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Impact investment preferences for carbon target difficulty, progress and science-based approval

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ABSTRACT

Alongside sustainable finance regulations, the new European Sustainability Reporting Standards introduce the need to disclose carbon target difficulty and the science-based nature of targets to enable better investment decisions. However, investment preferences towards established target attributes and emerging ones like target progress are understudied, especially in impact investments, where they can signal the potential for desired emission reduction beyond previous emission levels. This study uses a discrete choice experiment in Sweden with potential impact investors towards climate change mitigation to elicit their preferences towards progress on carbon targets, target emission reduction level and science-based approval for more or less emission-intensive firms. The findings suggest that respondents favour many target characteristics independently and in interactions with other carbon information. Results of the latent class analysis further suggest preference heterogeneity towards carbon targets to stem from attitudinal-, cognitive-, knowledge- and socio-demographic characteristics of individuals.

1. Introduction

As climate change mitigation is an increasingly urgent and existentially important matter, the private and public policy context on carbon targets for GHG emission reduction is rapidly evolving. To transition funding towards meeting the EU 2050 carbon-neutrality objective, a host of recent policies in the EU target the financial sector and corporate sustainability disclosures.[1] Notably, the new European Sustainability Reporting Standards (ESRS) now set explicit standards for firms in the EU, including the need to disclose the presence of carbon targets and whether they are science-based and aligned with maximum global warming of 1.5°C.[2] In parallel, the share of companies globally that have carbon targets aligned with the Paris Agreement has been rapidly increasing as more companies (Bjørn et al., 2022) follow the rules of the Science Based Targets Initiative (SBTi) to set and get their targets approved as science-based targets (SBTs). SBTi is further designing the measurement, reporting and verification framework to include target progress disclosure (SBTi and EY, 2023). As first disclosures according to the ESRS are yet to emerge and while frameworks on target progress disclosure are under development, exploring preferences for such carbon target characteristics in the investment context is timely.

This emerging emphasis on carbon targets in policy and practice is less reflected in the extensive literature on carbon disclosures, management and assurance (see a review by He et al., 2021). So far, studies have explained the methods, potential and limitations of science-based targets (Bjørn et al., 2021; 2022; 2023) and find that they are indeed more difficult (i.e. imply higher reduction) and followed by increased company investments to reduce emissions (Freiberg et al., 2021). The carbon target difficulty is, in turn, linked to the higher share of sub-targets being met (Ioannou et al., 2016). Overall, carbon targets are considered in terms of legitimacy considerations (Dahlmann et al., 2019), although it is not yet clear what aspects of target-setting are perceived as legitimate by the users of carbon disclosures in an investment context.

Target progress or achievement is an important understudied element of carbon disclosures as it relates to the development and performance quality dimensions of ESG information (Arvidsson and Dumay, 2022). Target progress can signal investors that a company can

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[1] The EU Taxonomy, Sustainable Finance Disclosure Regulation (SFDR), Corporate Sustainability Reporting Directive (CSRD).

[2] ESRS1 on climate change requires a reporting entity to disclose "the climate-related targets it has set" (§30) and "state whether the GHG emission reduction targets are science-based and compatible with limiting global warming to 1.5°C" (§34e).

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implement plans and mitigate risks (He et al., 2021; Ioannou et al., 2016). However, we lack an understanding of interactions between various types of carbon information (He et al., 2021) as well as how carbon information is traded off against risk and return (Heeb et al., 2023; Lagerkvist et al., 2020; Löfgren and Nordblom, 2024). Therefore, in this study, we focus on the relevance of carbon target characteristics of science-based approval, difficulty, and target progress.

Specifically, understanding the demand side for the carbon target disclosures is particularly relevant and lacking in the context of impact investment (Agrawal and Hockerts, 2021; Apostolakis et al., 2016; Barber et al., 2021; Paetzold et al., 2022) as a growing type of sustainable investing strategies. Compared to other widespread sustainable investment strategies such as screening or ESG integration, and similarly to SDG alignment, impact investing directly envisages integrating a positive externality like reduced GHG emissions (as a proxy for "impact") in investment preferences (e.g., Heeb et al., 2023). It is also especially relevant in terms of the regulatory focus towards promoting Article 9 sustainable funds in the EU (those having climate change mitigation as an explicit objective). So far, studies show that, in general, investors assign a price penalty for carbon emissions (e.g., Bolton and Kacperczyk, 2021; Griffin et al., 2017) and push for more disclosure and climate change mitigation (Hales, 2023). Studies also show investors exhibit a willingness to pay (or willingness to accept lower returns) for sustainable investments in general (Lagerkvist et al., 2020; Löfgren and Nordblom, 2024) and impact investments in particular (Barber et al., 2021; Heeb et al., 2023), albeit with the level of impact said to be less important so long as there is some GHG emission reduction impact promised (Heeb et al., 2023). Impact, while remaining vague and unsubstantiated in fund claims in practice, has thus been conceptualised in terms of emission offsets (ibid.). The role of envisaged impact through portfolio companies' ambitions, manifested as targets, is not explored despite their increasing proliferation and sophistication. It is thus relevant to investigate specifically how much investors are willing to forego return for carbon target characteristics versus GHG emission information.

Investors and their preferences are generally argued to be heterogeneous (Apostolakis et al., 2018; Gutsche and Ziegler, 2019; Hales, 2023; Kleffel and Muck, 2023; Lagerkvist et al., 2020). For example, being female and attentive (Löfgren and Nordblom, 2024), exhibiting warm glow (Kleffel and Muck, 2023), positive emotions (Heeb et al., 2023), negative affect, attitude to saving and psychological distance (Lagerkvist et al., 2020) have been found to affect stated choices, certainty and/or reliability of responses. We also consider behavioural issues to be relevant in our focus on carbon target attributes since a 'science-based' or 'on-track' label may affect more automatic cognitive processes while target reduction level may trigger more logical processes (Byerly et al., 2018). As the target attributes in this study may proxy notions of companies' ambitiousness, legitimacy or accountability vis-à-vis peers or 'science' (Bjørn et al., 2022; Dahlmann et al., 2019), the role of norms and perceived relevance of green objectives is also considered.

The objective of this study is, thus, to investigate investment preferences towards emerging carbon target attributes relative to disclosed carbon emissions and conventional risk and return information in the context of carbon impact investment. The study contributes to the literature on carbon disclosures and their investment implications in several ways. First, we identify the preferences towards emerging and more established carbon target attributes alone and compared to GHG emission performance and financial information. We add to the understanding of science-based targets, target difficulty and legitimacy of targets (Dahlmann et al., 2019; Freiberg et al., 2021; Ioannou et al., 2016) in relative terms one to another and in terms of the underexplored interactions between target features and other carbon disclosure elements like emission performance (He et al., 2021). Secondly, we add to the understanding of the willingness to pay for sustainability investment information (Gutsche and Ziegler, 2019; Kleffel and Muck, 2023) in the impact investment context (Apostolakis et al., 2018; Barber et al., 2021; Heeb et al., 2023) for carbon target disclosures as envisaged impact proxy. We also add to the understanding of the large category of potential private impact investors in contrast to the more prevalent institutional ones. Third, we add to the literature on the heterogeneity of preferences for sustainable investment (e.g., Kleffel and Muck, 2023; Lagerkvist et al., 2020), where we add to the understanding of the role of attitude towards and actual knowledge of emerging sustainable fund labels of Nordic Eco-labelled Funds, Morningstar, as well as European Union's Article 8 and 9 fund classification. We consider also specifically perceived relevance of EU green objectives for one's investment, warm glow and the propensity to be a more deliberate decision-maker.

2. Literature and hypotheses

2.1. Investment implications of GHG emissions

GHG emissions information, carbon disclosures, and, more generally, environmental disclosures have been found relevant to investment decisions. While the estimates of the negative effect of carbon emissions on firm value vary across regions and studies (Bolton and Kacperczyk, 2021; Griffin et al., 2017; He et al., 2021), scholars agree that the emissions performance is material for firm value and that higher emissions are penalised through stock price in developed countries. The negative role of GHG emissions on firm value has been explained by future operational, regulatory, and compliance costs (He et al., 2021) and likely non-pecuniary utility, argued to be especially relevant for impact investments aiming beyond financial return (Barber et al., 2021). While the general assumption in the literature on stock returns and investor preferences for carbon performance (as a proxy for impact) is that of the trade-offs between returns and impact, findings of Heeb et al. (2023, p. 1741) with regards to the insensitivity to the magnitude of GHG emission reduction impact nuance this to imply that pro-social investors "are more likely to maximise financial performance while optimising the warm glow that they derive from their choices". In several experiments, including a framed field experiment, they further find that, on average, the level of impact in terms of the GHG emission reduction is less relevant for preferences than its mere presence of impact. In an online experiment, Johnson et al. (2020) further distinguish between better or worse than industry firms in terms of overall and environmental performance. When firms perform above the industry average, the disclosed emissions management strategy type does not affect their valuation, unlike for underperformers. Therefore, as the literature suggests the relevance of GHG emissions as an impact proxy and potentially their relative levels being material for investment preferences, we expect:

Hypothesis 1. Past GHG emissions higher (lower) than the industry average negatively (positively) affect investment preferences.

2.2. Relevance of carbon target characteristics

To consider forward-looking information on carbon management and, thus, potential impact, we focus on carbon targets (Tang and Luo, 2014). Targets have gained prominence in practice, given their role in planning, coordination, resource allocation, and performance review (Arnold and Artz, 2015). Scholars have also examined carbon targets in terms of their presence (Johnson et al., 2022; Tang and Luo, 2014) and their characteristics, such as difficulty of the target level (Ioannou et al., 2016), absolute or intensity metrics and time horizon (Dahlmann et al., 2019; Freiberg et al., 2021) and science-based approval (Freiberg et al., 2021). We consider three established and emerging target characteristics.

First, target difficulty is key to the target-setting process (Locke and Latham, 2002) and, if achieved, is directly linked to the magnitude of impact the firm's actions generate. In goal-setting theory (ibid.), target

difficulty is positively associated with performance by directing attention to relevant activities, increasing effort intensity and/or effort duration, and leading to the discovery and use of task-relevant knowledge and strategies. Analysis by Ioannou et al. (2016) supports the expected link to emissions performance by finding that firms setting more difficult GHG emission reduction targets tend to reach more of their sub-targets for specific emission scopes. Dahlmann et al. (2019) argue that targets that reflect a substantive sincere commitment of a firm – in our case towards higher impact - rather than those used as a form of greenwashing are significantly associated with emissions reductions. This corroborates the general finding that investors find carbon disclosures especially useful for firms from the highly polluting industries (Jaggi et al., 2018). We thus expect harder targets to be favoured as more legitimate (Dahlmann et al., 2019) and even more so for firms emitting more, where targets difficulty would carry extra weight and imply a more substantive commitment:

Hypothesis 2. Target difficulty positively affects investment preferences.

Hypothesis 2a. Target difficulty positively affects investment preferences even more when a firm has had GHG emissions higher than the industry average.

A second and increasingly prominent characteristic of the carbon target is its 'science-based' approval. SBTs imply two types of safeguards: the level of reduction aligned with the latest climate change science, as well as the third-party verification of the target by the SBTi, resulting in a label-like accreditation claim of being 'science-based' (Bjørn et al., 2023). Being a relatively new practice, the potential legitimising role of the 'science-based' accreditation of the targets remains to be explored. On the other hand, we know that having a sustainability label as an attribute of sustainability disclosure in investment choices has a positive effect (Bassen et al., 2019; Kleffel and Muck, 2023; Lagerkvist et al., 2020). Since investors value information that adds legitimacy (Dahlmann et al., 2019) to the carbon targets and since science-based targets are found to be more difficult and linked to more investment in emissions reduction (Freiberg et al., 2021), we expect similarly positive preferences to SBTs directly and their role even stronger for firms with more to prove:

Hypothesis 3. Science-based approval positively affects investment preferences.

Hypothesis 3a. Science-based approval positively affects investment preferences even more when a firm has higher GHG emissions than the industry average.

A third and even more emerging target characteristic is target progress. To our knowledge, neither the effects of target progress nor the implications of different ways to communicate it in an investment context have been explored so far (SBTi and EY, 2023). Complex metrics to monitor compliance with the decarbonisation pathways have been proposed (Rekker et al., 2022). Other numerical metrics may include target completion percentage measured as the share of reduced emissions out of targeted. According to the SBTi (2022, p. 28), "4.2 % is the annual reduction required by the SBTi for a 1.5ºC trajectory alignment". However, evaluating the target completion would require awareness of such minimum annual levels of reduction for an SBT, sensitivity to target recalculation and a certain level of numeracy. Mindful of the potential complexity when exploring the measure for personal investors, we consider a label-like measure of being on-track for the target that captures the underlying annual emission reduction needed for an SBT. Since target progress is a potential legitimising tool focusing on actual performance, we expect it to have positive direct effects on investment preferences. Furthermore, we expect this effect to be moderated by the level of ambition that is being achieved in terms of other target characteristics and the gap of past performance to be remediated:

Hypothesis 4. On-track target progress positively affects investment preferences.

Hypothesis 4a. On-track target progress positively affects investment preferences even more when a firm has a more difficult target.

Hypothesis 4b. On-track target progress positively affects investment preferences even more when a firm has a science-based target.

Hypothesis 4c. On-track target progress positively affects investment preferences even more when a firm has higher GHG emissions than the industry average.

3. Method and data

3.1. Participants

Data was collected through an online survey (Appendix A in the Supplementary material) at the end of May 2023. A market research company recruited a sample of 800 individuals aged 18–75 in Sweden. The screening questions aimed to reflect the population of individuals who are potential impact investors towards climate change mitigation. Given the increasing ease of screening for "green" mutual funds and provided explanations by online investment platforms in Sweden, we aim to include both current and soon to be personal investors. The initial screening (see Q3 in the Appendix) thus involved checking that the respondent either already invests in stocks, funds or other financial products (85.25 % of the final sample) or "plans to invest" (14.75 % of the final sample), and thus screened out 19.6 % of the initial sample that don't plan to invest. The second and third screening concerned the same question "How important is it for you that your investments in companies contribute to the following?" (Q4 in the Appendix). As an attention check respondents had to select "not at all important" in a specific row (retained 1706 out of 2361 remaining respondents). As a screening question pertaining to the desired population of potential impact investors specifically towards climate change, similar to Heeb et al. (2023), the respondent was also shown here a merged EU Taxonomy green objective "mitigation and adaptation to climate change". Respondents who chose neutral, important, and very important (respectively 828, 836 and 270 out of 2361) proceeded with the survey (we thus screened out 8.7 % that selected "not at all important" and 9.3 % that chose "not important"). Finally, when presenting the choice attributes, we included an understanding check for each of the 6 experimental attributes (Q7-Q12 in the Appendix). Respondents who didn't correctly understand at least 3 attributes were also screened out (365, and thus retained 916). Of the retained respondents, over 91 % understood correctly all but SBT attribute. SBT attribute was correctly understood by 41 % of respondents but based on a somewhat harder question. Finally, 800 respondents completed the whole survey.

The final sample is comparable to the Swedish population in gender, age and education level. The demographic characteristics and investment practices of the sample are presented in Table 1. The final response rate was 26.5 % (out of 3009 invited). The median response time was 12.6 minutes and mean 31.3 min. In our sample, 85.63 % have made investments in the capital market regularly and/or occasionally, including allocation of pension fund investments in the Swedish system. Of our respondents with investment experience, sustainability was considered "somewhat", "much" and "very much" by respectively 28 %, 12 % and 2 %. These values can be considered comparable to the available data for Swedish population in 2023, where 80 % invested in funds and 37 % invested in funds with a sustainability-orientation, according to the Swedish Investment Fund Association.[3] Monthly and occasional investors invest most of all in equity funds (88.5 %), as in our

[3] https://www.fondbolagen.se/fakta_index/studier-och-undersokningar/hallbart-fondsparande/

Table 1
Respondent demographic and investment characteristics, as % of 800 respondents.

Panel A: Demographics, % of 800 respondents					
Gender		**Education level**		**Area of residence**	
Female	51.25	Elementary school or equivalent	4.00	>150,000 inhabitants	29.88
Male	47.88	High school or equivalent	50.50	50,000–150,000	27.38
Other	0.75	University up to three years	25.37	10,000–50,000	20.50
Don't say	0.13	University more than three years	1.00	<10,000	19.50
		Other post high-school education	19.12	Do not know	2.75
Age		**Household income**		**Household size**	
18–24	10.38	<10,000	1.87	One person	28.88
25–34	20.00	10,001 – 20,000	10.81	Two persons	34.00
35–44	18.63	20,001 – 30,000	15.89	Three persons	16.13
45–54	17.75	30,001 – 40,000	18.42	Four persons	14.50
55–64	17.25	40,001 – 50,000	11.62	Five or more	6.50
65–75	15.75	50,001 – 60,000	10.68		
		60,001 – 70,000	16.56		
		>70,000	14.15		
		Prefer not to say	6.37		
Panel B: Investment characteristics, % of 800 respondents					
Made previous investments in stocks, funds or other financial products		85.25	**Average amount invested monthly:**		
Investment practices in the financial market:			0 SEK		0.75
Monthly investments		52.87	1–500 SEK		11.25
Occasional investments		53.75	501–1000 SEK		12.88
Made own fund choices in the public pension		34.38	1001–2000 SEK		11.50
Invested in other ways than financial market		13.38	2001–5000 SEK		09.87
No investments in the financial market		11.13	Over 5000 SEK		06.62

Note: Gender share for Sweden from Statistics Sweden as of 02.22.2023 are 50 % for males and 50 % for females aged 18–75, and age categories for 2022 are: 11 % (18−24), 20 % (25−34), 19 % (35−44), 18 % (45−54), 17 % (55−64), 15 % (65−75). According to Statistics Sweden, 45 % of Swedish population aged 18–75 have higher education. At the time of data collection 1 SEK = 0.086 Euro. Investment characteristics show a share of the whole sample and "amount invested monthly" refers to only monthly investors.

choice context. Of the monthly investors, about half invest over 1000 SEK – the amount mentioned in this experiment.

3.2. Discrete choice experiment design

To elicit stated individual preferences, we use a discrete choice experiment (DCE) as the most widely used method (Johnston et al., 2017) based on random utility theory (McFadden, 1986). In developing the design, we followed the recommendations on qualitative pre-testing with professionals and students with the 'talk aloud' method and pilot study pre-testing with 142 respondents in Sweden (Johnston et al., 2017).

Table 2 shows the attributes and their levels that are allocated to the choice cards according to the experimental design. The attribute GHG emissions was presented for all emission scopes through a SFDR-aligned intensity metric for relative comparison across companies (Johnson et al. 2020), while target difficulty and SBT approval were formulated according to the common assumptions of target characteristics (Wang and Sueyoshi, 2018) and SBTi rules (including making SBT approval conditional on two highest difficulty levels in the design). Expected return and risk classes were specified similarly to Lagerkvist et al. (2020) but with variance ranges for risk updated to 2023 recommendations in Sweden. Q7-Q12 of the Appendix further show how the attributes were introduced to the study participants alongside the follow-up questions to check for attentiveness. The follow up/screening questions also helped to ensure the salience of the fact that the attribute levels do not vary in other meaningful ways.[4]

Table 2
Attributes and levels.

Attribute	Levels
GHG emissions	• Much lower GHG emissions than industry average • GHG emissions similar to industry average *(Reference level)* • Much higher GHG emissions than industry average
Target difficulty	• Target to reduce GHG emissions by 15 % • Target to reduce GHG emissions by 30 % • Target to reduce GHG emissions by 45 % • Target to reduce GHG emissions by 60 %
Science-based target	• Approved as science-based target • - (no approval exists) *(Reference level)*
Target progress	• On-track for its 2030 GHG target • Not on-track for its 2030 GHG target *(Reference level)*
Expected return	6 %, 10 %, 14 %, 18 %
Risk class	• Risk class 4, ± variation of 12 %-20 % *(Reference level)* • Risk class 5, ± variation of 20 %-30 % • Risk class 6, ± variation of 30 %-80 %

Given that Swedish personal investors mostly invest in mutual funds rather than single stocks and that impact fund managers consider portfolio companies' goals, disclosures, evidence of long-term commitment (GIIN, 2021) on behalf of investors, we introduced the decision context as such that respondents can invest in an impact fund with risk and return profile and which in turn considers the carbon information contained in our carbon attributes. To mimic the longer investment horizon of impact funds, we set it to be the same as the carbon target, 2030, and assumed a 1000 SEK monthly investment, a value a bit lower than set by Lagerkvist et al. (2020).

To enable estimation of the importance of each of the attribute levels, respondents were presented with the task of indicating their preferred fund in a series of tasks. Given that it is possible to construct a large number of funds with different combinations of the attribute levels included, we used a fractional factorial design, where a subset of the possible combinations is included in the survey. An example of a choice card presented to the respondents is shown in Q13 of the Appendix. We used a D-efficiency criterion to select which combinations to include, using NGENE software, assuming a multinomial logit model with interaction terms and linear utility functions, where coefficients from a pilot of 142 respondents in Sweden were used as priors. The study was preregistered on Aspredicted.org (nr. 133538). The design included 16 choice situations split into two blocks. Each respondent was randomly assigned to one of the blocks and thus made 8 choices, which included two unlabelled alternatives and an optout option formulated similarly to 'none of these' (Apostolakis et al., 2018). The order of the choice tasks was randomised, while the ordering of attributes was not altered to reduce the effects of fatigue and choice complexity.

3.3. Measures for preference heterogeneity

As investment controls, we included a dummy variable *monthly*

[4] For example, GHG emissions attribute was introduced to respondents with levels such as "Much lower GHG emissions than the industry average" and the follow up question checked the understanding of this to imply *lower* emissions. Similarly, the carbon target of 60 % was checked to be understood as the *most* ambitious level. Screening the respondents in terms of their correct comprehension of these issues also helps to reduce the likelihood that they misinterpret the alternatives as being different in some other respect than the presented attributes.

investing to capture if respondent invests monthly (Q14) and a variable on how much the respondent *considers sustainability in investments* (Q18). As for knowledge characteristics, we include three knowledge areas that likely play a role in understanding the information in impact investment decision-context:

i) *Financial literacy* (FL) was measured similarly to (Kleffel and Muck, 2023), focusing on one simpler (compound interest) and one harder (bonds and interest rates) question (Q24 and Q25). A dummy for answering both questions correctly was considered to signify high FL.

ii) *Stated knowledge* of sustainability reporting (Q17) captured how much respondent states to know in general about a) companies' sustainability reporting, b) science-based targets and c) carbon accounting (1 factor in exploratory factor analysis with eigenvalue over 1, Cronbach's alpha 0.87).

iii) *Actual knowledge* of three third-party labels of sustainable funds (Q20.1-20.3): Morningstar (4.4 % correctly identified "low CO2 risk"), Nordic Eco-labelled funds (9 % correctly identified "Refrain from certain industries") and European Union fund classification (3 % correctly identified - "Light green/dark green"). We generated a dummy variable on whether the respondent correctly identified at least 1 of the three labels of sustainable funds.

To capture attitudes to such sustainable fund labels and green impact objectives, we had two variables. A dummy *relevance of labels* was constructed for Q21 if at least one of the three labels was selected. Another variable *green objectives' relevance* was obtained from factor analysis for the screening on the importance of EU Taxonomy objectives Q4 (1 factor with eigenvalue over 1, Cronbach's alpha 0.83).

Finally, *warm glow* was measured as in Kleffel and Muck (2023) and is considered to describe the good feeling from giving (Gutsche and Ziegler, 2019). Investors deriving warm-glow were found to accept a lower return for green assets (ibid.). Additionally, similarly to Gutsche and Ziegler (2019) and Kleffel and Muck (2023), we consider *social norms,* as decisions and behaviour may be affected by the desire to comply with the norms of one's social environment. For each warm glow and social norm, we consider two items (in Q22) and measure the variables as the average of the two items and assign a dummy when both items are above 4 in terms of agreement with the statements.

We also assessed the *preference for intuition and deliberation* scale (Betsch and Kunz, 2008), theoretically comprised of two 9-item orthogonal sub-scales related to intuition and deliberation. The deliberation sub-scale corresponds to the mode of thinking that individuals expect to be most successful, and its two sub-scales echo the notions of System 1 for intuition and System 2 for reasoning (ibid.). All items in Q23 asked how much a statement was applicable to how participants generally made decisions. Despite this scale being well-tested, only the items for deliberation have an acceptable reliability of internal consistency. For deliberation, items 10 and 16 were excluded due to low factor loading. Factor analysis was conducted for retained items 1, 3, 6, 7, 11, 13 and 14 to get a factor score (1 factor with eigenvalue above 1, Cronbach's alpha = 0.72).

3.4. Data analysis

Individuals are assumed to derive pecuniary and non-pecuniary utility from impact investing, which is derived from attributes of this investment pertaining to financial and climate change mitigation benefits. They have underlying latent decision protocols based on random utility maximisation (McFadden, 1986), from which preferences for impact investment attributes can be inferred. The random utility U includes a deterministic component $V_{n,j}$ and a random, unobservable component $\varepsilon_{n,j}$ that is iid type 1 extreme value distributed. The deterministic component as a function of the β_n vector of parameters of marginal utility to be estimated, $X_{n,j}$ vector of 6 choice attributes describing the alternative j presented to respondent n, and an alternative constant $\alpha_{n,j}$ present only for the optout but not two other unlabelled alternatives, is specified in the preference space as follows:

$$U_{n,j} = V_{n,j} + \quad \varepsilon_{n,j} = \quad \alpha_{n,j} + \beta'_n X_{n,j} + \quad \varepsilon_{n,j} \tag{1}$$

The corresponding probability for respondent n choosing alternative j includes a scale parameter μ, commonly normalised to 1, and can be expressed as follows:

$$P_{n,j} = \frac{\exp(\mu V_{n,j})}{\sum_{i=1}^{J} \exp(\mu V_{n,i})} \tag{2}$$

We estimated a multinomial logistic model (MNL) using maximum likelihood estimation, yielding average marginal utility estimates of the attributes. To facilitate interpretation of the marginal utility parameters, the monetary value for each attribute is obtained from the negative ratio of the preference parameter of the attribute and the expected return parameter β_r. For a categorical attribute $x_{j,c}$, this shows us how much individuals are willing to pay extra for a fund with this attribute level compared to a fund that has the reference level, assuming that the funds are equal in all other aspects. For attribute levels that are associated with negative marginal utility, the ratio is interpreted as the willingness to accept (WTA) a fund with this attribute level rather than choosing a fund with the reference level:

$$WTP_{x_{j,c}, x_{j,r}} = -\frac{\frac{\partial V_j}{\partial x_{j,c}}}{\frac{\partial V_j}{\partial x_{j,r}}} = -\frac{\beta_c}{\beta_r} \tag{3}$$

To examine preference heterogeneity between various potential groups of impact investors, we estimate latent class conditional logit models (LCL). All estimations are done in STATA. In the LCL model, instead of assuming iid, respondents are allocated to C classes, where each class c has a class preference coefficient β_c. The probability of an individual n choosing alternative j is:

$$P(j|\boldsymbol{B}, \boldsymbol{\Theta}) = \sum_{c=1}^{C} \frac{\exp(z'_n \boldsymbol{\Theta}_c)}{1 + \sum_{l=1}^{C-1} \exp(z'_n \boldsymbol{\Theta}_l)} \quad \frac{\exp(\alpha_{c,j} + \beta'_c \boldsymbol{X}_{n,j})}{\sum_{i=1}^{J} \exp(\alpha_{c,I} + \beta'_c \boldsymbol{X}_{n,i})} \tag{4}$$

where, $\boldsymbol{B}$ is a matrix of β utility coefficient vectors for each of C classes and $\boldsymbol{\Theta}$ is a matrix of C-1 membership coefficients for each class c with $\boldsymbol{\Theta}_c$ set to 0 for the reference class (Yoo, 2020). The first multiplicative component represents the probability of belonging to class c, which is a function of also z_n vector of individual n's characteristics.

As a robustness check, we also estimate a Random Parameter Logit (RPL) model that allows for heterogeneity of preferences at the individual level, as indicated by the estimates of interest having mean and standard deviation ∂_n across individual respondents. In the preference space parametrisation (Hensher et al., 2015), this looks as follows:

$$U_{n,j} = \alpha_{n,j} + (\beta_n + \partial_n)' X_{n,j} + \quad \varepsilon_{n,j} \tag{5}$$

In the WTP space parametrisation, the estimates represent the WTP distribution parameters rather than the preference coefficients. Here, the utility function is adjusted so that the return coefficient multiplies the rest of the utility function, including $X^r_{n,j}$ monetary attribute and $X^{-r}_{n,j}$ other attributes, producing β^{-r}_n as the direct estimates of marginal WTP measures.

$$U_{n,j} = \beta^r_n (X^r_{n,j} + \beta^{-r}_n X^{-r}_{n,j})' + \quad \varepsilon_{n,j} \tag{6}$$

4. Results

Table 3 shows results from MNL models without (Model 1) and with (Model 2) interactions of attributes. In both models, the statistically significant estimates for our attributes of interest - target difficulty, science-based approval, on-track progress and GHG emissions relative to the industry - are of hypothesised signs (H1-H4). In Model 1, respondents have positive preferences for target difficulty, evidenced by the coefficient (0.962), for on-track progress (0.86) and science-based approval (0.39). Investment options in companies with GHG emissions

Table 3
Results from the MNL models with and without interaction effects.

	Hypo-theses	Model 1	z-val.	WTP/ WTA	Model 2	z-val.	WTP/ WTA
Optout		**0.39**	3.79	-0.447	0.11	0.85	-0.011
GHG lower than industry av.	+ H1	**0.31**	7.59	-0.035	**0.31**	7.78	-0.034
GHG higher than industry av.	- H1	**-0.51**	-9.58	0.058	**-0.73**	-6.90	0.079
Target level difficulty	+ H2	**0.96**	8.97	-0.109	-0.15	-0.77	-0.016
Science-based target	+ H3	**0.39**	10.95	-0.045	**0.57**	8.93	-0.062
On-track progress	+ H4	**0.86**	16.14	-0.975	**0.49**	3.63	-0.053
Expected return		**8.80**	17.21	-1	**9.14**	17.47	-1
Risk class 5		0.03	0.93	-0.004	**0.08**	2.04	-0.008
Risk class 6		**-0.23**	-4.40	-0.026	**-0.20**	-3.47	0.021
Higher GHG x diff.	+ H2a				**0.88**	3.67	-0.965
Higher GHG x SBT	+ H3a				-0.18	-1.82	0.020
On-track x difficulty	+ H4a				**1.40**	5.01	-0.153
On-track x SBT	+ H4b				**-0.28**	-3.47	0.030
On-track x higher GHG	+ H4c				**-0.18**	-2.47	0.019
Log-likelihood		-5505.9			-5479.9		
LR chi2 compared to Model 1				52			

Note: Bold numbers are significant at the 5 %-level and lower. Standard errors clustered at the respondent level. N respondents = 800, N choices = 6006.

much higher than industry are disliked (-0.51), and those with much lower emissions are preferred (0.31). The estimate for the attribute of expected return is also positive and statistically significant (8.8), mitigating potential concerns about experimenter demand effect steering preferences towards GHG-related attributes.

We note that including interaction terms improves model fit significantly (LR test result). In line with our expectations, target difficulty is more important when associated with higher than industry-average GHG emissions (H2a). The same positive association holds when difficulty is associated with on-track progress (H4a). Interestingly, comparing the main effects model with the interaction effects model reveals that target level difficulty is only valued positively when associated with higher GHG emissions (H2a) and on-track progress (H4a), while the main effect difficulty parameter is statistically not significantly different from zero. While we hypothesised that preferences for on-track progress would be even more positive when associated with an SBT (H4b), this is not confirmed in the results. Rather, the opposite is observed. We can interpret this as respondents finding these two positive attributes to be, to some degree, substitutes. It is good if the firm is on track, and it is good if it has a science-based target, but having both is not worth even more. Further, the negative preference for higher GHG emissions is even more negative when the firm is on track (H4c). We speculate if this could be because respondents find such a combination not credible or suspicious: how can a firm that has previously not performed be on track? Finally, the estimate of the interaction of an SBT and higher GHG emissions is not statistically significant at 5 %, failing to show a similar legitimising effect for higher emitters as difficulty does.

Focusing on the WTP/WTA column in Table 3, we see that, on average, respondents are willing to accept lower returns for lower than industry emissions (by 3.5 percentage points), for target difficulty increase of 15 ppt (by 10.9 ppt), SBT approval (by 4.5 ppt) and on-track progress (by 9.75 ppt). These estimated trade-offs between monetary marginal utility and non-pecuniary marginal utility for carbon attributes are further adjusted depending on the respective interaction terms. For example, on average, the respondents are willing to accept even lower returns for target progress when targets are more difficult, but the accepted returns increase if the targets are also science-based or the firm was a high emitter previously.

Preference heterogeneity among latent classes

Finally, we consider results from the latent class analysis suitable for exploring preference heterogeneity between sub-groups of respondents. We considered models with and without the interaction of attributes, but given the MNL results and model fit, we present the model with attribute interactions (Table 4). Through class enumeration (LCL models with 2–5 classes), we selected the model with three classes based on BIC and CAIC fit statistics (Table A1 of the Appendix B). We can distinguish the following three latent classes of preferences based on considered class membership variables.

Class 1: Results-oriented experienced investors

This latent class, covering 30.5 % of the sample, has the highest gap between financial return and carbon information estimates. It is also the only class where the negative risk estimate is statistically significant. Contrary to the other classes, the lower relative emissions estimate is not significant. However, the statistically significant estimate for higher emissions shows awareness of the materiality of negative past emission performance. While the direct estimates of target difficulty and progress are negative, their interaction term estimate is very high and statistically significant, suggesting a positive preference only for the combination of the two. Similar to other classes, difficulty is even more favoured for high emitters. Similar to class 2, SBTs are favoured on their own but are not viewed as credible for high emitters. Similarly to class 3, SBTs are likely viewed as substitutes for on-track target progress labels. This latent class is the reference class in terms of the coefficient of the class membership.

Class 2: Balanced, target favouring, non-deliberate investors

This largest latent class, roughly half of our sample, exhibits the hypothesised positive preferences for individual target characteristics and lower emissions as well as negative preferences for high relative emitters. The positive interaction term of high emissions and target difficulty suggests that more ambitious targets are viewed extra positively for companies with more to prove, while the same legitimising effect is not observed for SBTs. Members of this class are less likely than the first class to have more extensive investment experience or to have a high income, but they are more likely to be women. They are more likely to score higher on warm glow and consider EU green objectives relevant to their investments. Interestingly, this class is less likely to score high on deliberation in terms of their mode of thinking and decision-making.

Class 3: Progress- and SBT-favouring investors aware of labels

This latent preference class is highly focused on progress but also views SBTs favourably on their own and for high-emitters. Interestingly, compared to other classes, members of this class have a positive estimate of the optout alternative, suggesting they would rather not invest at all in our choice context of impact investment than do so into assets with not appealing characteristics, e.g. not showing progress on carbon targets. This class is similar to class 2 in all membership characteristics but deliberation and actual knowledge of any of the following sustainable investment labels: Nordic Eco-labelled Funds, Morningstar's label or the new European Union's Article 8 and 9 fund classification.

As robustness checks, we estimate the models in Table 3 with RPL in a preference- and WTP space. Estimates reported in Table A2 of the Appendix B show similar results in terms of the main and interaction terms estimates, their hypothesised signs and WTP/WTA values to those

Table 4
Latent class logit model with attribute interactions.

	Class 1. Results-oriented experienced investors		2. Balanced, target favouring, non-deliberate investors		3. Progress- and SBT-favouring investors aware of labels	
Class share	30.0 %		47.8 %		22.2 %	
	Estimate	z-val.	Estimate	z-val.	Estimate	z-val.
Optout	**-1.58**	2.73	**-1.25**	4.02	**2.72**	8.49
GHG lower than average	0.04	0.24	**0.49**	6.01	**0.75**	6.88
GHG higher than average	**-1.21**	3.28	**-0.99**	4.58	**-1.36**	3.66
Target level difficulty	**-2.47**	2.90	**1.20**	2.30	0.57	0.91
Science-based target	**0.77**	3.38	**0.87**	7.47	**0.42**	2.11
On-track progress	**-1.19**	2.13	**1.31**	3.92	**1.80**	5.33
Expected return	**21.91**	10.56	**6.38**	5.15	**7.64**	5.52
Risk class 5	0.11	0.73	-0.06	0.71	0.14	1.03
Risk class 6	**-0.50**	2.75	-0.09	0.81	-0.13	0.84
Higher GHG x diff.	**2.43**	3.23	**0.93**	2.15	0.85	1.14
Higher GHG x SBT	**-0.70**	2.12	**-0.42**	2.05	**0.93**	3.27
On-track x difficulty	**4.66**	4.35	-0.03	0.04	0.69	0.89
On-track x SBT	**-0.87**	3.10	-0.01	0.09	-0.46	1.95
On-track x higher GHG	0.09	0.39	-0.18	1.24	-0.13	0.50
Class Membership						
Monthly investing, dummy	0	-	**-0.50**	2.02	**-1.02**	3.86
Consider sustainability in investments	0	-	0.04	0.46	-0.02	0.19
Post-high school education, dummy	0	-	-0.11	0.47	-0.04	0.16
Income over 50kSEK, dummy	0	-	**-0.53**	2.26	**-0.61**	2.35
Age	0	-	0.00	0.20	0.01	1.27
Female, dummy	0	-	**0.52**	2.09	0.52	1.95
Warm glow	0	-	**0.88**	3.18	**1.25**	4.04
Social norms	0	-	-0.20	0.66	-0.33	0.99
Green objectives' relevance	0	-	**0.73**	4.15	**0.87**	4.78
Stated knowledge (sust. reporting)	0	-	-0.16	1.04	-0.25	1.55
Relevance of labels	0	-	0.20	0.84	-0.17	0.63
Actual knowledge (sust. fund labels)	0	-	0.17	0.44	**0.81**	2.17
High FL, dummy	0	-	0.03	0.09	-0.04	0.12
Deliberation	0	-	**-0.41**	2.83	-0.30	1.90
Constant	0	-	0.05	0.09	-0.88	1.56

Note: Bold numbers are significant at the 5 %-level and lower. Number of respondents = 800, Number of choices = 6006.

of the MNL models. Moreover, since we focus on the population of interest of potential impact investors, our main analysis includes 15 % of respondents who have not made previous investments. As a further robustness check, we perform analyses of Tables 3 and 4 on solely 85 % of respondents who indicated that they had made previous investments. This intends to consider the potential role for preferences of knowledge accumulated through experience (even though this is included in the LCA analysis of preference heterogeneity through several membership covariates). The findings presented in Table A3 of the Appendix B are comparable to those of the main analysis with the full sample, suggesting that the relatively small share of individuals who are so far only planning to begin investing and could do so towards impact on climate change does not affect the findings in our case.

5. Concluding discussion

This study has conducted a DCE with personal investors in Sweden in the context of impact investing towards climate change mitigation. We find strong support for hypothesised positive preferences of investors towards carbon target information, namely more difficult targets, on-track target progress and science-based approved targets. This extends our understanding of carbon target attributes (Dahlmann et al., 2019; Freiberg et al., 2021; Ioannou et al., 2016) from the demand side for impact investment and across various sub-groups of investors.

We learn that different groups of investors prioritise these target attributes differently, and some consider them synergetic while others consider them as trade-offs. Regarding characteristics explaining the heterogeneity of preferences (e.g., Lagerkvist et al., 2020), we find knowledge of sustainability labels, attitudes towards environmental objectives and doing good for the environment, as well as cognitive characteristics like the tendency to deliberate to be relevant on top of socio-demographic ones like income and gender. Higher investment experience and deliberate decision-making underlie preferences towards financial return, towards seeing GHG management results through progress on difficult targets and preferences towards high emitters needing more difficult targets, possibly due to materiality considerations. The aspect of deliberation corroborates the findings of Löfgren and Nordblom (2024) regarding attentiveness being an important aspect of investing in green mutual funds in Sweden. On the other hand, investors with relatively lower income, more likely female, finding sustainability objectives to be more important for their investments specifically and feeling good from doing more for the environment generally tend to consider favourably target characteristics such as difficulty and/or progress individually, depending of their familiarity with sustainable environmental labels.

In terms of GHG emissions as the most widely studied aspect of carbon information, we find that the homogeneity of negative preferences towards higher past relative GHG emissions attests to their materiality for both experienced and more altruistic investor groups. The opposite is, however, not always the case, as we don't observe statistically significant positive preferences for lower relative emissions by experienced investors. Moreover, while literature acknowledges the negative effect of GHG emissions (e.g., Griffin et al., 2017) and their moderating role on perceptions of carbon reduction strategies (Johnson et al., 2020), we add to the lacking understanding (He et al., 2021) of the moderating effect of relative emissions for carbon targets. Namely, we observe positive interaction effects with target difficulty for companies emitting above the industry average. The favourable preference for more ambitious targets for lagging companies is observed among all latent classes of investors.

We add to the body of literature on sustainable investment preferences using DCEs (Gutsche and Ziegler, 2019; Kleffel and Muck, 2023; Lagerkvist et al., 2020), which carry many advantages compared to more standard experiments conducted on the topic of sustainability and carbon disclosure characteristics (Haji et al., 2021; Johnson at al., 2020). We can assess the relative role and interactions of several target attributes relative to risk and return information and estimate trade-offs in terms of WTP. Previous aggregate WTP estimates for social and environmental impact in venture capital funds ranged between 2.5–3.7 ppt in expected internal rate of return, with the highest estimates for environmental impact (Barber et al., 2021). According to Löfgren and Nordblom (2024), 72 % of Swedish respondents state to be willing to give up some return to invest in a sustainable fund and 30 % would be willing to accept more than 5 % lower return than for another fund. While our WTP estimates for target attributes are much larger (from 4.5 ppt for an SBT to 10.9 ppt for 15 ppt of target difficulty), it is worth noting that besides the often inflated WTP estimates from stated preference methods, our population includes individuals that identify themselves as current or potential impact investors towards climate change mitigation and for whom carbon information including

emerging attributes like target progress, difficulty and approval would thus be especially material.

The findings are relevant for fund- and corporate sustainability managers, private standard-setters and policy-makers. Forward-looking target information and label-like target characteristics of on-track progress and science-based approval are desirable in the impact investment context. While both are positively regarded, progress has higher preference estimates and can be viewed as a substitute for an SBT as a legitimising characteristic. Emphasising on-track target progress on its own seems particularly relevant for potential impact investors who are more familiar with existing sustainable fund labels (Nordic Ecolabelled Funds, Morningstar's label, as well as European Union's Article 8 and 9 fund classification) and those who view sustainability as important for their investments. However, even the more experienced and deliberate investors also consider progress positively when it is in tandem with target difficulty as they likely assess investments more analytically and in light of what is relevant for future firm performance. Overall, this study suggests that carbon target characteristics of progress, SBT approval and difficulty are relevant for corporate sustainability reporting and management of companies, for consideration in thematic impact investment portfolios by fund managers, for third-party ESG rating and, in the case of on-track progress designation, for consideration by standard-setters.

Given the focus and limitations of the analysis, there are several fruitful venues for future research. In terms of generalizability, our findings relate to the population of potential impact investors towards climate change, meaning that we do not analyse the preferences of investors who actively oppose their investments contributing to climate change mitigation (18 % in our screening). Considering that our sample comes from a market research panel, it may not represent all potential climate change impact investors even though it is representative of the Swedish population in observable demographic characteristics and comparative in terms of investment in funds and considering sustainability. Randomised field experiments of actual investment decisions through popular online platforms for private investment or among the networks of specifically impact investors (as in Heeb et al., 2023) would offer a valuable extension of our analysis. While we do not find substantial differences in preferences among our full sample and its only experienced subsample, this may be due to the relatively small share of the upcoming investors and may warrant a more balanced comparison in future studies. Our design has limitations with regard to specific industry inferences, and while respondents were screened in terms of understanding attribute levels, we cannot rule out the fact that some may conflate the role of certain industries. Future research would thus benefit from explicitly factoring in industry designations in the design and considering the role of perceived impact likelihood. On a broader methodological note, while investigating the role of omitted variable bias is outside the scope of this study, doing so in the DCE-based studies in the field of investment decisions would be highly warranted given a large range of factors that may be pertinent to the choice context, from management fees to regional focus. Our findings also suggest it is worthwhile to explore the interactions between carbon disclosure attributes in general and consider alternative formulations of target progress or additional target characteristics like target horizon. Finally, since SBTs for nature are gradually emerging in terms of published guidance and practice, it would be relevant to asses if our findings hold for impact investments towards other EU Taxonomy objectives.

CRediT authorship contribution statement

Uliana Gottlieb: Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Anna Kristina Edenbrandt:** Methodology, Formal analysis, Writing – review & editing.

Declaration of Competing Interest

None.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jbef.2024.100960.

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