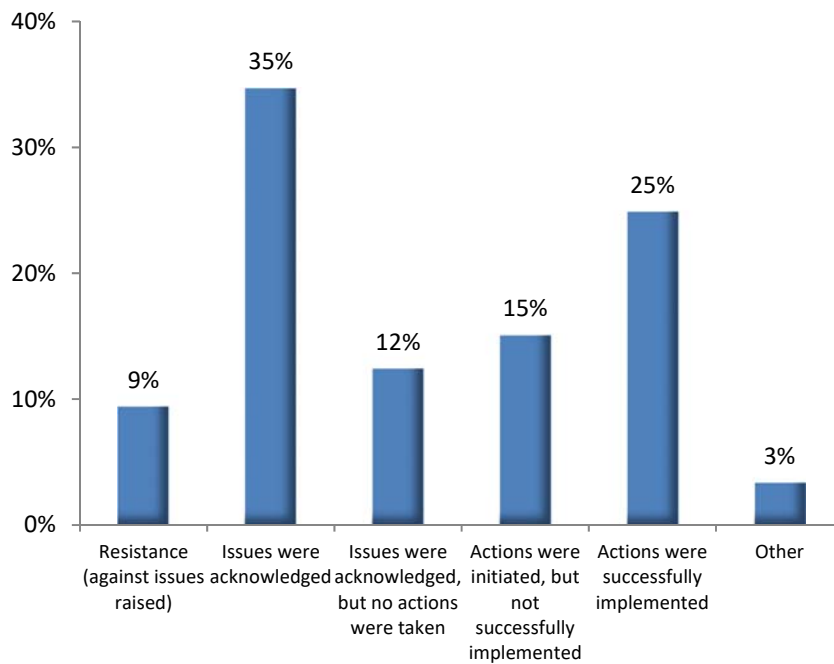


Figure 7 (continued)

Figure 7C: What was your response if you indicated "Firm did not respond" or "Resistance"?

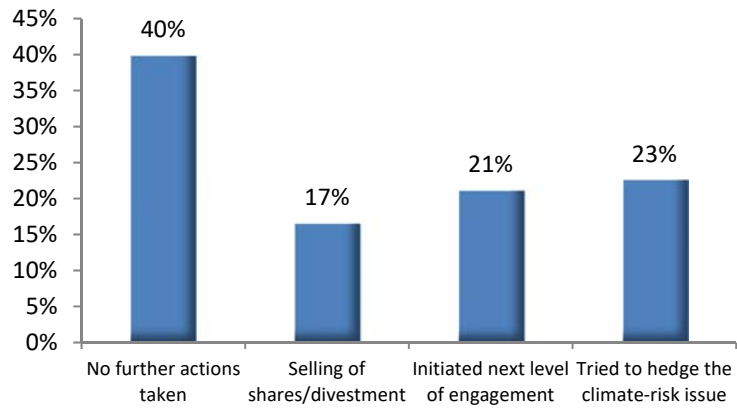


Figure 8: Stranded Asset Risk and Investment Opportunities from Climate Change

Figure 8A reports the investors’ responses to the question of how large they consider the risk that climate change causes some assets to become stranded, i.e., unable to recover their investment cost, with a loss of value for investors. We listed in the survey six industries for which we asked the respondents to evaluate this risk. Respondents could indicate their views on a scale of one (“very high”) through five (“low”). The figure reports the percentage of respondents that considered stranded asset risks to be “very high”. Figure 8B displays in a word cloud the responses that were given to an open question that asked the respondents to indicate in which areas, if any, they see the biggest investment opportunities resulting from climate change. The size of the words in the cloud corresponds to the frequency of their occurrence, with larger font sizes reflecting that an investment opportunity was more frequently stated. We list the top 15 words only.

Figure 8A: Percentage of respondents that believe that stranded asset risk is "very high" in the industry

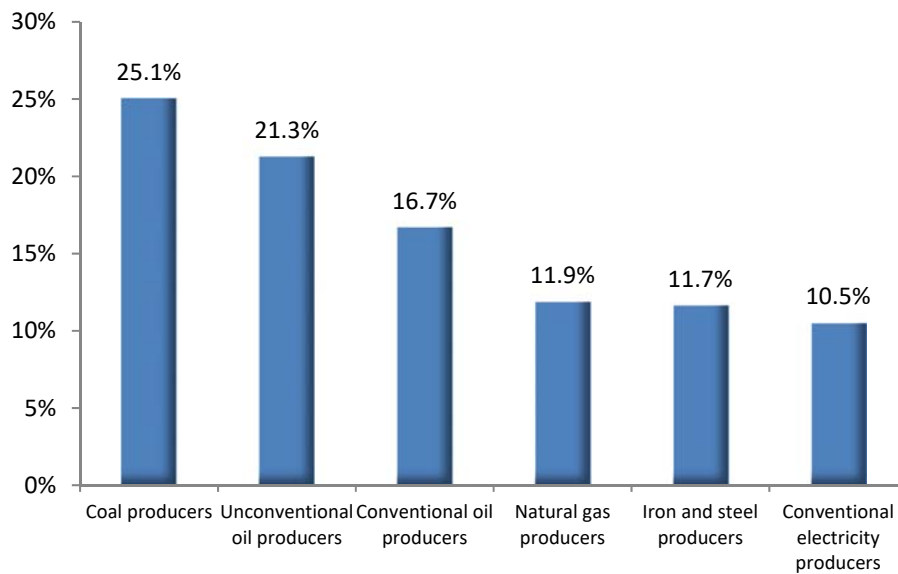


Figure 8B: Investment opportunities from climate change



Figure 9: Disclosure of Climate Risks

Figure 9A illustrates how important investors consider reporting by portfolio firms on climate risks compared to reporting on financial information. Figure 9B reports the percentage of respondents that “strongly agree” to different statements regarding disclosure on climate risks. We rank results based on their relative frequency. Figure 9C reports information about whether the investors engage or plan to engage their portfolio firms to report according to the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). Figure 9D reports whether the investors disclose or plan to disclose the overall carbon footprint of their portfolios.

Figure 9A: How important do you consider reporting by portfolio firms on climate risk compared to reporting on financial information?

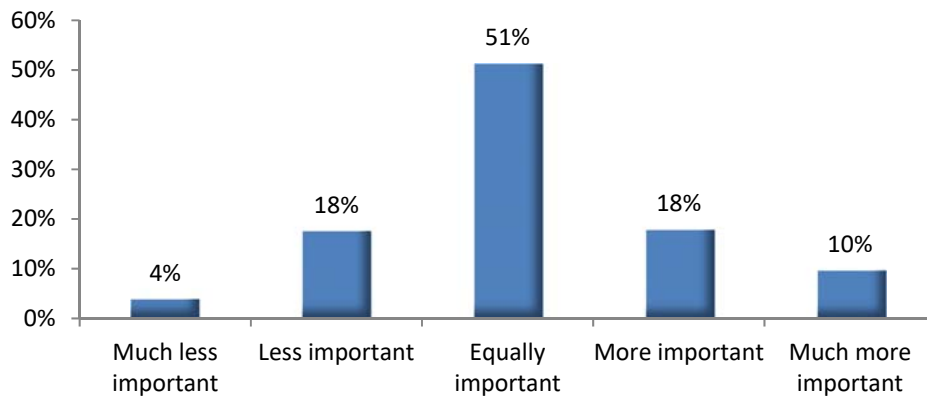


Figure 9B: Views on climate-risk disclosure
Percentage of responses that "strongly agree"

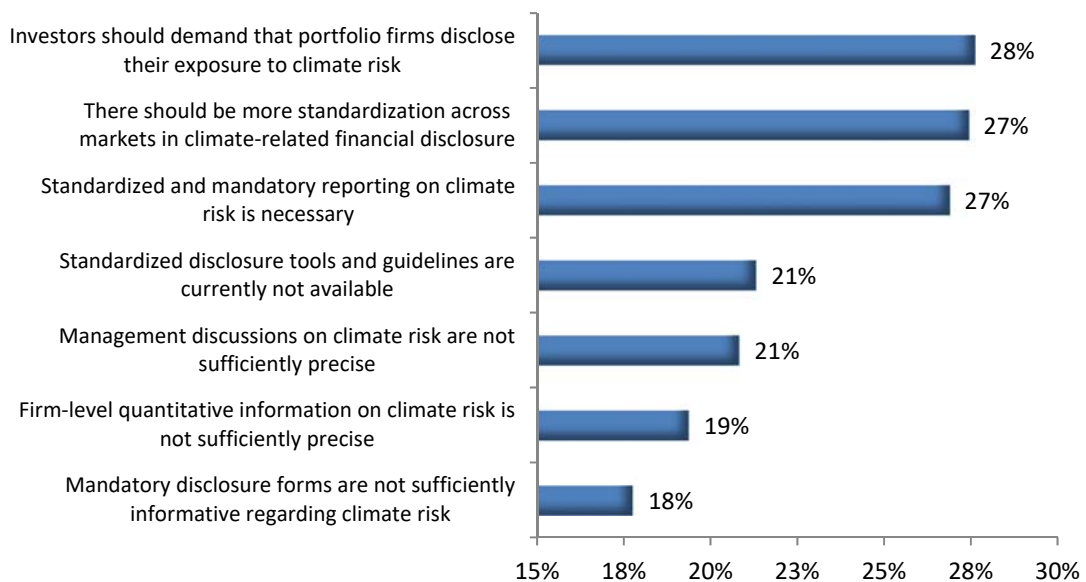


Figure 9 (continued)

Figure 9C: Engagement of portfolio companies to report according to TCFD recommendations?

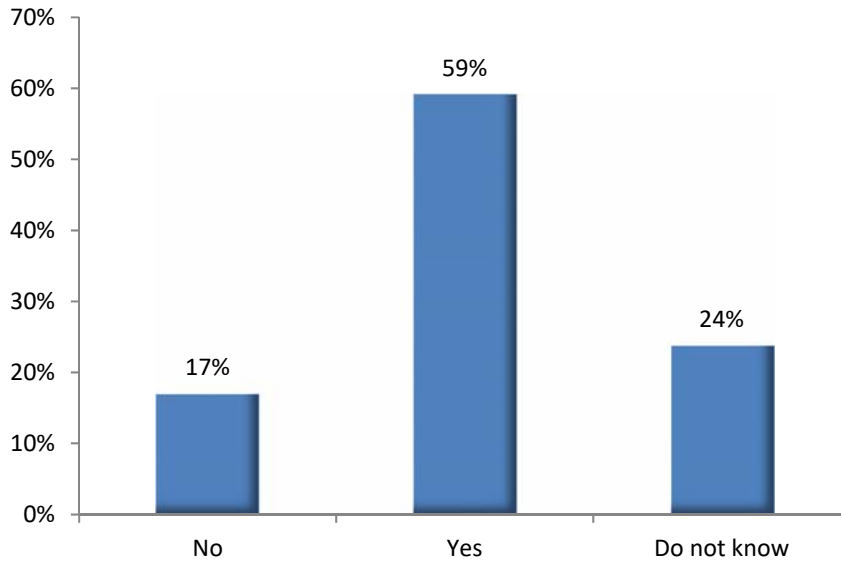


Figure 9D: Carbon-footprint disclosure by investors?

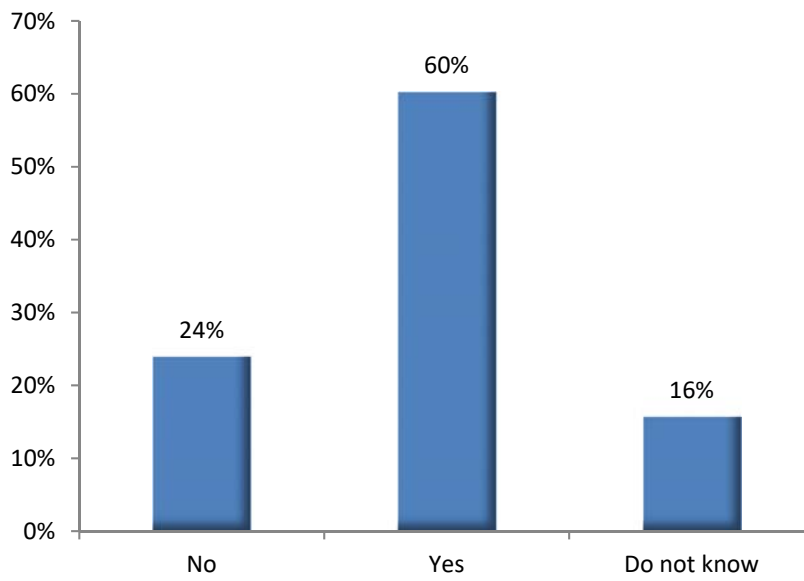


Table 1: Importance of Climate Risk

This table provides summary statistics on the characteristics of the 439 individuals that participated in our survey. As not all respondents provided information on all investor or investment characteristics in our survey, the number of observations in each of the different charts falls below 439. We report data on the position of the responding individuals, type of institution, institution size, investment horizon, geographic distribution, investment structure, and institutional responsibility for climate-risk policies.

Position (N=428)	Percentage	Country (N=429)	Percentage
Fund/Portfolio manager	21%	United States	32%
Executive/Managing director	18%	United Kingdom/Ireland	17%
Investment analyst/strategist	16%	Canada	12%
CIO	11%	Germany	11%
CEO	10%	Italy	7%
CFO/COO/Chairman/Other executive	10%	Spain	5%
ESG/RI specialist	10%	The Netherlands	4%
Other	2%	France	3%
Institutional investor type (N=439)	Percentage	Poland	2%
Asset manager	23%	Switzerland	2%
Bank	22%	Others (<1%)	6%
Pension fund	17%	Investment structure of the portfolio	Mean
Insurance company	15%	ESG share (N=415)	40.6%
Mutual fund	8%	Equity share (N=400)	47.0%
Other institutions	15%	Fixed-income share (N=402)	43.1%
Assets under management (N=430)	Percentage	Passive share (N=419)	38.2%
Less than \$1bn	19%	Positions responsible for climate risk	Percentage
Between \$1bn and \$20bn	32%	CIO	36%
Between \$20bn and \$50bn	23%	Fund/Portfolio manager	29%
Between \$50bn and \$100bn	16%	Investment analyst/strategist	26%
More than \$100bn	11%	CEO	23%
Investor horizon (N=432)	Percentage	ESG/RI specialist	23%
Short (less than 6 months)	5%	CFO/COO/Chairman/Other	19%
Medium (6 months to 2 years)	38%	Executive/Managing director	18%
Long (2 years to 5 years)	38%		
Very long (more than 5 years)	18%		

Table 2: Importance of Climate Risks and Investor Characteristics

This table reports results from OLS regressions relating the perceived importance of climate risks to investor characteristics. We use four dependent variables. *Climate-risk ranking* is the outcome of a ranking of the importance of climate risks relative to other more standard investment risks shown in Figure 2. The variable ranges from one (if considered the most important risk) to six (least important risk). *Regulatory, physical and technological risks* measure the financial materiality of regulatory climate risk, physical climate risk and technological climate risk, respectively. All three variables can range between one (not at all important) and five (very important). *Medium horizon* takes the value one if the indicated typical holding period of an institutional investor is between six months and two years, and zero otherwise. *Long horizon* takes the value one if the indicated holding period of an institutional investor is above two years, and zero otherwise. *Assets under management* indicates the size of an institutional investor and takes the values of one (less than \$1bn); two (between \$1bn and \$20bn); three (between \$20bn and \$50bn); four (between \$50bn and \$100bn); and five (more than \$100bn). *ESG share* is the percentage of the institution's portfolio that incorporates ESG issues. *Passive share* is the percentage of the institution's portfolio that is passively managed. The omitted categories for the region and investor-type dummy variables are North America and a pension fund, respectively. *t*-statistics (reported in parentheses) are based on standard errors that are clustered at the investor-country level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

	Climate-risk ranking (1)	Regulatory risk (2)	Physical risk (3)	Technological risk (4)
Medium horizon	0.21 (0.41)	0.03 (0.13)	0.24 (0.87)	0.44 (1.64)
Long horizon	0.44 (0.70)	0.30 (1.21)	0.41** (2.11)	0.59** (2.31)
Assets under management	-0.12 (-1.64)	0.08 (1.63)	0.09** (2.35)	0.03 (0.54)
ESG share (x100)	-0.60 (-1.29)	0.17 (0.56)	0.58*** (3.78)	0.48*** (3.85)
Passive share (x100)	-0.37 (-0.89)	0.16 (0.38)	0.19 (1.16)	0.05 (0.17)
Continental Europe	0.02 (0.07)	-0.28 (-1.66)	-0.19** (-2.27)	-0.23* (-1.80)
United Kingdom/Ireland	0.06 (0.86)	0.08 (0.71)	-0.23*** (-7.15)	0.05 (0.48)
Rest of World	-0.38 (-0.66)	0.28 (0.87)	0.48** (2.26)	-0.27 (-0.81)
Bank	-0.37 (-1.01)	0.26* (2.00)	0.46*** (3.29)	0.25 (1.43)
Insurance company	-0.58 (-1.70)	0.27* (1.97)	0.07 (0.50)	0.14 (0.82)
Mutual fund	0.10 (0.30)	0.37* (2.05)	0.40 (1.32)	0.56*** (3.53)
Asset manager	-0.08 (-0.29)	0.49*** (4.88)	0.10 (0.85)	0.05 (0.29)
Other institution	-0.45 (-1.52)	0.22** (2.21)	0.23 (1.70)	0.27 (0.96)
Constant	4.74*** (17.88)	3.22*** (16.96)	2.64*** (8.68)	2.96*** (8.77)
N	368	376	376	376
Adj. R-sq.	0.006	0.020	0.054	0.027

Table 3: Motivation to Incorporate Climate Risks and Investor Characteristics

This table reports results of OLS regressions relating motivations for incorporating climate risks to investor characteristics. We use two dependent variables. *Financial motives* is an index that averages the responses on three questions about incorporating climate risk because of primarily financial reasons (whether it is beneficial to returns, reduces overall portfolio risk, and reduces tail risk). *Nonfinancial motives* is an index that averages the responses on eight questions about incorporating climate risks due to motives that include possible nonfinancial motives (e.g., because of representation of asset owners' investment preferences or because of moral/ethical obligations). For both dependent variables, the variable ranges from one to five, with larger numbers indicating stronger average agreement with the statements. *Climate-risk materiality* is an index that averages the responses to three questions about the financial materiality of regulatory, physical, and technological climate risk. Each of these three variables can range between one (not at all important) and five (very important). *Medium horizon* takes the value one if the indicated holding period of an institutional investor is between six months and two years, and zero otherwise. *Long horizon* takes the value one if the indicated holding period of an institutional investor is above two years, and zero otherwise. *Assets under management* indicates the size of an institutional investor and takes the values of one (less than \$1bn); two (between \$1bn and \$20bn); three (between \$20bn and \$50bn); four (between \$50bn and \$100bn); and five (more than \$100bn). *ESG share* is the percentage of the institution's portfolio that incorporates ESG issues. *Passive share* is the percentage of the institution's portfolio that is passively managed. The omitted categories for the region and investor-type dummy variables are North America and a pension fund, respectively. *t*-statistics (reported in parentheses) are based on standard errors that are clustered at the investor-country level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

	Financial motives	Non-financial motives
	(1)	(2)
Climate-risk materiality	0.20*** (4.13)	0.20*** (3.89)
Medium horizon	0.13 (0.96)	0.18 (0.84)
Long horizon	0.11 (1.03)	0.11 (0.64)
Assets under management	0.05 (1.39)	0.03* (1.87)
ESG share (x100)	0.44*** (2.94)	0.14 (1.51)
Passive share (x100)	0.34*** (3.36)	0.15 (1.13)
Continental Europe	0.01 (0.17)	-0.05 (-0.97)
United Kingdom/Ireland	-0.08 (-1.23)	-0.06 (-1.54)
Rest of World	-0.17 (-0.69)	-0.29 (-0.99)
Bank	-0.24** (-2.40)	0.04 (0.56)
Insurance company	-0.17 (-1.17)	-0.06 (-0.61)
Mutual fund	-0.33* (-1.73)	-0.19 (-1.33)
Asset manager	-0.27** (-2.69)	-0.04 (-0.90)
Other institution	-0.10 (-0.62)	0.15* (1.95)
Constant	2.71*** (7.50)	2.76*** (6.91)
N	373	373
Adj. R-sq.	0.135	0.099

Table 4: Climate-Risk-Management Approaches and Investor Characteristics

This table reports results of OLS regressions relating climate-risk-management approaches to investor characteristics. *Climate-risk management* is an index of the number of approaches used in the past five years to incorporate climate risks into the investment process. *Climate-risk materiality* is an index that averages the responses to three questions about the financial materiality of regulatory, physical, and technological climate risk. Each of these three variables can range between one (not at all important) and five (very important). *Climate-risk horizon* is an index that averages the responses to three questions about when the risk related to climate change will materialize financially. Smaller numbers indicate that the risks will materialize sooner. *Medium horizon* takes the value one if the indicated holding period of an institutional investor is between six months and two years, and zero otherwise. *Long horizon* takes the value one if the indicated holding period of an institutional investor is above two years, and zero otherwise. *Assets under management* indicates the size of an institutional investor and takes the values of one (less than \$1bn); two (between \$1bn and \$20bn); three (between \$20bn and \$50bn); four (between \$50bn and \$100bn); and five (more than \$100bn). *ESG share* is the percentage of the institution's portfolio that incorporates ESG issues. *Passive share* is the percentage of the institution's portfolio that is passively managed. *Climate risk history* measures how many years ago the institutions started to incorporate climate risk into the investment process. The omitted categories for the region and investor-type dummy variables are North America and a pension fund, respectively. *t*-statistics (reported in parentheses) are based on standard errors that are clustered at the investor-country level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

	Climate-risk management				
	(1)	(2)	(3)	(4)	(5)
Climate-risk materiality	0.51*** (8.17)				0.47*** (7.41)
Climate-risk horizon		-0.05 (-0.26)			0.01 (0.05)
Medium horizon			0.86*** (3.37)		0.59* (2.02)
Long horizon			1.21*** (3.01)		0.77* (1.98)
Assets under management				0.23** (2.36)	0.17 (1.68)
ESG share (x100)	1.84*** (4.48)	2.05*** (4.71)	2.06*** (4.29)	1.95*** (3.88)	1.71*** (3.92)
Passive share (x100)	-0.04 (-0.07)	0.01 (0.03)	-0.12 (-0.23)	0.09 (0.14)	-0.04 (-0.07)
Climate-risk history	0.10*** (4.07)	0.10*** (4.24)	0.09*** (3.01)	0.10*** (3.81)	0.09*** (3.59)
Continental Europe	0.49* (2.04)	0.38 (1.58)	0.35 (1.52)	0.34 (1.46)	0.45* (1.89)
United Kingdom/Ireland	-0.28*** (-3.27)	-0.37*** (-3.42)	-0.30*** (-2.96)	-0.24** (-2.14)	-0.26*** (-2.99)
Rest of World	0.80 (1.65)	1.02** (2.26)	0.92** (2.15)	0.99** (2.48)	0.67 (1.34)
Bank	-0.56 (-1.52)	-0.37 (-0.98)	-0.37 (-1.03)	-0.30 (-0.77)	-0.37 (-1.06)
Insurance company	-0.33 (-0.72)	-0.22 (-0.48)	-0.24 (-0.52)	-0.08 (-0.17)	-0.10 (-0.22)
Mutual fund	0.61 (1.50)	0.85* (1.94)	0.89* (2.08)	0.96** (2.11)	0.87** (2.18)
Asset manager	0.34 (0.65)	0.50 (0.94)	0.47 (0.91)	0.58 (1.04)	0.56 (1.13)
Other institution	0.15 (0.34)	0.28 (0.67)	0.28 (0.66)	0.46 (0.90)	0.44 (1.00)
Constant	0.25 (0.60)	1.95*** (3.51)	1.17** (2.33)	1.25* (1.93)	-0.77 (-1.00)
N	364	363	363	364	362
Adj. R-sq.	0.175	0.143	0.148	0.155	0.182

Table 5: Climate-Risk Engagement and Investor Characteristics

This table reports results of OLS regressions relating the number of climate-risk-engagement channels to investor characteristics. *Climate-risk engagement* is an index of the number of different direct engagement channels that an investor has taken in the past five years. *Climate-risk materiality* is an index that averages the responses to three questions about the financial materiality of regulatory, physical, and technological climate risk. Each of these three variables can range between one (not at all important) and five (very important). *Climate-risk horizon* is an index that averages the responses to three questions about when the risk related to climate change will materialize financially. Smaller numbers indicate that the risks will materialize sooner. *Medium horizon* takes the value one if the indicated holding period of an institutional investor is between six months and two years, and zero otherwise. *Long horizon* takes the value one if the indicated holding period of an institutional investor is above two years, and zero otherwise. *Assets under management* indicates the size of an institutional investor and takes the values of one (less than \$1bn); two (between \$1bn and \$20bn); three (between \$20bn and \$50bn); four (between \$50bn and \$100bn); and five (more than \$100bn). *ESG share* is the percentage of the institution's portfolio that incorporates ESG issues. *Passive share* is the percentage of the institution's portfolio that is passively managed. *Climate-risk history* measures how many years ago the institutions started to incorporate climate risk in the investment process. The omitted categories for the region and investor-type dummy variables are North America and a pension fund, respectively. *t*-statistics (reported in parentheses) are based on standard errors that are clustered at the investor-country level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

	Climate-risk engagement				
	(1)	(2)	(3)	(4)	(5)
Climate-risk materiality	0.42*** (4.78)				0.39*** (4.19)
Climate-risk horizon		-0.33*** (-3.40)			-0.26** (-2.61)
Medium horizon			0.60*** (2.99)		0.31 (1.29)
Long horizon			0.33 (1.17)		-0.04 (-0.12)
Assets under management				0.12** (2.70)	0.11* (2.07)
ESG share (x100)	0.74** (2.50)	0.89*** (2.91)	0.94** (2.73)	0.87** (2.40)	0.64** (2.16)
Passive share (x100)	-0.39 (-0.74)	-0.37 (-0.83)	-0.39 (-0.82)	-0.31 (-0.61)	-0.36 (-0.69)
Climate-risk history	0.04*** (4.48)	0.06*** (3.84)	0.05*** (3.81)	0.05*** (4.07)	0.05*** (4.21)
Continental Europe	0.29* (1.91)	0.25 (1.65)	0.21 (1.21)	0.18 (0.93)	0.33** (2.45)
United Kingdom/Ireland	0.00 (0.02)	-0.06 (-0.43)	-0.02 (-0.10)	0.01 (0.06)	0.02 (0.15)
Rest of World	0.61 (1.02)	0.65 (1.18)	0.90* (1.80)	0.78 (1.50)	0.56 (0.87)
Bank	0.06 (0.38)	0.16 (1.04)	0.17 (1.14)	0.24 (1.58)	0.11 (0.58)
Insurance company	-0.16 (-0.72)	-0.09 (-0.44)	-0.08 (-0.41)	-0.01 (-0.05)	-0.02 (-0.10)
Mutual fund	0.32 (1.15)	0.48** (2.31)	0.48** (2.41)	0.56** (2.47)	0.40 (1.35)
Asset manager	0.23* (1.93)	0.32* (2.06)	0.31* (2.05)	0.39** (2.58)	0.31** (2.69)
Other institution	0.30 (1.64)	0.39** (2.52)	0.38** (2.49)	0.48** (2.62)	0.46** (2.78)
Constant	0.16 (0.70)	1.92*** (7.46)	1.05*** (3.05)	1.19*** (3.33)	-0.09 (-0.27)
N	364	363	363	364	362
Adj. R-sq.	0.106	0.077	0.062	0.062	0.130

Table 6: Pricing of Climate Risks across Industry Sectors

This table reports survey responses to a question that asked respondents to evaluate to what extent equity valuations of firms in different industries reflect the risk and opportunities related to climate change. Responses for each industry can range between plus two (valuations much too high) and minus two (valuations much too low). The table reports in Column (1) the mean scores across all respondents and in Column (2) the corresponding standard deviations. Column (3) reports a measure of relative misvaluation across industries. It is constructed as the mean industry score divided by the mean score across all industries, minus 1. We also report in Columns (4) and (5) the percentage of respondents that indicate valuation levels that are “much too high” or “much too low”. Column (6) reports the mean score only for those respondents that indicate that they are “relatively confident” about their valuation assessment. We rank responses by the mean score in Column (1).

Industry	Mean score (1)	STD (2)	Relative industry misvaluation (3)	Percentage with score of +2 (much too high) (4)	Percentage with score of -2 (much too low) (5)	Mean Score (Confident respondents) (6)
Oil	0.52	1.03	37%	17%	3%	0.59
Automotive (traditional)	0.48	0.94	25%	14%	2%	0.53
Electric utilities	0.47	0.91	25%	13%	3%	0.48
Information Technology	0.47	0.98	23%	16%	3%	0.50
Insurance	0.46	0.91	21%	14%	1%	0.39
Natural gas	0.44	0.91	17%	11%	2%	0.51
Coastal real estate	0.43	0.96	13%	14%	3%	0.43
Gas utilities	0.40	0.94	6%	11%	4%	0.38
Transportation	0.40	0.92	4%	12%	3%	0.37
Construction	0.39	0.90	3%	10%	3%	0.44
Banking	0.38	0.96	0%	13%	4%	0.40
Telecommunications	0.38	0.88	-1%	11%	2%	0.40
Water utilities	0.37	0.96	-2%	13%	3%	0.46
Infrastructure	0.37	0.93	-3%	12%	3%	0.35
Nuclear energy	0.35	1.05	-7%	14%	5%	0.37
Chemicals	0.35	0.96	-8%	12%	3%	0.40
Coal mining	0.35	1.07	-9%	16%	5%	0.35
Automotive (electric)	0.33	0.92	-14%	11%	2%	0.36
Renewable energy	0.31	0.98	-17%	11%	3%	0.30
Raw materials (excluding coal)	0.27	0.90	-28%	7%	3%	0.34
Battery producers	0.27	0.97	-28%	11%	4%	0.30
Agriculture	0.27	1.02	-28%	13%	5%	0.39
Forestry and paper	0.27	0.97	-29%	9%	4%	0.36
Mean (Across All Industries)	0.38			12%	3%	0.41

Table 7: Climate-Risk Pricing across Industry Sectors and Investor Characteristics

This table reports results of OLS regressions relating perceptions of climate-risk pricing to investor characteristics. The dependent variable tries to capture the respondents' views on mispricing of climate risks through the use of two indexes. The first index, *Climate-risk underpricing*, approximates the aggregate view about overvaluation across sectors by averaging positive mispricing scores (negative scores are set to zero). The index ranges between plus two (strong average overvaluation) and zero (no average overvaluation). The second index, *Climate-risk mispricing*, is non-directional and captures general mispricing of climate risks by averaging the absolute values of all mispricing. We also report regressions that explain the underpricing of climate risks in the three industries perceived to be most mispriced (oil, utilities and traditional automotive). *Climate-risk materiality* is an index that averages the responses to three questions about the financial materiality of regulatory, physical, and technological climate risk. Each of these three variables can range between one (not at all important) and five (very important). *Climate-risk horizon* is an index that averages the responses to three questions about when the risk related to climate change will materialize financially. Smaller numbers indicate that the risks will materialize sooner. *Medium horizon* takes the value one if the indicated holding period of an institutional investor is between six months and two years, and zero otherwise. *Long horizon* takes the value one if the indicated holding period of an institutional investor is above two years, and 0 otherwise. *Assets under management* indicates the size of an institutional investor and takes the values of one (less than \$1bn); two (between \$1bn and \$20bn); three (between \$20bn and \$50bn); four (between \$50bn and \$100bn); and five (more than \$100bn). *Climate-risk engagement* is an index that counts the number of different direct engagement channels that an investor has taken in the past five years. *Climate-risk management* is an index that counts the number of approaches that were used in the past five years to incorporate climate risks in the investment process. *ESG share* is the percentage of the institution's portfolio that incorporates ESG issues. *Passive share* is the percentage of the institution's portfolio that is passively managed. *Climate-risk history* measures how many years ago the institutions started to incorporate climate risk in the investment process. The omitted categories for the region and investor-type dummy variables are North America and a pension fund, respectively. *t*-statistics (reported in parentheses) are based on standard errors that are clustered at the investor-country level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

Table 7 (continued)

	Climate-risk underpricing		Climate-risk mispricing		Climate-risk underpricing		
	Average across all sectors		Average across all sectors		Oil	Automotive (traditional)	Electric utilities
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Climate-risk materiality	-0.01 (-0.26)	-0.00 (-0.05)	0.03 (0.85)	0.04 (1.22)	0.03 (0.53)	-0.05 (-0.65)	-0.04 (-0.88)
Climate-risk horizon	0.01 (0.31)	-0.00 (-0.02)	0.05 (1.40)	0.04 (1.22)	0.02 (0.46)	0.12** (2.17)	-0.02 (-0.43)
Medium horizon	-0.07 (-0.47)	-0.06 (-0.46)	-0.00 (-0.02)	0.01 (0.05)	0.08 (0.56)	0.03 (0.15)	-0.18 (-1.04)
Long horizon	-0.02 (-0.15)	-0.02 (-0.20)	0.01 (0.07)	0.01 (0.12)	0.10 (0.66)	0.02 (0.06)	-0.17 (-1.13)
Climate-risk engagement	0.03* (2.05)		0.03* (2.03)		0.01 (0.42)	0.06*** (3.00)	0.02 (0.76)
Climate-risk management		0.01 (1.01)		-0.00 (-0.21)			
Assets under management	0.03 (1.52)	0.03 (1.64)	-0.00 (-0.10)	0.00 (0.05)	-0.04 (-1.20)	0.04 (1.33)	0.09** (2.27)
ESG share (x100)	0.32*** (4.50)	0.33*** (4.41)	0.21*** (3.39)	0.23*** (3.85)	0.34** (2.21)	0.27** (2.83)	0.53*** (3.54)
Passive share (x100)	-0.00 (-0.05)	-0.02 (-0.18)	-0.03 (-0.30)	-0.04 (-0.40)	0.28 (1.72)	0.09 (0.47)	0.08 (0.41)
Climate-risk history	-0.00 (-0.58)	-0.00 (-0.49)	-0.00 (-0.22)	0.00 (0.07)	0.01 (0.85)	-0.01 (-1.41)	0.00 (0.61)
Continental Europe	-0.03 (-0.83)	-0.02 (-0.65)	-0.03 (-0.65)	-0.02 (-0.43)	-0.04 (-0.41)	-0.01 (-0.10)	-0.04 (-1.02)
United Kingdom/Ireland	-0.02 (-1.06)	-0.02 (-0.91)	-0.03 (-1.36)	-0.03 (-1.27)	0.04 (1.20)	-0.08* (-1.91)	0.02 (0.54)
Rest of World	0.12 (0.76)	0.13 (0.85)	0.13 (1.05)	0.15 (1.14)	-0.00 (-0.01)	-0.15 (-0.68)	-0.46* (-1.99)
Bank	0.06 (0.79)	0.06 (0.84)	0.04 (0.52)	0.04 (0.52)	-0.11 (-0.42)	0.23 (1.23)	0.14 (1.15)
Insurance company	-0.07 (-1.17)	-0.08 (-1.36)	-0.12 (-1.17)	-0.12 (-1.26)	-0.12 (-0.53)	0.01 (0.07)	-0.06 (-0.42)
Mutual fund	-0.07 (-0.82)	-0.07 (-0.78)	-0.05 (-0.85)	-0.04 (-0.69)	-0.06 (-0.43)	0.10 (0.81)	0.00 (0.01)
Asset manager	-0.06 (-1.11)	-0.06 (-0.99)	-0.13*** (-2.98)	-0.12** (-2.72)	-0.13 (-0.97)	0.07 (1.21)	0.08 (1.22)
Other institution	0.07* (2.01)	0.08** (2.14)	0.02 (0.26)	0.03 (0.48)	-0.04 (-0.18)	0.04 (0.40)	0.35*** (4.16)
Constant	0.42* (1.99)	0.43* (2.01)	0.55** (2.75)	0.55** (2.79)	0.39 (1.52)	0.23 (0.60)	0.38 (1.31)
N	343	343	343	343	340	341	340
Adj. R-sq.	0.054	0.045	0.034	0.026	-0.007	0.016	0.048

Internet Appendix

for

The Importance of Climate Risks for Institutional Investors

Philipp Krueger

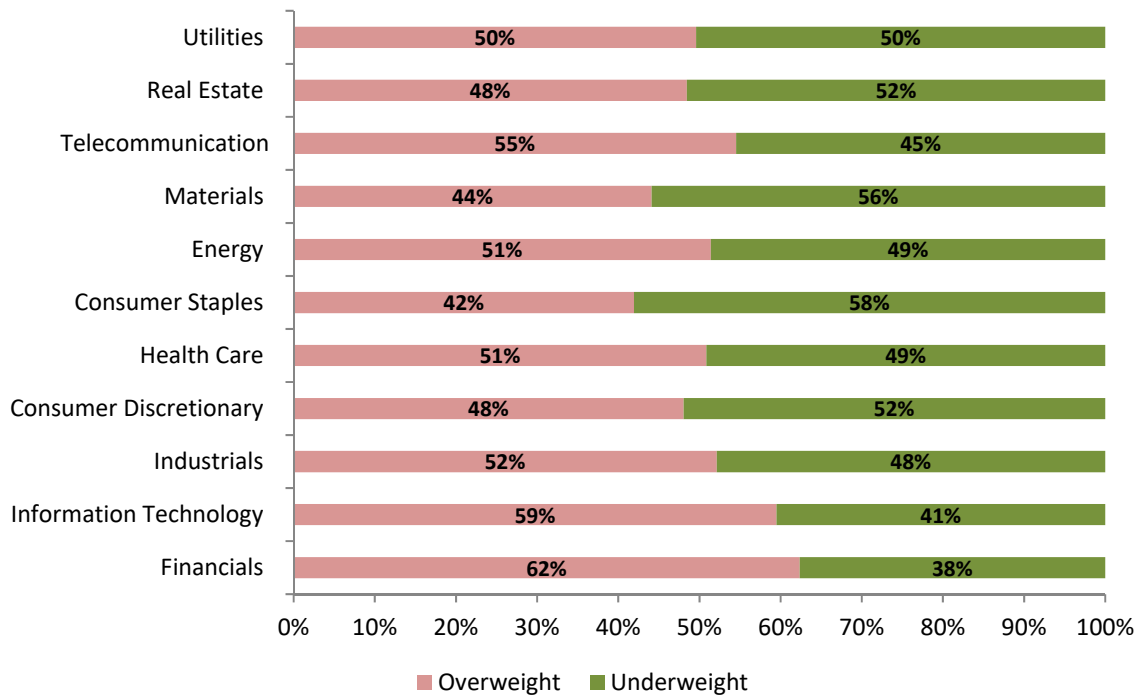
Zacharias Sautner

Laura T. Starks

Internet Appendix A: Additional Figures and Tables

Internet Appendix Figure 1: Portfolio Holdings Relative to Low-Carbon Benchmark

This figure compares the institutional investors' portfolio holdings in different sectors relative to a low-carbon benchmark. We report the percentage of respondents that indicated that they are overweight or underweight in a sector. As a benchmark we used sector-weights in the MSCI ACWI Low Carbon Target Index, which includes large and mid-sized equities with a lower carbon exposure than the market (i.e., it is overweighting firms with low carbon emissions). We provided the respondents with information on the index weight when asking whether they are over- or underweight relative to the index.



Internet Appendix Figure 2: Comparison of Sample Characteristics with Universe of Institutional Investors

These figures compare key characteristics of the institutional investors in our sample with those of the universe of institutional investors as defined by the FactSet Standard Entity database. Summary statistics of the sample are identical to the statistics reported in Table 1. In Figure 2A we use the FactSet item “entity_sub_type” to identify institutional investor types. Pension fund, Insurance and Mutual Fund correspond to “Pension fund manager”, “Insurance Company”, and “Mutual fund manager” entity structures, respectively. Bank corresponds to “Bank investment division” and “Investment banking”. Asset manager includes “Fund of funds manager”, “Fund of hedge funds manager”, “Private banking/Wealth Management”, “Real estate manager”, “Family office” and “Investment Company entities”. In Figure 2B assets under management measure the market value of a given fund portfolio. We use the Ownership (LionShares) - Unadjusted Fund Holdings Historical database to compute the market values of each fund portfolios. In Figure 2C we identify the geographic region of an institution by using FactSet item “ISO_country”, which reports the country in which a security is domiciled. We do not use the fund country of incorporation since “ISO_country” better matches the location of the entity headquarters provided by the variable metro_area that reports the metropolitan area of the fund headquarters. Continental Europe includes Malta and Iceland. Our FactSet data covers the year 2015.

Figure 2A: Institutional investor type

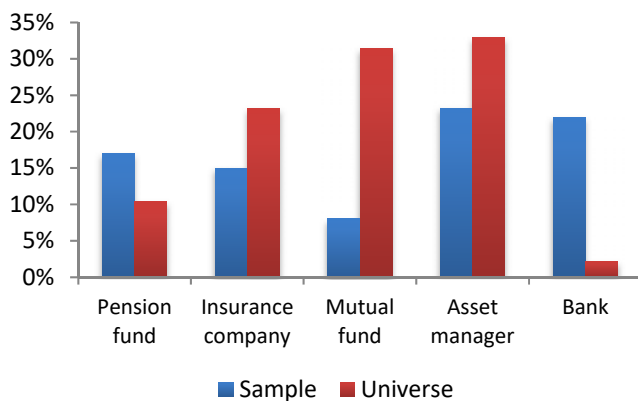


Figure 2B: Assets under management

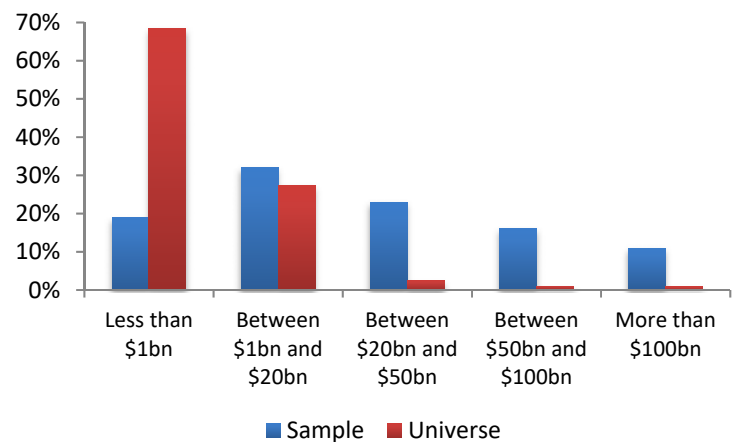
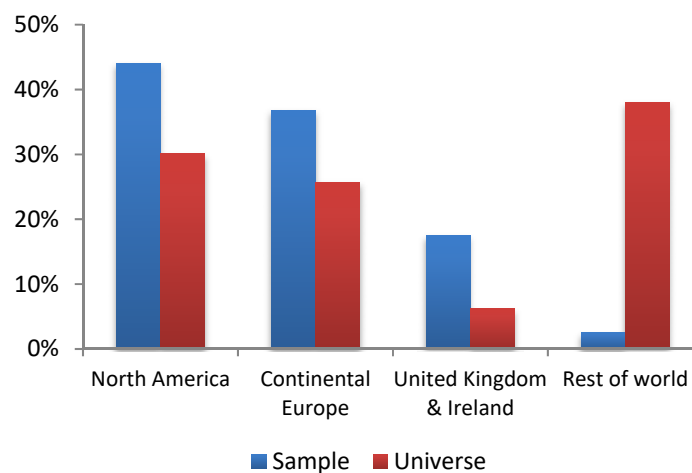


Figure 2C: Region



Internet Appendix Table 1: Comparison of Sample Characteristics across Distribution Channels

This table compares respondent characteristics across the four distribution channels used for the survey. First, we personally distributed the paper version at four institutional investor conferences (“Conferences”). We obtained a total of 72 responses from these four conferences. Second, we distributed the survey to a list of investment professionals compiled by a professional survey service provider that manages a large global panel of more than 5m registered participants (“Panel”). We received 320 responses through this channel. Third, we emailed invitations to participate in the survey to a list of institutional investors that cooperate with a major asset owner (“AO”) on climate-risk topics through CERES and IIGCC. We obtained 28 responses through this channel. Fourth, we sent invitations to participate in the online survey to personal contacts of the authors (“Personal”) who work at different institutional investors, yielding 17 additional responses.

	Conferences	Panel	AO	Personal		Conferences	Panel	AO	Personal
N	72	320	28	19	Percent of sample	16%	73%	6%	4%
	Conferences	Panel	AO	Personal		Conferences	Panel	AO	Personal
Fund/Portfolio Manager	10%	25%	14%	11%	None	0%	4%	0%	0%
Investment analyst/strategist	19%	17%	9%	11%	Up to 1 degree	7%	18%	6%	0%
CIO	4%	13%	0%	11%	Up to 2 degrees	21%	33%	6%	25%
CFO/COO/Chairman/Other executive	15%	10%	5%	0%	Up to 3 degrees	45%	24%	53%	50%
CEO	6%	13%	9%	0%	More than 3 degrees	10%	12%	12%	25%
Executive/Managing director	7%	22%	50%	0%	Do not know	17%	8%	24%	0%
ESG/RI specialist	22%	2%	14%	67%		Conferences	Panel	AO	Personal
Other	16%	0%	0%	0%	Short (less than 6 months)	4%	6%	0%	0%
	Conferences	Panel	AO	Personal	Medium (6 months to 2 years)	15%	46%	19%	18%
Pension fund	43%	9%	29%	37%	Long (2 years to 5 years)	49%	35%	44%	47%
Insurance company	0%	20%	0%	11%	Very long (more than 5 years)	32%	12%	37%	35%
Mutual fund management company	3%	10%	7%	5%		Conferences	Panel	AO	Personal
Asset manager	31%	19%	32%	42%	ESG share	55%	33%	87%	74%
Bank	8%	27%	4%	5%	Equity share	51%	46%	65%	40%
Other institutions	15%	15%	29%	14%	Fixed-income share	43%	44%	23%	49%
	Conferences	Panel	AO	Personal	Passive share	35%	40%	33%	29%
Less than \$1bn	6%	22%	19%	6%		Conferences	Panel	AO	Personal
Between \$1bn and \$20bn	23%	34%	33%	28%	Fund/Portfolio manager	36%	26%	22%	16%
Between \$20bn and \$50bn	18%	24%	29%	11%	Investment analyst/strategist	21%	27%	20%	8%
Between \$50bn and \$100bn	21%	15%	5%	22%	CIO	41%	34%	14%	22%
More than \$100bn	32%	5%	14%	33%	CFO/COO/Chairman/Other	7%	23%	6%	4%
	Conferences	Panel	AO	Personal	ESG/RI specialist	15%	27%	8%	0%
North America	28%	47%	45%	39%	Executive/Managing director	7%	23%	4%	2%
Continental Europe	51%	33%	27%	50%	CEO	40%	17%	26%	10%
United Kingdom & Ireland	13%	18%	23%	11%					
Rest of World	9%	1%	5%	17%					

Internet Appendix Table 2: Internal Validity of Responses

This table reports results of OLS regressions relating climate-risk financial materiality measures to investor characteristics. We use three dependent variables. *Regulatory risk* measures the financial materiality of regulatory climate risk. *Physical risk* measures the financial materiality of physical climate risk. *Technological risk* measures the financial materiality of technological climate risk. All three variables can range between one (not at all important) and five (very important). *Climate expectation* is the respondents' personal expectations for the global temperature rise by the end of the century. We anchored expectations by referring to the two degrees Celsius target of the 2016 Paris Climate Accord. Respondents were asked to state their own expectations. Larger numbers for the variable indicate higher expected temperatures. The omitted categories for the region and investor-type dummy variables are North America and a pension fund, respectively. The United Kingdom dummy includes Ireland. *t*-statistics (reported in parentheses) are based on standard errors that are clustered at the investor-country level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

	Regulatory risk (1)	Physical risk (2)	Technological risk (3)
Climate expectation	0.18*** (3.46)	0.25*** (10.18)	0.25*** (5.20)
Continental Europe	-0.34* (-1.99)	-0.15 (-1.42)	-0.22* (-1.94)
United Kingdom/Ireland	0.00 (0.00)	-0.24** (-2.45)	-0.07 (-0.51)
Rest of World	0.56*** (3.41)	0.51*** (3.19)	-0.16 (-0.46)
Bank	0.10 (0.61)	0.31 (1.28)	0.09 (0.52)
Insurance company	0.08 (0.42)	0.04 (0.16)	0.05 (0.27)
Mutual fund	0.10 (0.36)	0.16 (0.36)	0.20 (1.22)
Asset manager	0.36 (1.46)	0.06 (0.26)	0.02 (0.16)
Other institution	0.04 (0.16)	0.10 (0.42)	-0.02 (-0.07)
Constant	3.22*** (24.94)	2.74*** (11.26)	3.05*** (10.96)
N	341	341	341
Adj. R-sq.	0.054	0.063	0.051

Internet Appendix B: Survey Instrument



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Frankfurt School
of Finance & Management
German Excellence. Global Relevance.

Survey on Climate Risk

We are a team of professors from the University of Geneva, the Swiss Finance Institute, the University of Texas at Austin, and Frankfurt School of Finance & Management.

This survey seeks a better understanding of whether and how institutional investors incorporate **climate risk** when making investment decisions. The survey will take about **10 minutes**.

You can use this survey questionnaire or take the survey online at: <http://bit.ly/2l8uLRi>

We take the **confidentiality** of your responses very seriously. We **will not share your responses** with anyone, nor will individual firms or respondents be identified. Only aggregate data will be made public. We will not link the survey responses to any other data.

Thank you for participating in this survey. If you have any questions, please contact us.

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GENERAL INFORMATION

G1: How is the institution at which you work best described?

- | | |
|--|---|
| <input type="checkbox"/> Public pension fund | <input type="checkbox"/> Private pension fund |
| <input type="checkbox"/> Insurance company | <input type="checkbox"/> Hedge fund |
| <input type="checkbox"/> Mutual fund management company | <input type="checkbox"/> Private equity fund |
| <input type="checkbox"/> Asset manager (for pension funds, endowments, etc.) | <input type="checkbox"/> Endowment, charity |
| <input type="checkbox"/> Sovereign wealth fund | <input type="checkbox"/> Bank |
| <input type="checkbox"/> Other (please specify): _____ | |

G2: What is the typical holding period for investments in your portfolio, on average?

- Short (less than 6 months)
- Medium (6 months to 2 years)
- Long (2 years to 5 years)
- Very long (more than 5 years)

G3: What percentage of your portfolio is invested in fixed income versus equity securities?

___ % in fixed income
___ % in equities

G4: What percentage of your portfolio is invested actively versus passively?

___ % in active investments
___ % in passive investments

G5: What percentage of your portfolio incorporates Environmental, Social and Governance (ESG) issues? ___ %

G6: What is the total size of assets under management for your institution?

- | | |
|--|---|
| <input type="checkbox"/> Less than \$1 billion | <input type="checkbox"/> Between \$1 billion and \$20 billion |
| <input type="checkbox"/> Between \$20 billion and \$50 billion | <input type="checkbox"/> Between \$50 billion and \$100 billion |
| <input type="checkbox"/> More than \$100 billion | |

G7: In which country are your institution's headquarters based? _____

G8: What is your position?

- | | |
|---|--|
| <input type="checkbox"/> Fund/Portfolio Manager | <input type="checkbox"/> Chief Executive Officer |
| <input type="checkbox"/> Investment Analyst/Strategist | <input type="checkbox"/> Executive/Managing Director |
| <input type="checkbox"/> Chief Investment Officer | <input type="checkbox"/> ESG/Responsible Investment Specialist |
| <input type="checkbox"/> CFO/COO/Chairman/Other Executive | <input type="checkbox"/> Other (please explain): _____ |

PART A: IMPORTANCE OF CLIMATE RISK

A1: Please rank the following six risks when making investments in portfolio firms from 1 to 6, where 1 is the most important to you and 6 the least important.

Financial risk (earnings, leverage, payout policy, etc.)	
Operating risk (changes in demand, input costs, etc.)	
Governance risk (board structure, executive pay, etc.)	
Social risk (labor standards, human rights, etc.)	
Climate risk	
Other environmental risk (pollution, recycling, etc.)	

A2: We have divided climate risk into regulatory risks (changes in regulation), physical risks (changes in the physical climate), and technological risks (climate-related technological disruption). Please rate the financial materiality of these risks.

	Not at all important	Slightly important	Important	Fairly important	Very important
Regulatory risks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Physical risks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Technological risks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

A3: Over what time horizons, if any, do you expect these risks to materialize financially? (Choose only one time horizon per risk category)

Regulatory risks	Physical risks	Technological risks
<input type="checkbox"/> Already today	<input type="checkbox"/> Already today	<input type="checkbox"/> Already today
<input type="checkbox"/> <2 years	<input type="checkbox"/> <2 years	<input type="checkbox"/> <2 years
<input type="checkbox"/> 2 to 5 years	<input type="checkbox"/> 2 to 5 years	<input type="checkbox"/> 2 to 5 years
<input type="checkbox"/> 5 to 10 years	<input type="checkbox"/> 5 to 10 years	<input type="checkbox"/> 5 to 10 years
<input type="checkbox"/> 10 to 25 years	<input type="checkbox"/> 10 to 25 years	<input type="checkbox"/> 10 to 25 years
<input type="checkbox"/> >25 years	<input type="checkbox"/> >25 years	<input type="checkbox"/> >25 years
<input type="checkbox"/> Never	<input type="checkbox"/> Never	<input type="checkbox"/> Never
<input type="checkbox"/> Uncertainty is too great to provide an estimate	<input type="checkbox"/> Uncertainty is too great to provide an estimate	<input type="checkbox"/> Uncertainty is too great to provide an estimate

A4: To what extent do you agree with the following statements?

Incorporating climate risk ...	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
• Is beneficial to investment returns	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Reduces overall portfolio risk	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Reduces tail risks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Protects our reputation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Helps attract fund flows	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Reflects our asset owners' investment preferences	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Allows us to address negative spillovers from individual firms	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Is a legal obligation/fiduciary duty that we have to consider	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Follows the concerns of other institutional investors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Is a moral/ethical obligation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Is increasingly stressed by proxy voting advisors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

A5: When did you start to incorporate climate risk into your investment process, if at all? Approximately ____ years ago

PART B: DISCLOSURE ON CLIMATE RISK

B1: How important do you consider reporting by portfolio firms on climate risk compared to reporting on financial information?

Much less important	Less important	Equally important	More important	Much more important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

B2: Do you disclose (or plan to disclose) the overall carbon footprint of your portfolio?

- No Yes Do not know

B3: To what extent do you agree with the following statements regarding climate-risk disclosure by portfolio firms?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
• Investors should demand that portfolio firms disclose their exposure to climate risk	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Firm-level quantitative information on climate risk is not sufficiently precise	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Management discussions on climate risk are not sufficiently precise	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Standardized and mandatory reporting on climate risk is necessary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Mandatory disclosure forms are not sufficiently informative regarding climate risk	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• There should be more standardization across markets in climate-related financial disclosure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• Standardized disclosure tools and guidelines are currently not available	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

PART C: CLIMATE RISK MANAGEMENT & ENGAGEMENT

C1: Which approaches, if any, have you taken in the past five years to incorporate climate risk in your investment process? (Choose all that apply)

- | | |
|--|--|
| <ul style="list-style-type: none"> <input type="checkbox"/> None <input type="checkbox"/> Negative/exclusionary screening <input type="checkbox"/> Analyzing carbon footprint of portfolio firms <input type="checkbox"/> Reducing carbon footprint of portfolio firms <input type="checkbox"/> Divestment <input type="checkbox"/> General portfolio diversification <input type="checkbox"/> Use of third-party ESG ratings | <ul style="list-style-type: none"> <input type="checkbox"/> Firm valuation models that incorporate climate risk <input type="checkbox"/> Shareholder proposals <input type="checkbox"/> ESG integration <input type="checkbox"/> Analyzing stranded asset risk <input type="checkbox"/> Reducing stranded asset risk <input type="checkbox"/> Hedging against climate risk <input type="checkbox"/> Other (please explain): _____ |
|--|--|

C2: What measures of direct engagement over climate-risk issues have you taken in the past five years with any of your portfolio companies? (Choose all that apply)

- | | |
|--|---|
| <input type="checkbox"/> None | <input type="checkbox"/> Questioning management on a conference call about climate-risk issues |
| <input type="checkbox"/> Holding discussions with management regarding the financial implications of climate risks | <input type="checkbox"/> Publicly criticizing management on climate-risk issues |
| <input type="checkbox"/> Voting against management on proposals over climate-risk issues at the annual meeting | <input type="checkbox"/> Voting against re-election of any board directors due to climate-risk issues |
| <input type="checkbox"/> Submitting shareholder proposals on climate-risk issues | <input type="checkbox"/> Legal action against management on climate-risk issues |
| <input type="checkbox"/> Other (please explain):
_____ | <input type="checkbox"/> Proposing specific actions to management on climate-risk issues |

C3: If you have directly engaged portfolio companies over climate-risk issues in the past five years, how has the management of the portfolio companies *typically* responded?

- | | |
|--|---|
| <input type="checkbox"/> Firm did not respond | |
| <input type="checkbox"/> Firm responded | What was the typical response (select one only) |
| <input type="checkbox"/> Resistance (against issues raised) | <input type="checkbox"/> Actions were initiated, but not successfully implemented |
| <input type="checkbox"/> Issues were acknowledged | <input type="checkbox"/> Actions were successfully implemented |
| <input type="checkbox"/> Issues were acknowledged, but no actions were taken | <input type="checkbox"/> Other (please explain):
_____ |

C4: If you indicated “Firm did not respond” or “Resistance” in the previous question (C3), how did you *typically* react? (Select one only)

- | | |
|---|--|
| <input type="checkbox"/> No further actions taken | <input type="checkbox"/> Initiated next level of engagement |
| <input type="checkbox"/> Selling of shares/divestment | <input type="checkbox"/> Tried to hedge the climate-risk issue |
| <input type="checkbox"/> Other actions (please explain):
_____ | |

C5: Which of the following approaches, if any, do you use to evaluate the consequences of climate risk for your portfolio? (Choose all that apply)

- | | |
|---|--|
| <input type="checkbox"/> None | <input type="checkbox"/> Scenario analysis and stress tests of climate scenarios |
| <input type="checkbox"/> Measurement of carbon footprint of investments | <input type="checkbox"/> Assessment of the impact of climate change on returns |
| <input type="checkbox"/> Other actions (please explain):
_____ | |

C6: What data sources, if any, do you use to measure the carbon footprint of portfolio companies? (Choose all that apply)

- | | |
|---|--|
| <input type="checkbox"/> Do not know | <input type="checkbox"/> Data from CDP (formerly the Carbon Disclosure Project) |
| <input type="checkbox"/> None, as we do not measure carbon footprints | <input type="checkbox"/> MSCI ESG data |
| <input type="checkbox"/> None, as reliable data do not exist yet | <input type="checkbox"/> Data from other commercial data providers, namely:
_____ |
| <input type="checkbox"/> Self-collected data from corporate disclosures | <input type="checkbox"/> Other (please explain):
_____ |

PART D: PRICING OF CLIMATE RISK

D1: To what extent do equity valuations of firms in different industries reflect the risks and opportunities related to climate change?

Industry	Valuations much too high	Valuations somewhat too high	Valuations more or less correct	Valuations somewhat too low	Valuations much too low
Oil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Natural gas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Renewable energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nuclear energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Electric utilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gas utilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water utilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Coal mining	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Raw materials (excluding coal)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Infrastructure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Chemicals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Automotive (traditional)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Automotive (electric)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Battery producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Construction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Banking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insurance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Agriculture	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Forestry and paper	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Information Technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Telecommunications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Transportation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Coastal real estate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

D2: How confident are you about your assessment in the previous question?

- Relatively confident
 More or less confident
 Not very confident

D3: Responses to climate change may cause some assets to become 'stranded' – i.e. unable to recover their investment cost, with a loss of value for investors. How large do you consider this risk in the following areas:

	Very high	High	Moderate	Low	Do not know
Coal producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Unconventional oil producers (e.g., tar sands, fracking)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Conventional oil producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Natural gas producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Iron and steel producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Conventional electricity producers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

D4: In which areas, if any, do you see the biggest investment opportunities resulting from climate change? (Please explain)

PART E: ADDITIONAL INFORMATION

E1: The Paris Climate Accord aims to keep the global temperature rise “well below 2 degrees Celsius” above pre-industrial levels by the end of this century. What are your expectations for the global temperature rise by the end of this century?

Increase in global temperature by:					
None	Up to 1 degree	Up to 2 degrees	Up to 3 degrees	More than 3 degrees	Do not know
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

E2: How confident are you about your assessment in the previous question?

- Relatively confident
 More or less confident
 Not very confident

E3: In your institution, who is responsible for the implementation of climate risk in the investment process? (Choose all that apply)

- | | |
|---|--|
| <input type="checkbox"/> Fund/Portfolio Manager
<input type="checkbox"/> Investment Analyst/Strategist
<input type="checkbox"/> Chief Investment Officer
<input type="checkbox"/> CFO/COO/Chairman/Other Executive | <input type="checkbox"/> Chief Executive Officer
<input type="checkbox"/> Executive/Managing Director
<input type="checkbox"/> ESG/Responsible Investment Specialist
<input type="checkbox"/> Other (please explain): _____ |
|---|--|

E4: How do your portfolio holdings differ from a “low-carbon benchmark”? As a benchmark we use the MSCI ACWI Low Carbon Target Index, which includes large and mid-sized equities with a lower carbon exposure than the market.

Sector	Index weights (September 2017)	My portfolio is <u>overweight</u> in this sector	My portfolio is <u>underweight</u> in this sector
Financials	20%	<input type="checkbox"/>	<input type="checkbox"/>
Information Technology	18%	<input type="checkbox"/>	<input type="checkbox"/>
Industrials	12%	<input type="checkbox"/>	<input type="checkbox"/>
Consumer Discretionary	12%	<input type="checkbox"/>	<input type="checkbox"/>
Health Care	11%	<input type="checkbox"/>	<input type="checkbox"/>
Consumer Staples	9%	<input type="checkbox"/>	<input type="checkbox"/>
Energy	5%	<input type="checkbox"/>	<input type="checkbox"/>
Materials	4%	<input type="checkbox"/>	<input type="checkbox"/>
Telecommunication	3%	<input type="checkbox"/>	<input type="checkbox"/>
Real Estate	3%	<input type="checkbox"/>	<input type="checkbox"/>
Utilities	2%	<input type="checkbox"/>	<input type="checkbox"/>
Total	100%		

E5: Do you engage (or plan to engage) portfolio companies to report according to the recommendations of the Task Force on Climate related Financial Disclosures (TCFD)?

- No
 Yes
 Do not know

Thank you for participating in this survey.