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Research Paper

Beyond preferences: Beliefs in sustainable investing ☆

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ABSTRACT

We investigate the effect of investors' pro-sustainable beliefs – the beliefs about other investors' pro-sustainable preferences – on sustainable investing. Using an incentive-compatible coordination game that incorporates important aspects of a stock market, we elicit investors' pro-sustainable beliefs. We find that, first, investors with pro-sustainable beliefs invest in sustainable assets, even when controlling for investors' pro-sustainable preferences. Second, investors with pro-sustainable preferences invest more in assets with positive sustainability performance than in assets with negative sustainability performance, a result we do not obtain for investors with pro-sustainable beliefs. This finding underscores the complementary relation and importance of pro-sustainable preferences and beliefs for sustainable investing.

1. Introduction

Climate change is an imminent and global challenge with an enormous potential to impact financial markets (e.g., Litterman et al., 2020).[1] An increasing number of investors have individual preferences for firms' positive environmental externalities and align these pro-sustainable preferences with their investment decisions. Another widely recognized driver of investment decisions is investors' beliefs, for example about future payoffs or discount rates. However, it is unclear whether investors also form pro-sustainable beliefs – beliefs about other investors' pro-sustainable preferences – and use these for their investment decisions. Therefore, we study whether investors' pro-sustainable beliefs explain investments in sustainable assets, beyond investors' pro-sustainable preferences.

Prior research has separately determined the importance of investors' preferences and beliefs for investment decisions. On the one hand, investor preferences refer to personal tastes and describe which asset characteristics an investor values more over others.

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[1] In response to climate change and growing investor demand, sustainable investments reached USD 35.3 trillion by 2020, comprising 36% of globally managed assets in major financial markets (Global Sustainable Investment Alliance, 2020). Sustainable investments are expected to exceed USD 53 trillion by 2025 (Bloomberg Intelligence, 2021).

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Investor preferences vary across individuals, reflecting their personal attitude toward firm outcomes, risk, time, and other factors in decision-making. Fama and French (2007) show theoretically that investors can have preferences for certain assets, while Friedman and Heinle (2016) extend their model and illustrate how investor preferences for sustainability, an asset characteristic, can influence stock prices and drive firms' investments in sustainable assets. Some investors even accept lower financial returns to invest in assets aligned with their pro-sustainable preferences (e.g., Riedl and Smeets, 2017; Pedersen et al., 2021). Recent literature has emphasized the emergence of a green premium, which refers to empirical evidence showing that sustainable assets outperform non-sustainable ones. This outperformance can be explained by unexpected increases in environmental concerns by investors (Pástor et al., 2022), underscoring the importance of pro-sustainable preferences.

On the other hand, investor beliefs refer to an individual's expectations about specific events, such as market movements, stock performances, or the overall economic climate. Unlike preferences, beliefs involve expectations about asset outcomes rather than a preference for a specific asset characteristic and can be updated with new information. Prior research shows investor beliefs' influence on portfolio allocations and asset prices (e.g., Amromin and Sharpe, 2014; Brunnermeier et al., 2021; Giglio et al., 2021). Investor beliefs can be subdivided into first-order beliefs and higher-order beliefs. First-order beliefs are investors' direct expectations about specific outcomes, such as their expectations about asset prices, discount rates, or the general state of the economy. In contrast, higher-order beliefs involve an investor's expectations about the beliefs of others. For example, a second-order belief is what an investor expects about what other investors believe about specific outcomes. These higher-order beliefs are important in financial markets because they affect an investor's expectations about how others will act, which in turn can influence market dynamics, asset prices, and the investor's own strategic decisions (e.g., Keynes, 1936; Allen et al., 2006; Egan et al., 2014; Zhou, 2022).[2]

While it is established that investor beliefs are crucial in decision-making and asset pricing, the role of beliefs in the context of sustainability is still unexplored. Our study focuses on beliefs about pro-sustainable preferences, which we refer to as *pro-sustainable beliefs*. Following our definition, beliefs about pro-sustainable preferences involve expectations about the utility other investors receive from holding sustainable assets, and consequently, other investors' demand for sustainable assets. Understanding pro-sustainable beliefs is pivotal due to climate change's potential to structurally shift investors' preferences toward sustainable assets. Significant changes in investors' pro-sustainable preferences can lead to demand shocks that affect prices (e.g., Ardia et al., 2023; Pástor et al., 2021, 2022). By forming beliefs about these changes in investor preferences and anticipating demand-induced price changes, investors can earn abnormal returns, in line with empirical evidence about the dot-com bubble in the early 2000s (Brunnermeier and Nagel, 2004). In this study, we combine the two concepts, investors' *pro-sustainable preferences* and *pro-sustainable beliefs*, to assess the additional effect of pro-sustainable beliefs on investment decisions. Furthermore, we shed some light on the nature of the green premium and whether it is driven by investors' beliefs about other investors' pro-sustainable preferences.

We conduct an online experiment to elicit the participants' pro-sustainable beliefs, which would be difficult to measure in a setting with firm and market data. In our experiment, we use an incentive-compatible coordination game, where participants are assigned to teams of two and asked to invest a fixed budget in two firms. Each participant's payoff depends on the investment decision of both participants so that the participants are incentivized to consider the other participant's preferences.[3]

In our coordination game, we exploit the effect of demand on asset prices. Theoretical and empirical evidence show that large parts of the variation in stock returns can be explained by demand shifts that are unrelated to changes in observed firm characteristics (Koijen and Yogo, 2019; Gabaix and Koijen, 2021). In a similar vein, Pástor et al. (2021, 2022) show the relevance of demand effects on prices for sustainable assets. We use this effect in our setting to have a closer fit between our coordination game and a stock market, particularly in two aspects.

First, each participant acts as an asset manager who invests a fixed budget in financial assets. Some asset managers include not only their own return expectations but also form beliefs about other investors' expectations to anticipate the stock market's response (De Long et al., 1990; Abreu and Brunnermeier, 2003; Brunnermeier and Nagel, 2004). Thus, if one asset manager believes that a significant fraction of investors invests more in sustainable assets, i.e. has pro-sustainable beliefs, she also invests in such assets due to the demand-induced expected price increase. In our coordination game, each participant acts as an asset manager and tries to anticipate the pro-sustainable preferences of the overall asset market, which is represented by the other participants.

Second, in a stock market beliefs affect investor demand and, hence, asset prices, while in our coordination game beliefs affect participants' budget allocation and, hence, payoffs. Thus, the budget only has an indirect influence on the participants' payoffs since the investment budget allocation reflects the demand for certain assets. The budget's indirect effect on payoffs allows us to isolate the pure effect of beliefs and analyze it separately from possible confounding factors. For this reason, we do not introduce any other characteristics that might exist in real stock markets, such as risk or diversification.

We follow the literature and use treatment manipulations that vary the information the participants receive about the firms in two ways. First, since sustainability performance affects to what extent investors invest in sustainable assets (e.g., Flammer, 2013; Krüger, 2015; Bonnefon et al., 2022), we vary the sustainability performance, comparing the effect of positive vs. negative sustainability performance. We define sustainability performance as a comparison of firms' sustainability information along certain

[2] Our study does not depend on the distinction between first-order and higher-order beliefs as it does not make a difference for our research question and design on which level of (iterated) reasoning the investor forms beliefs about pro-sustainable preferences. We therefore use the term "beliefs" throughout the study to encompass both.

[3] We provide a detailed Online Appendix including screenshots of the experiment and all treatments, which can be accessed via https://github.com/VSchauer/Sustainability_Appendix.

sustainability performance metrics, such as water consumption, CO_2 emissions, waste generation, and working accidents.[4] Second, since individual information processing is affected by the presentation format (e.g., Libby and Emett, 2014; Rennekamp, 2012; Elliott et al., 2017), we compare the effect of a narrative vs. a visual presentation format of sustainability information.

Our results confirm the importance of investors' beliefs about other investors' pro-sustainable preferences in sustainable investing. First, our regression results show that investors with pro-sustainable beliefs invest more in sustainable firms, even when controlling for pro-sustainable preferences. This result suggests that investors with pro-sustainable beliefs invest in sustainable assets if they believe other investors have pro-sustainable preferences. Second, the results show that pro-sustainable preferences are sensitive to a firm's sustainability performance, suggesting that investors derive higher utility from holding assets with positive sustainability performance than from holding assets with negative sustainability performance. This finding is in line with recent experimental evidence by Bonnefon et al. (2022) who show that investors' willingness to pay for firms' positive social externalities is proportional to the value of these externalities. In contrast, we do not find evidence that investors' pro-sustainable beliefs are sensitive to a firm's sustainability performance. The difference in findings regarding the sensitivity to sustainability performance suggests that pro-sustainable preferences and beliefs are not substitutes. Third, the results do not support the hypothesis that pro-sustainable preferences or pro-sustainable beliefs are sensitive to the presentation format of sustainability information.

Our study makes two main contributions. First, while the literature demonstrates that investors' preferences are a crucial driver of socially responsible investments (e.g., Barber et al., 2021; Bauer et al., 2021; Riedl and Smeets, 2017), we show that pro-sustainable beliefs are an additional driver and have an effect on investment decisions beyond the effect of pro-sustainable preferences. This result demonstrates that pro-sustainable beliefs are an integral part of sustainable investing and contribute to our understanding of investors' motives to invest in sustainable assets. This result also shows that pro-sustainable beliefs are another important driver, in addition to pro-sustainable preferences, which may contribute to the emergence of the green premium associated with sustainable assets. Second, to the best of our knowledge, we are the first to explicitly elicit investors' pro-sustainable beliefs using an experiment. Previous research investigated expectations about other investors' forecasts either explicitly in surveys or implicitly in experimental asset markets (e.g., Egan et al., 2014; Hommes et al., 2005). We complement this research by designing a coordination game that incentivizes participants to invest according to their beliefs about other participants' pro-sustainable preferences. Thus, our coordination game and the resulting payoff structure reflects this characteristic of capital markets.

The remainder of this paper is organized as follows. Chapter 2 derives our hypotheses. Chapter 3 introduces our experimental design. Chapter 4 reports the results and discusses their robustness. Chapter 5 concludes.

2. Theory and hypotheses development

2.1. Investors' pro-sustainable beliefs

Recent research has focused on investor preferences, an investor's personal taste for specific asset characteristics. In particular, this research examined the effect of non-pecuniary preferences on investments in sustainable assets. Classical asset pricing models assume that investors agree on the probability distribution of future payoffs and discount rates. Fama and French (2007) relax the assumption of complete agreement among investors and show theoretically that assets can also be seen as consumption goods and that the preference for assets can affect asset prices. Building on these insights, more recent theoretical work includes non-pecuniary utility in an investor's utility function and considers that investors can derive utility from holding sustainable assets (e.g., Avramov et al., 2022; Goldstein et al., 2022; Pástor et al., 2021; Pedersen et al., 2021). The predictions of these models are supported by empirical and experimental evidence that shows that some investors value sustainability and are willing to forego expected financial returns if the investments align with their preferences (e.g., Pástor et al., 2022; Riedl and Smeets, 2017). Bauer and Smeets (2015) provide evidence that investors with higher social identification invest more in socially responsible assets. Similarly, Riedl and Smeets (2017) find that investors' preferences and social signaling make them invest in socially responsible investment funds. Hartzmark and Sussman (2019) provide insights into how sustainability is associated with positive future (expected) returns, which contrasts with the findings by Bolton and Kacperczyk (2021) that firms with higher carbon dioxide emissions have higher (realized) returns. Hedging future climate-related risks caused by regulation may be another reason to invest in sustainable assets (Engle et al., 2020; Pástor et al., 2022).

Unlike investor preferences, which have been widely researched within the context of sustainability, investor beliefs have received less attention. Investor beliefs can be divided into first-order and higher-order beliefs. First-order beliefs equal an investor's expectations about specific events. It is implicitly assumed in any asset pricing model that beliefs about future payoffs and discount rates determine asset prices (Brunnermeier et al., 2021). While Manski (2004) was among the first to measure beliefs about stock returns, further research related expected stock returns to investors' actions. One large stream of research has shown that equity market participation is linked to expected stock returns (e.g., Kézdi and Willis, 2009, 2011; Hurd et al., 2011; Amromin and Sharpe, 2014; Ameriks et al., 2020; Giglio et al., 2021), a finding that is also confirmed for bond holdings (De Marco et al., 2022). A further string of research has examined the special role of beliefs in the housing market, particularly based on personal experiences (Kuchler and Zafar, 2019), during periods of boom and bust (Piazzesi and Schneider, 2009; Burnside et al., 2016), and concerning the effect on household decision-making (Bailey et al., 2019).

[4] While sustainability *information* refers to the disclosure of environmental and social externalities of a firm's business, for example about CO_2 emissions, sustainability *performance* refers to the comparison of firms' sustainability information along certain sustainability performance metrics, for example firm X emits less CO_2 than firm Y for a given output.

Higher-order beliefs equal an investor's expectations about other investors' beliefs. In his seminal work about belief formation, Keynes (1936) relates the stock market to a beauty contest and describes that the stock market is influenced by investors' anticipation of changes in the valuation of an investment ahead of the public. In this case, investors buy a stock not only because they find it attractive but also because they believe other investors do. Harrison and Kreps (1978) show that investors with diverse expectations exhibit speculative behavior given that they are willing to pay more for an asset if they have the right to resell an asset instead of having to hold it forever. Prior theoretical research shows that investors form beliefs about other investors' beliefs and explain how beliefs are reflected in asset prices (e.g., Townsend, 1983; Allen et al., 2006; Banerjee et al., 2009; Han and Kyle, 2018; Zhou, 2022).

The relevance of beliefs is further supported by experimental and archival evidence about the effect of forecasts of other investors' forecasts on asset prices. Hommes et al. (2005) conduct an experiment where participants forecast the future price of an asset over multiple periods, with the market price determined by these forecasts. The resulting price significantly deviates from its fundamental value.[5] Investors can also benefit if the price deviates from its fundamental value as shown by Brunnermeier and Nagel (2004). The authors implicitly analyze beliefs formed by hedge funds and find empirical evidence that hedge funds anticipated investor sentiment about technology stocks in the early 2000s. While initially they were heavily invested in technology stocks, they largely reduced their position before the bubble burst. Thus, the anticipation of large structural changes in the market led them to make large abnormal returns.

Our study is independent of the distinction between first-order and higher-order beliefs, as the specific level of (iterated) reasoning at which investors form beliefs about other investors' pro-sustainable preferences does not affect our research question and design. We combine the literature about investors' preferences and beliefs and expect that pro-sustainable beliefs explain why investors invest in sustainable assets, even when controlling for pro-sustainable preferences. Thus, we test against the null hypothesis that there is no statistically significant difference between the investment decisions of investors with pro-sustainable beliefs and investors without them. Therefore, we hypothesize:

Hypothesis 1 *(H1). Pro-sustainable beliefs lead to higher investments in sustainable assets, beyond the effect of pro-sustainable preferences.*

2.2. Sustainability performance and presentation format

This study examines the effect of investors' pro-sustainable preferences and beliefs on investments in sustainable assets. We consider two factors that could moderate this effect: The firm's actual sustainability performance (positive vs. negative) and the presentation format of the disclosed sustainability information (visual vs. narrative).[6]

Sustainability performance Financial information about future expected payoffs is the main driver of investment decisions. However, a broad range of literature shows that investors also consider sustainability information and sustainability performance, which are two interlinked but different concepts (Liesen et al., 2017).

Sustainability information refers to firms disclosing information about the environmental and social externalities their business creates. Thus, the focus is on the sustainability *disclosure* per se, for example whether a firm discloses information about its greenhouse gas (GHG) emissions. Sustainability information is increasingly demanded by investors and shown to be value-relevant (e.g., Dhaliwal et al., 2011; Hartzmark and Sussman, 2019; Stefan and Paul, 2008).

Contrarily, sustainability performance focuses on comparing the sustainability information between firms along a certain performance metric. Thus, sustainability performance refers to a firm's relative position with regard to a dimension of sustainability, such as the *level* of GHG or the *efficiency* of GHG emission relative to a certain level of production. Liesen et al. (2017) provide empirical evidence about the distinct effect of sustainability *information* and sustainability *performance*. The authors show that a portfolio of firms, which disclose their greenhouse gas emissions, outperforms a portfolio of firms, which do not disclose their emissions. Additionally, within the portfolio of disclosing firms, investing in those firms with better greenhouse gas efficiency, a performance metric, generates further abnormal returns. This highlights the distinction between disclosing sustainability information and sustainability performance.

Friedman and Heinle (2016) use a theoretical model, assuming that the utility of investors with pro-sustainable preferences increases in the firm's sustainability performance. Pástor et al. (2021) provide evidence for this assumption: In their model, sustainable assets are defined by their sustainability performance. Assets with a positive sustainability performance have a positive social impact and generate positive externalities. The authors show that investors, who have a preference for sustainable assets, demand a lower financial return due to the non-pecuniary utility from holding these assets. Furthermore, the expected financial return of a stock is decreasing in its sustainability performance. Thus, investors with pro-sustainable preferences are willing to pay more for more sustainable assets and, consequently, receive a higher utility from a higher sustainability performance of these assets. This is further supported by experimental evidence from Bonnefon et al. (2022). The authors show that investors have a higher willingness to pay for firms' positive social externalities and that this relation is proportional to the value of these social externalities. Based on these findings about the effect of a firm's sustainability performance, we hypothesize:

[5] This type of experiment has been replicated successfully in various forms (see Hommes, 2011, for a literature review).

[6] The project's initial research question, as preregistered on OSF, was about the effect of sustainability performance and its presentation format as well as the effect of preferences and beliefs on investment decisions. While the findings are interesting, we are convinced that this study, which puts pro-sustainable beliefs center-stage, provides a more significant contribution to the literature. In this study, we address the preregistered hypotheses 1, 2, and 3, however in a different order. The preregistered hypotheses 4a/4b do not add significantly to answering our research question and are thus not part of our analyses anymore.

Hypothesis 2a *(H2a). The effect of pro-sustainable preferences on investments in sustainable assets is sensitive to the sustainability performance.*

Hypothesis 2b *(H2b). The effect of pro-sustainable beliefs on investments in sustainable assets is sensitive to the sustainability performance.*

Presentation format Libby and Emett (2014) propose three channels through which the presentation format of information can affect investor behavior: First, through its direct effect on information content. Second, indirectly through an effect on managers' actions, which then affect information content. Third, through the effect on investors' ease of processing. Conducting an experiment allows us to hold the information content of the sustainability information constant. Thus, we can neglect the first and the second channels and focus on the third channel, investors' ease of processing.

The ease of processing varies by the degree to which narrative or visual formats are used. Narrative disclosures provide the opportunity to explain results (Aerts, 2005; Clatworthy and Jones, 2003). However, they are harder to process, a finding that can be linked to lower readability of narrative disclosures (Libby and Emett, 2014). Rennekamp (2012) provides experimental evidence that the readability of disclosures changes investor judgments. Similarly, Tan et al. (2014) find that readability influences investors' future earnings performance predictions of a firm. Lee (2012) demonstrates that lower readability reduces the informational efficiency of stock prices. Using data from a large US brokerage firm, Lawrence (2013) shows that investors invest more in firms whose financial statements are more readable and concise.[7]

Contrarily, a visual illustration of information is easier to process (Elliott et al., 2017; Kosslyn, 1985). Elliott et al. (2017) show that the presentation format of sustainability information, highlighting either visual or narrative elements, affects the investment decisions of unsophisticated investors. Based on these findings, a visual presentation format should reduce the processing costs of the sustainability information and make the sustainability information easier to understand for all investors. However, we expect that only those investors who consider sustainability in investing, i.e. those *with* pro-sustainable preferences or beliefs, will change their investment decisions based on a visual presentation format. For example, an investor with pro-sustainable preferences or beliefs, who invests comparatively more in sustainable assets than an investor without such preferences or beliefs, will be inclined to invest even more in such assets if the sustainability information, on which she bases her investment decision, is easier to process. The presentation format enables the investor to understand the information so that her pro-sustainable preferences and/or beliefs can be revealed.

Alternatively, we expect a null effect for investors *without* pro-sustainable preferences or beliefs. An investor without such preferences or beliefs is not willing to invest more in sustainable assets even if the sustainability information, on which she bases her investment decision, is easier to process. Based on the reasoning about the effect of the presentation format of sustainability information, we hypothesize:

Hypothesis 3a *(H3a). The effect of pro-sustainable preferences on investments in sustainable assets is sensitive to the presentation format.*

Hypothesis 3b *(H3b). The effect of pro-sustainable beliefs on investments in sustainable assets is sensitive to the presentation format.*

3. Experimental design

3.1. Treatments and dependent variable

We conduct an online experiment employing a 2x2+1 between-subjects design.[8] Participants assume the role of investors and have to invest a budget in two firms. All participants receive the same financial reports about two firms, firm A with positive financial performance and firm B with negative financial performance. Whereas participants in the control group receive only financial information, the participants in the treatment groups receive additional sustainability information about the two firms. Both the financial and the sustainability reports are based on actual firm reports and were adapted to the experimental setting. For the financial reports, we closely followed the design of actual 10-K reports and kept the most important financial information on a single page so as not to include too much information as part of the treatment.

Following the hypothesis development in chapter 2, we manipulate the reported sustainability performance and the presentation format of the sustainability information, as shown in Table 1. The first manipulation refers to the sustainability performance. Therefore, treatment groups one and two receive sustainability information reporting negative sustainability performance for firm A, while the other two groups receive sustainability information reporting positive sustainability performance for firm B. For the design of the treatments, we also followed firms' actual sustainability reports. We focused on the environmental and social aspects and divided the firms' sustainability activities into four dimensions: CO_2 Emissions, Water Consumption, Waste Generation, and Working Accidents. We vary the sustainability performance by mirroring the historical trend of each firm's sustainability risk so that both firms have the exact opposite historical trend in each of the four dimensions.

[7] See the literature review by Blankespoor et al. (2020) about disclosure processing costs and their impact on investor decision making and market outcomes.

[8] For a detailed overview of all treatments and screenshots of the experiment, please refer to the Online Appendix. https://github.com/VSchauer/Sustainability_Appendix

Table 1
Overview of Experimental Groups.

Firm	Performance		Presentation Format	
	Financial	Sustainability	Narrative	Visual
A	+	−	TG1	TG2
B	−			
A	+		TG3	TG4
B	−	+		

This table shows the experimental groups of this study. Performance shows the manipulation of the presented financial and sustainability performance of firms A and B. + indicates a positive performance and – indicates a negative performance. Presentation format shows the manipulation of the sustainability information's presentation format, which is either narrative or visual.

The second manipulation refers to the presentation format, as some formats are easier to process than others. Therefore, treatment groups one and three receive the sustainability information in a narrative format, while groups two and four receive the sustainability information in a visual format. The variation of the presentation format follows the largely unregulated mixture of visual and narrative presentation formats in actual reports. For the visual presentation format, we included four line graphs showing the historical trend of the firm's sustainability performance. Below those graphs, we included the firm's sustainability risk rating and its historical ratings. Additionally, we provided a graphical illustration of the rating as well as a definition of the rating in written form to ensure that the participants interpreted the rating correctly. For the narrative presentation format, we included the information as plainly written text. Participants in the control group receive only the financial reports and serve as a baseline scenario without any sustainability information.

Our treatments match the classification of disclosure elements by Christensen et al. (2023). Our *narrative* treatment, which presents numbers in a text, would be classified as *low visual impact*, while our *visual* treatment, which presents the same numbers in line graphs, would be classified as *high visual impact*. We ensure to hold the information content between the two presentation formats constant so that any differences in investor behavior can only be attributed to the presentation format.

This procedure results in the following variables for the statistical analyses. *Positive Sustainability Performance* is a binary indicator of whether the participant receives negative sustainability performance for firm A (= 0) or positive sustainability performance for firm B (= 1). *Visual* is a binary indicator of whether the participant receives the sustainability information in a narrative (= 0) or visual (= 1) presentation format.

The participants' experimental task is to invest a fixed budget. For this purpose, the participants receive 1,000 coins they have to invest in two firms, A and B, in steps of 1 coin. The budget only has an indirect influence on the participants' payoffs since the investment allocation shows the demand for certain assets. Ultimately, only the demand for assets, i.e. the coordination, determines the participants' payoffs. This setup can be compared to an asset manager who has to allocate an investment budget between firms. The literature has shown that unexpected increases in demand for certain assets (e.g. sustainable assets) exert upward pressure on the prices of these assets (e.g., Pástor et al., 2021, 2022). Therefore, a rational asset manager who tries to anticipate investors' increasing pro-sustainable preferences, and consequently an increase in demand and prices of sustainable assets, would also allocate a significant part of the investment budget to these assets to profit from higher prices. Our experiment in general and the investment allocation task in particular mirror this feature of stock markets.

To measure the effect of the treatments and pro-sustainable preferences and beliefs, the dependent variable in all analyses is the investment in firm B.

3.2. Coordination game to elicit preferences and beliefs

We design the experiment as an incentive-compatible coordination game so that the participants invest based on their preferences and beliefs about the other participants' preferences. Coordination games as part of experiments have mainly been used in the economics literature to understand the relation between beliefs and output in macroeconomic models (Cooper, 1999), for public good provisions (Hirshleifer, 1983; Suri and Watts, 2011), or firm production (Brandts and Cooper, 2006a,b). In addition, coordination games have also been applied to experimental asset markets.[9] Hommes et al. (2005) design an experiment where participants need to forecast the future price of a risky asset over multiple periods. The participants are compensated according to their forecast errors so that they are, ultimately, incentivized to forecast the average forecast.

Our study is different in that we use an incentivized one-shot non-cooperative simultaneous coordination game to explicitly elicit the participants' *pro-sustainable* preferences and beliefs. Most importantly, the experimental task is incentive-compatible. The belief

[9] Experimental asset markets have mainly been analyzed following the experimental setup by Smith et al. (1988) to understand factors contributing to the emergence of bubbles (see Palan (2013) and Nuzzo and Morone (2017) for literature reviews).

elicitation, however, is not incentive-compatible to avoid hedging bias.[10] In the experiment, participants are randomly assigned to groups of two participants and their payoff depends on their mutual investment decisions. Since they are not allowed to communicate, they do not have information about each other's preferences. This two-player setting is the easiest way to elicit pro-sustainable beliefs but can be generalized assuming that one participant represents the asset market as a whole. Consequently, we mimic a situation where an investor forms beliefs about the pro-sustainable preferences of the overall asset market.

Each of the two participants (*P1* & *P2*) may be one of two possible types in the sense of Harsanyi (1967): a financially-oriented type (weak preference toward sustainability) or a sustainability-oriented type (strong preference toward sustainability). The financially-oriented type would invest in firm A (positive financial performance, negative sustainability performance), while the sustainability-oriented type would invest in firm B (negative financial performance, positive sustainability performance). However, each participant knows her own but not the other participant's type, leading to incomplete information. Consequently, each participant forms beliefs about the other participant's type conditional on her type. Hence, the coordination game in this experiment is a Bayesian game and a strategy profile is a Bayesian Nash equilibrium if each participant's strategy is the best response to the other participant's strategy given the beliefs about the other participant's type.

Due to the nature of the Bayesian game, the belief formation works as follows: If *P1* thinks that *P2* is sustainability-oriented, *P1*'s best response is to invest in firm B, as *P2* will invest in the more-sustainable firm B, too. If *P1* thinks that *P2* is financially oriented, *P1*'s best response is to invest in the less-sustainable firm A, as *P2* will invest in firm A, too. Likewise, *P2* will form beliefs in the same way about *P1*'s preferences. Generally speaking, *P1* expects *P2* to invest in one of the firms with a certain likelihood. If this likelihood is sufficiently high, *P1* will invest in the same firm. This basic example demonstrates that it does not matter whether both participants invest in firm A or firm B as long as both participants choose the same firm in the Bayesian game.[11] This setting, in turn, results in two pure Bayesian Nash equilibria.

Overall, our experimental design resembles parts of the classic Battle of the Sexes (BoS), a standard example of coordination games. A woman and a man can decide between two activities, going to the ballet or a boxing fight. While the woman prefers going to the ballet, the man prefers going to the boxing fight. The woman and the man want to spend their time together but cannot agree on which activity to choose. This results in two pure Nash equilibria: Both choose the ballet and both choose the boxing fight. In our coordination game, participants in the treatment groups receive both financial and sustainability information about the two firms. Some may prefer financially better-performing firms, while others may prefer sustainably better-performing firms. As long as participants do not form beliefs about others' preferences, they randomly select a firm and invest their entire budget, as the payoff is not determined by the firms' performance. Similar to the BoS, this leads to two pure Nash equilibria.[12] However, in our setting, we incentivize participants to form beliefs about the other participants' preferences, as payoffs depend on their mutual investment decisions. Consequently, participants forming beliefs deviate from picking a firm randomly to maximize their payoff. The role of beliefs about preferences distinguishes our experiment from the classic BoS.

Furthermore, we are confident that in our experimental design experimenter demand effects (EDE) are only a minor concern. EDE refers to "changes in behavior by experimental subjects due to cues about what constitutes appropriate behavior" (Zizzo, 2010, p. 75). EDE becomes particularly relevant when participants' beliefs about the experimental objectives are positively correlated with the true experimental objectives (Zizzo, 2010). In our setting, this could be the case if participants believed that the experimental objective was to measure investment in more sustainable firms and for this reason invested more in the more sustainable firm. However, we are convinced that our experiment minimizes EDE concerns for several reasons. First, the coordination game is incentive-compatible so that participants are incentivized to behave according to their preferences and beliefs about the other participant's preferences. Thus, it is not in the participant's best interest to anticipate the expectations of the experimenters. Second, we do not introduce the concept of sustainability before the actual experimental task, nor do we frame sustainability in any way. Third, the sustainability information comes bundled up with other types of information, such as detailed financial information, so it is not salient for the participants that the sustainability information and the specific sustainability performance are being manipulated. Fourth, we employ a between-subjects design so that the participants are not able to compare different treatments with and without sustainability information and of different sustainability performances. Fifth, since we conduct an online experiment, there is no interaction with the experimenters, further reducing the relevance of participants' beliefs about the experimenters' expectations.

[10] Schlag et al. (2015) argue that hedging bias is an important issue in belief elicitation. Armantier and Treich (2013) show theoretically and empirically that this bias distorts reported probabilities. Specifically, in our experiment, if participants were asked to perform the investment decision task and the belief elicitation task, they would have an incentive to hedge. They could reduce the variance of their payoff by choosing options that have the maximum expected payoff in opposite outcomes. In consequence, this behavior would bias the results. For these reasons, we kept the main experimental task incentive-compatible and the belief elicitation not incentive-compatible.

[11] This shows that the information about the two firms can be seen as sunspots since the information does not directly affect payoffs. However, sunspots affect agents' beliefs and expectations and, in turn, their actions (Azariadis, 1981; Cass and Shell, 1983). This also applies to this study's setting. Importantly, this study does not focus on measuring a direct effect of the information on the investment decision. Instead, it focuses on measuring the effect of preferences and beliefs on investment decisions and the information serves as a coordination device. Therefore, information only has an indirect effect on the participants' expectations, investment decisions, and payoffs.

[12] As in the classic BoS, in our coordination game, there is also a Nash equilibrium in mixed strategies. With probability $p = 50\%$, the participants randomize between investing all of their budgets in firm A or firm B. Different from the classic BoS, in our coordination game, participants can make more granular decisions by investing their 1000 coins in steps of 1 coin. The payoff function incentivizes participants to invest all of their budgets into the firm they think the other participant invests in primarily. Even with a 50-50 split by one participant, the other participant has an incentive to invest all of her budget into firm A or firm B to maximize her payoff.

3.3. Variable construction for preferences and beliefs

Pro-sustainable beliefs are the main variable of interest. However, since they are unobservable, we need to elicit beliefs to make them quantifiable (Schlag et al., 2015; Schotter and Trevino, 2014). We thereby follow the experimental economics literature and elicit beliefs by asking the participants implicitly for their subjective probabilities regarding the other participants' preferences.[13] While, in our experiment, there are no known ex-ante objective frequencies, we compare participants' ex-ante subjective estimations to the ex-post objective frequencies based on participants' actual investment decisions. With this comparison, we are able to infer the participants' beliefs about the other participants' preferences. In particular, we use two pieces of information for the belief elicitation: the actual mean investment of all participants within the same experimental group, and the respective participant's *estimation* of the actual mean investment of all other participants resulting from asking the following question:

"In this experiment, how do you think all the other participants, not only the participant assigned to you in the game, distributed their 1,000 coins between firm A and firm B?"

To answer the question about how the other participants distributed their 1000 coins, each participant could choose from 10 answers that cover the range from 1 to 999 coins in steps of 125 coins, in addition to the answers "exactly 0 coins" and "exactly 1000 coins". We provided these answer ranges for two reasons: First, we thereby incorporate any uncertainty of a participant estimating the other participants' investment and avoid the bias associated with treating all observations as if they were distinct with the potential for a unique optimum (Manski and Neri, 2013; Schotter and Trevino, 2014). Second, the step size makes it much easier for the participants to choose. Subsequently, we use the midpoint value between the upper and the lower bound of each answer range as the participant's estimation. We discretize at a bin width of 125 coins to balance precision and the aforementioned advantages of discretization. In chapter 4.3, we provide alternative definitions of a participant's estimation by using the lower and the upper bound of the chosen answer range. We also construct a variable, which incorporates whether and by how many answer ranges the participant overestimates or underestimates the other participants' actual mean investment. The results remain qualitatively the same.

The variable to measure participants' pro-sustainable beliefs is binary. We infer these beliefs by comparing the participant's estimation of the other participants' mean investment in firm B (the more sustainable firm) with the actual mean investment in firm B within the respective experimental group. We define that a participant has pro-sustainable beliefs when she overestimates the other participants' investment in the more sustainable firm B (*Pro-sustainable Beliefs* = 1). This overestimation expresses the participant's expectation of the other participants' pro-sustainable preferences, which lead to more investments in the more sustainable firm B. Put differently, the participant believes that the other participants have stronger pro-sustainable preferences than they actually do and, consequently, holds pro-sustainable beliefs.

The following example illustrates this procedure. Assume a participant *P*, who estimates that the mean investment in the more sustainable firm B is between 250 and 375 coins, and the actual mean in *P*'s experimental group is 100 coins. We take the midpoint value between the lower and the upper bound, which equals 312.5, as the participant's estimation. Hence, *P* overestimates the other participants' investment in firm B by 212.5 coins. Therefore, *P* believes that the other participants have stronger pro-sustainable preferences than they actually do. Thus, we attribute pro-sustainable beliefs to *P*. In this case, the corresponding binary variable *Pro-sustainable Beliefs* takes the value 1.

In the experiment, we infer pro-sustainable preferences using the participants' answers to the following question:

"The sustainability performance was important to me in making the investment decision."

We subsequently normalize the Likert-scale answers (1 Strongly disagree, ..., 5 Strongly agree) to values between 0 and 1 to increase the interpretability of the coefficients. In chapter 4.3, we provide alternative proxies for pro-sustainable preferences. The results are qualitatively the same.[14]

3.4. Experiment structure and procedure

We conduct our online experiment on the open-source behavioral research platform oTree, which enables the implementation of interactive economic experiments, such as coordination games (Chen et al., 2016).[15] Participants receive a link to the online experiment and are randomly assigned to one of the five experimental groups.

At the beginning of the experiment, participants receive information about the set-up, the time limit, and the payoff, which consists of a fixed compensation of $2.50 and a maximum variable compensation of $3.00, determined through the coordination

[13] See Manski (2004) for a literature review about belief elicitation in surveys.

[14] For the full distribution of the untransformed variables *Pro-sustainable Preferences* and *Pro-sustainable Beliefs* as well as granular investment amounts in firm B per experimental group, please refer to Table E.1 in the Appendix.

[15] Online experiments have become popular using platforms, such as Amazon Mechanical Turk. Over the recent years, many studies from economics and psychology have been replicated successfully (e.g., Arechar et al., 2018; Hergueux and Jacquemet, 2015; Horton et al., 2011; Paolacci et al., 2010), making online experiments a valid alternative to laboratory experiments.

game. Afterward, participants receive detailed instructions about the experimental task.[16] As each participant's payoff is determined through the coordination game, we randomly assign the participants in groups of two.

We explain to the participants how their variable payoff depends on their own investment decision and the investment decision of the other participant in their respective groups. In addition to the payoff formula, shown in Equation (1), we explain to the participants intuitively that they receive the highest payoff if they invest their complete budgets of 1000 coins in the same firm and the lowest payoff if they invest their complete budgets in different firms. To ensure that the participants understand how the payoff mechanism works, we provide them with interactive sliders that allow them to try out any combination of the two participants' investment amounts and the resulting payoffs. Furthermore, before moving on to the actual investment task, the participants have to answer two comprehension questions correctly.[17]

$$\text{Payoff}_i = 1000 * 1.5 * \left[\left(\frac{A_1}{1000} * \frac{A_2}{1000} \right)^2 + \left(\frac{B_1}{1000} * \frac{B_2}{1000} \right)^2 \right] \quad \text{for participant } i = 1,2; A_1 + B_1 = 1000; A_2 + B_2 = 1000 \tag{1}$$

While the participants within one group cannot communicate, they receive the same information and variable payoff. This payoff increases the more both invest in the same firm to align the incentives in the experiment with the Bayesian game described in chapter 3.2. The payoff is highest (1,500 coins; equal to $3.00) if both participants invest their complete budgets in the same firm (e.g., $A_1 = 1{,}000$ and $A_2 = 1{,}000$) and lowest (0 coins; equal to $0.00) if both participants invest their complete budgets in different firms (e.g., $A_1 = 1{,}000$ and $B_2 = 1{,}000$).[18] This payoff mechanism reflects recent evidence by Koijen and Yogo (2019) and Gabaix and Koijen (2021) who show that the variation in stock returns is largely explained by demand shifts that are unrelated to changes in observed firm characteristics. Likewise, Pástor et al. (2022) shows that an (unexpected) increase in investor demand due to stronger preferences for sustainable assets can increase the prices of such assets. Furthermore, as described in chapter 3.2, the payoff formula discourages the participants from distributing their coins equally between firms. Such a safe option would render the beliefs about the other participants' preferences irrelevant.[19] Thus, we incentivize the participants to invest according to their pro-sustainable preferences and beliefs to maximize their payoffs.

Subsequently, the participants receive the financial and sustainability information for the two firms and submit their investment decision. Before ending the experiment, participants answer follow-up questions about the reasons for their investment decision, and their estimation of the other participants' investment decisions. In line with previous research, we use ten items from Fernandes et al. (2014)'s 13-item financial literacy test and, subsequently, ask for demographic information. All survey questions are provided in the Online Appendix. An overview of all variables is provided in Table A.1 in the Appendix.

3.5. Participants

We recruited 408 participants from the crowdsourcing platform Prolific.[20] This platform is similar to Amazon's Mechanical Turk but allows for a more sophisticated prescreening of participants. Prolific is considered to provide superior data quality and explicitly informs participants that they participate in research (Palan and Schitter, 2018; Eyal et al., 2021).

To achieve high data quality and generalizability of the findings, we follow the guidelines of Hauser et al. (2019) and apply several prescreening criteria. First, we only include participants whose first language is English to reduce variance in the participants' language skills. Second, following Eyal et al. (2021), we only include participants with a high reputation (Prolific approval rating of at least 95 percent) and between five and 10,000 submissions on Prolific. Third, to ensure that participants can assess the financial and sustainability information provided, we require them to have investment experience (either personal or through their employment). In sum, these prescreening criteria ensure that the participants possess sufficient knowledge to process the experimental stimuli and perform the experimental task.

Applying these criteria, we recruit from a pool of around 17,000 Prolific users. On average, the recruited participants are 38.8 years old; 47.9% report being female, 57.0% have a net monthly income of $3,000 or less, and 76.5% hold at least a Bachelor's degree.[21] The average time to complete the study has been approximately nine minutes, with an average payoff of $4.67, which equals an average hourly wage of $31.13. The relatively high hourly wage and the fact that participants are only paid upon completion incentivize the participants to complete the experiment.

The dropout rate is 15.1%, which is lower than in online social psychology experiments with dropout rates ranging from 30% to 50% (Zhou and Fishbach, 2016). We expected a higher dropout rate than in laboratory experiments, given that dropping out in online experiments is less costly for participants. Furthermore, we employ a coordination game, which might lead to a higher

[16] A flowchart of the experiment is provided in Fig. B.1 in the Appendix. Screenshots and all treatments of the experiment are provided in the Online Appendix.

[17] In the Online Appendix, we provide full details of the various measures we take to ensure that the participants understand the payoff mechanism.

[18] For a graph showing how the payoff depends on the investment amounts, please refer to Fig. C.1 in the Appendix.

[19] Overall, we observe that only 5 out of 408 participants equally split their budgets between firm A and firm B. This shows that different risk preferences are negligible in our setting.

[20] The number of recruited participants is based on a power analysis performed before the data collection, assuming rather conservative medium effect sizes for all treatment effects (Cohen's d of 0.5), a power of 80%, and a dropout rate of 20%.

[21] We find no statistical differences regarding the demographic variables across the experimental groups. An overview of the demographic information is provided in Table E.2 in the Appendix.

dropout rate, given that participants have to wait for the other participant's investment decision, an argument also made by Arechar et al. (2018) and Suri and Watts (2011).

There is neither a significant association between the dropout rate and experimental groups after the participants receive the treatment nor between the dropout rate and demographic variables. Therefore, the results imply neither a selection bias nor false conclusions regarding treatment effects (Arechar et al., 2018; Hauser et al., 2019; Zhou and Fishbach, 2016).

4. Results

4.1. Descriptive results

Table 2 reports descriptive statistics for the investment amounts in the more sustainable firm B, divided by experimental groups. As expected, the participants in the control group, who receive exclusively financial information, make the lowest investment in firm B with, on average, 106.6 coins ($SE = 24.0$). This demonstrates that the participants in the control group use the financially more successful firm A as a sunspot to coordinate with each other. Participants in the treatment group (TG) 3, who receive narratively presented positive sustainability performance for firm B, invest the most in firm B with an average investment of 254.3 ($SE = 40.6$) coins.

The descriptive statistics provide insights into the treatment manipulations but do not directly address our hypotheses, which will be tested in chapter 4.2. First, investments in the relatively more sustainable firm B are higher when sustainability information is presented narratively than when it is presented visually (two-sample t-test TG1/3 vs. TG2/4, $\Delta = 61.3$, $SE = 31.1$, $p < 0.05$). Second, the difference between participants' investment in firm B when they receive information about the negative sustainability performance of firm A (TG1 and TG2) and when they receive information about the positive sustainability performance of firm B (TG3 and TG4) is insignificant (two-sample t-test, $\Delta = 45.1$, $SE = 31.3$, $p = 0.151$). This statistical insignificance might be due to missing power in this test. Another reason might be the omission of factors driving investment decisions in the sustainability context, such as investors' pro-sustainable preferences or beliefs.

Table 2
Investment per Experimental Group.

Firm	Performance		Presentation Format		Row Mean
	Financial	Sustainability	Narrative	Visual	
			TG1	TG2	
A	+	−	172.789	139.747	157.343
			(26.886)	(28.176)	(19.438)
B	−		n = 90	n = 79	n = 169
			TG3	TG4	
A	+		254.342	157.080	202.429
			(40.642)	(28.569)	(24.543)
B	−	+	n = 76	n = 87	n = 163
			210.127	148.831	
		Column Mean	(23.773)	(20.050)	
			n = 166	n = 166	
		106.592			
	Control Group	(24.042)			
		n = 76			

This table reports the average investment in firm B per experimental group as well as for each treatment. Presentation format indicates the treatment of the presentation format of the sustainability information, with Narrative (Visual) being a binary indicator of whether the participant receives the sustainability information in a narrative (visual) presentation format. Performance indicates the respective firm's financial and sustainability performance. + indicates positive performance, − indicates negative performance in the respective category. Standard errors are reported in parentheses and the number of observations is reported below.

Table E.2 in the Appendix reports descriptive statistics for *Pro-sustainable Preferences* and *Beliefs*. First, for the whole sample, the mean of *Pro-sustainable Preferences* (0.514) shows that the participants, on average, tend to have pro-sustainable preferences. However, the mean value is not statistically different from the midscale value of 0.5 (Wilcoxon signed-rank test, $p = 0.398$). This suggests that participants, on average, neither have a preference toward sustainability nor an aversion toward sustainability.[22] Second, the mean of *Pro-sustainable Beliefs* (0.443) demonstrates that the participants, on average, underestimate the other participants' investment in the more sustainable firm. Thus, they do not attribute pro-sustainable preferences to the other participants. In this case, the mean value is statistically different from the midscale value of 0.5 (Wilcoxon signed-rank test, $p = 0.026$). This contrasting finding provides initial insights into the importance of considering *both* pro-sustainable preferences and beliefs in investment decisions.

Finally, we determine the correlation between each participant's estimation of the other participants' investment in firm B and her own investment in firm B. The estimation of other participants' investment is calculated, as described in chapter 3.2, by taking

[22] To alleviate concerns that the reported preferences are random, we have additionally conducted a Kolmogorov-Smirnov test to compare the distribution of our variable *Pro-sustainable Preferences* against a continuous uniform distribution, which could indicate randomness. Given the resulting p-value of $p < 0.01$, we reject the null hypothesis that the responses of our variable *Pro-sustainable Preferences* follow a uniform distribution.

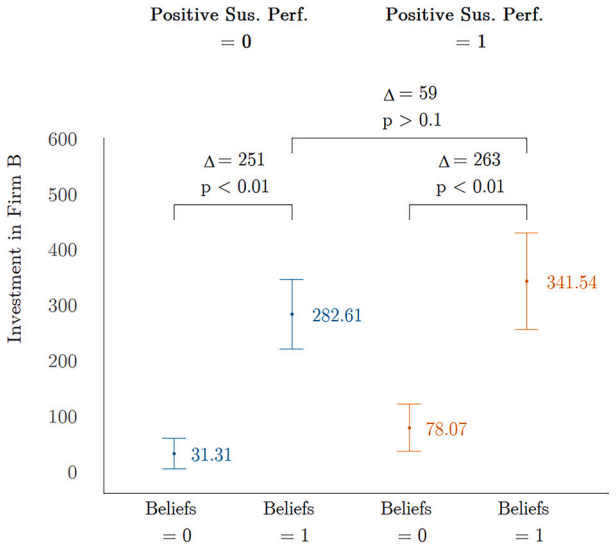

Fig. 1. Mean Investments for Beliefs and Positive Sustainability Performance. This figure illustrates the mean investment amounts in firm B given that participants have pro-sustainable beliefs and given positive or negative sustainability performance. The dots show the mean investment in firm B while the error bars indicate the 95%-confidence interval of the mean. Pro-sustainable Beliefs is a binary indicator equal to one if the participant has pro-sustainable beliefs, and zero otherwise, following the procedure described in chapter 3.2. Positive Sus. Perf. is a binary indicator equal to one if the participant receives positive sustainability performance for firm B, and zero if the participant receives negative sustainability performance for firm A.

the midpoint value of the upper and the lower bound of each answer range as the participant's estimation. We observe that there is a positive correlation ($\rho = 0.53$), suggesting that participants consider the investment decisions of other participants when making their investment decisions.[23] Thus, if a participant believes that the other participants invest more in the more sustainable firm, the participant tends to invest more in the more sustainable firm as well. While this effect might at least partially be driven by the participant's individual pro-sustainable preferences, we disentangle the effect of pro-sustainable beliefs and pro-sustainable preferences on investment decisions in chapter 4.2.

4.2. Main results

In the following chapter, we provide the main results that address our three hypotheses about the effect of pro-sustainable preferences and beliefs on investment decisions (H1) as well as the sensitivity of the effect to the sustainability performance (H2a and H2b), and to the presentation format (H3a and H3b). Fig. 1 descriptively summarizes the results for H1 and H2b. It shows mean investments in firm B, the more sustainable firm, if the participants have pro-sustainable beliefs (Beliefs = 1) or have no pro-sustainable beliefs (Beliefs = 0), and if the firm's sustainability performance is positive (Positive Sus. Perf. = 1) or negative (Positive Sus. Perf. = 0).

H1 argues that pro-sustainable beliefs lead to higher investments in sustainable assets. As shown in Fig. 1, we observe that the participants invest significantly more in firm B if they have pro-sustainable beliefs. This holds for both positive sustainability performance, Positive Sus. Perf. = 1 ($\Delta = 263$ coins, $p < 0.01$), and for negative sustainability performance, Positive Sus. Perf. = 0 ($\Delta = 251$ coins, $p < 0.01$). These findings suggest a confirmation of H1.

H2b argues that the relation between pro-sustainable beliefs and the investment in sustainable assets is sensitive to the sustainability performance. Notably, we do not find evidence that participants with pro-sustainable beliefs invest significantly more in firm B if the sustainability performance is positive than if it is negative ($\Delta = 59$ coins, $p > 0.1$). Overall, the descriptive findings in Fig. 1 hint toward the importance of considering investors' pro-sustainable beliefs for investment decisions.

Next, we conduct regression analyses and further analyze the effect of pro-sustainable beliefs. Table 3 presents the results for H1. Specifications (1) and (2) show the baseline results including either *Pro-sustainable Preferences* (1) or *Pro-sustainable Beliefs* (2) as explanatory variables. *Pro-sustainable Preferences* is included as a linear variable with values between 0 and 1. Specification (3) shows the result when including both *Pro-sustainable Preferences* and *Pro-sustainable Beliefs*. Specification (4) includes the treatment dummies *Positive Sustainability Performance* and *Visual* and, therefore, only includes participants of the treatment groups. Additionally, we include control variables *Importance Financial Information* and *Financial Literacy*. The results in specifications (1) and (2) show that *Pro-sustainable Preferences* ($\beta = 216.2$, $SE = 48.0$, $p < 0.01$) and *Pro-sustainable Beliefs* ($\beta = 244.3$, $SE = 25.5$, $p < 0.01$) relate positively to the investment in the more sustainable firm B. The results in specification (3) confirm the baseline results when including both variables and exhibit a positive effect of *Pro-sustainable Preferences* ($\beta = 168.6$, $SE = 43.5$, $p < 0.01$) and *Pro-sustainable Beliefs* ($\beta = 237.4$, $SE = 24.7$, $p < 0.01$) on investments in firm B. The results are robust to including the treatment dummies *Positive*

[23] Figure D.1 in the Appendix illustrates the correlation between participants' estimated investment and own investment.

Table 3
The Effect of Pro-sustainable Preferences and Beliefs on Investment Decisions.

	(1)	(2)	(3)	(4)
Dependent Variable: Inv. firm B				
Sample	All	All	All	TG
Pro-sustainable Preferences	216.247***		168.649***	214.203***
	(48.046)		(43.521)	(52.688)
Pro-sustainable Beliefs		244.316***	237.354***	208.053***
		(25.463)	(24.745)	(28.447)
Positive Sus. Performance				75.379***
				(26.812)
Visual				−37.951
				(25.844)
Importance Financial Information				−93.922***
				(21.323)
Financial Literacy				4.713
				(26.778)
Constant	54.731**	46.919***	−37.809*	288.549***
	(23.353)	(10.593)	(21.854)	(90.550)
Observations	408	375	375	306
Adj. R^2	0.056	0.218	0.254	0.344

This table reports the results for H1. The dependent variable is the investment in firm B. Pro-sustainable Preferences is a variable based on the participant's response to the statement "The sustainability performance was important to me in making the investment decision." (1 Strongly disagree, ..., 5 Strongly agree), normalized to values between 0 and 1. Pro-sustainable Beliefs is a binary indicator equal to one if the participant has pro-sustainable beliefs, and zero otherwise, following the procedure described in chapter 3.2. Positive Sus. Performance is a binary indicator equal to one if the participant receives positive sustainability performance for firm B, and zero if the participant receives negative sustainability performance for firm A. The remaining variables are defined in Table A.1 in the Appendix. We estimate the regression using OLS with robust standard errors that are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Sustainability Performance and *Visual* and control variables in specification (4). These results show that investors with pro-sustainable beliefs invest more in sustainable asset than investors without such beliefs. This relationship is robust after controlling for pro-sustainable preferences. In conclusion, the results in specifications (1) through (4) support H1.

To gain further insights about the economic significance of *Pro-sustainable Preferences* and *Pro-sustainable Beliefs*, we test whether there is a statistically significant difference between both coefficients. An F-test between these two variables using the estimated coefficients of specification (4) shows that there is no statistically significant difference ($F = 0.01$, $p = 0.92$). This suggests that neither pro-sustainable beliefs nor pro-sustainable preferences are more economically significant than the other, but that both are important for investment decisions in the context of sustainability.

Subsequently, we test whether the effect of pro-sustainable preferences and beliefs on investments in sustainable assets is sensitive to the sustainability performance (H2a/H2b) and the presentation format (H3a/H3b).

With respect to the sustainability performance, in specification (1) of Table 4, we observe a significant and positive interaction between *Pro-sustainable Preferences* and *Positive Sustainability Performance* ($\beta = 267.2$, $SE = 104.5$, $p < 0.05$). These findings are in line with Bonnefon et al. (2022) and Pástor et al. (2021), suggesting that investors with pro-sustainable preferences derive higher utility from higher sustainability performances. Therefore, the relation between pro-sustainable preferences and the investment in sustainable assets is sensitive to sustainability performance, confirming H2a.

The results of *Pro-sustainable Beliefs* show a significant main effect ($\beta = 208.3$, $SE = 33.6$, $p < 0.01$) but no statistically significant interaction with *Positive Sustainability Performance*. Accordingly, we do not have sufficient evidence to suggest that pro-sustainable beliefs are sensitive to the underlying sustainability performance. Investors with pro-sustainable beliefs generally invest more in the more sustainable firm without considering a negative sustainability performance of one firm or a positive sustainability performance of another firm. Therefore, we do not find sufficient evidence to support H2b.

With respect to the presentation format, in specification (2) of Table 4, we do not observe statistically significant interactions effects between *Visual* and *Pro-sustainable Preferences* ($\beta = -106.7$, $SE = 106.3$, $p > 0.1$) or *Pro-sustainable Beliefs* ($\beta = -28.2$, $SE = 54.8$, $p > 0.1$). Consequently, investors do not significantly invest more in sustainable assets if they receive the sustainability information in a visual presentation format. We do not find sufficient evidence to support H3a or H3b. In line with our hypothesis development that lower readability leads to higher information processing costs, we find that participants who receive the sustainability information narratively spend 15% (20 seconds) more time on the treatment than participants who receive the sustainability information visually, a difference that is statistically significant (two-sample t-test, $\Delta = 20$, $SE = 10.4$, $p < 0.1$). It could be argued that all participants could process the sustainability information similarly although the information processing costs were higher for participants who received the information narratively. Given that ultimately the sustainability information could be processed by all participants, we do not find a statistically significant effect of the presentation format.

The coefficients of *Importance Financial Information* are negative and statistically significant in all specifications, as expected. The participants who value financial information invest less in the financially weaker firm B. The variable *Financial Literacy* is unrelated to the investment decision.

Table 4
The Effect of Sustainability Performance and Presentation Format.

	(1)	(2)
Dependent Variable: Inv. firm B		
Sample	TG	TG
Pro-sustainable Preferences	83.509	260.947***
	(65.040)	(68.187)
Pro-sustainable Beliefs	208.287***	220.576***
	(33.605)	(41.679)
Positive Sus. Performance	−59.434	76.591***
	(51.767)	(26.733)
Visual	−40.911	28.096
	(25.568)	(53.380)
Pro-sustainable Preferences × Positive Sus. Performance	267.243**	
	(104.536)	
Pro-sustainable Beliefs × Positive Sus. Performance	1.075	
	(53.380)	
Pro-sustainable Preferences × Visual		−106.703
		(106.307)
Pro-sustainable Beliefs × Visual		−28.199
		(54.847)
Importance Financial Information	-88.430***	−92.993***
	(20.992)	(21.036)
Financial Literacy	2.450	4.104
	(26.461)	(26.960)
Constant	339.849***	256.367***
	(90.746)	(90.125)
Observations	306	306
Adj. R^2	0.361	0.344

This table reports the results for H2a/H2b and H3a/H3b. The dependent variable is the investment in firm B. Pro-sustainable Preferences is a variable based on the participant's response to the statement "The sustainability performance was important to me in making the investment decision." (1 Strongly disagree, ..., 5 Strongly agree), normalized to values between 0 and 1. Pro-sustainable Beliefs is a binary indicator equal to one if the participant has pro-sustainable beliefs, and zero otherwise, following the procedure described in chapter 3.2. Positive Sus. Performance is a binary indicator equal to one if the participant receives positive sustainability performance for firm B, and zero if the participant receives negative sustainability performance for firm A. The remaining variables are defined in Table A.1 in the Appendix. We estimate the regression using OLS with robust standard errors that are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

4.3. Robustness checks

4.3.1. Alternative definitions of pro-sustainable beliefs

In the first part of our robustness checks, we test whether our results are robust to alternative definitions of the variable *Pro-sustainable Beliefs*. The results are shown in Table 5.

In our main analyses, we define that a participant has *Pro-sustainable Beliefs* if this participant overestimates the actual mean investment in firm B of the participants in the same experimental group. As alternative definitions of *Pro-sustainable Beliefs*, in specification (1), we use a binary variable that compares the participant's estimation of the investment in firm B to the actual mean of all *estimations* in the *control group*. We define that a participant has *Pro-sustainable Beliefs* if this participant overestimates the actual mean estimation of the investment in firm B of the participants in the control group. With this definition of *Pro-sustainable Beliefs*, we compare participants' estimations in the treatment groups with participants' estimations in the control group. The variable for *Pro-sustainable Preferences* is defined as in our main analyses in Table 3. The results remain qualitatively the same. The coefficients for *Pro-sustainable Preferences* and *Beliefs* are still positive and statistically significant.

Next, we further explore the robustness of *Pro-sustainable Beliefs*. As described in chapter 3.2, participants estimate the other participants' investment by choosing from 8 answer ranges in steps of 125 coins, in addition to the 2 answers "exactly 0 coins" and "exactly 1000 coins", leading to a total of 10 possible answer ranges. While we use the midpoint of the upper and lower bound of the answer ranges as the participant's estimation in our main analyses, in specifications (2) and (3), we use the lower bound and the upper bound as a participant's estimation of the other participants' investment. Using the lower bound in specification (2) as well as the upper bound in specification (3) in Table 3, we obtain qualitatively unchanged results and all variables keep their signs and statistical significance.

For specification (4), we calculate the variable *Pro-sustainable Beliefs* by comparing the answer range of the participant's estimation to the answer range, which contains the actual average investment in the respective treatment group. We form a trinary variable equal to 0 if the participant correctly estimates the answer range, which contains the other participants' mean investment in firm B. The variable is 1 if the participant *over*-estimates the other participants' investment in firm B, and -1 if the participant *under*-estimates the other participants' investment in firm B. For example, if the participant estimates the investment in firm B to be between 625 and 750, we take the midpoint value of 687.5 as the participant's estimation. Assuming the average investment in firm B for one of the

Table 5
Robustness of Pro-sustainable Beliefs.

	(1)	(2)	(3)	(4)	(5)
Dependent Variable: Inv. firm B					
Measure	Beliefs from CG Est.	Belief Est. Lower Bound	Belief Est. Upper Bound	Belief Est. Range (trinary)	Belief Est. Range (discrete)
Sample	TG	TG	TG	TG	TG
Pro-sustainable Preferences	207.979***	214.203***	225.498***	217.460***	206.882***
	(53.149)	(52.688)	(52.379)	(51.482)	(52.159)
Pro-sustainable Beliefs	199.583***	208.053***	230.854***	129.705***	48.421***
	(27.649)	(28.447)	(36.650)	(17.438)	(10.140)
Positive Sus. Performance	57.341**	75.379***	64.265**	72.459***	67.356**
	(26.970)	(26.812)	(26.830)	(26.328)	(26.799)
Visual	−19.421	−37.951	−28.162	−34.834	−43.188*
	(26.105)	(25.844)	(25.867)	(25.436)	(26.146)
Importance Financial Information	−97.863***	−93.922***	−82.584***	−81.333***	−79.512***
	(21.329)	(21.323)	(22.499)	(21.293)	(23.809)
Financial Literacy	3.762	4.713	4.074	9.329	−3.300
	(27.165)	(26.778)	(26.327)	(26.072)	(26.253)
Constant	301.779***	288.549***	267.738***	364.797***	352.637***
	(90.200)	(90.550)	(92.507)	(83.785)	(88.189)
Observations	306	306	306	306	306
Adj. R^2	0.336	0.344	0.345	0.369	0.347

This table reports robustness tests considering alternative measures for Pro-sustainable Beliefs. The dependent variable is the investment in firm B. Column (1) shows Pro-sustainable Beliefs based on a participant's estimation of the investment in firm B compared to the mean of all estimations in the control group. Column (2) shows Pro-sustainable Beliefs based on the lower bound of the answer range chosen by the participant. Column (3) shows Pro-sustainable Beliefs based on the upper bound of the answer range chosen by the participant. For the aforementioned definitions of Pro-sustainable Beliefs, the variable is 1 if a participant has Pro-sustainable Beliefs, and 0 otherwise. Column (4) shows Pro-sustainable Beliefs as a trinary variable, which is 0 if the participant correctly estimates the answer range that contains the other participants' mean investment in firm B, 1 if the participant overestimates the mean investment in firm B, and -1 if the participants underestimates the mean investment in firm B. Column (5) shows Pro-sustainable Beliefs as a discrete measure indicating by how many answer ranges the participant misses the answer range that contains the actual mean investment in firm B. The remaining variables are defined in Table A.1 in the Appendix. We estimate the regression using OLS with robust standard errors that are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

treatment groups is 300, this value and the participant's estimation are in separate answer ranges. Since the participant overestimates the other participants' investment in firm B, the value for *Pro-sustainable Beliefs* of this participant is equal to 1. Using this alternative definition, all results remain qualitatively unchanged.

In specification (5), we construct the variable for *Pro-sustainable Beliefs* as a discrete measure indicating by how many answer ranges the participant misestimates the actual mean investment. The variable *Pro-sustainable Beliefs* is 0 if the participant correctly estimates the answer range, which contains the other participants' investment in firm B. If the participant does not correctly estimate the other participants' investment in firm B, the variable is equal to the difference in the number of answer ranges between the answer range, which contains the average investment in firm B of the respective treatment group, and the answer range, which contains the participant's estimation. Since there are 10 answer ranges, the logical minimum is −9 and the logical maximum is +9. For example, if the participant estimates the investment in firm B to be between 625 and 750, we take the midpoint value of 687.5 as the participant's estimation. Assuming the average investment in firm B for one of the treatment groups is 300, this value and the participant's estimation are in separate answer ranges. The average of 300 is in the 7^{th} answer range, while the estimation of 687.5 is in the 4^{th} answer range. Since the participant overestimates the other participants' investment in firm B by three answer ranges, the value for *Pro-sustainable Beliefs* of this participant is equal to +3 (= 7 − 4). As before, the results remain qualitatively the same. Overall, the results of our main analyses appear robust to alternative definitions of the variable *Pro-sustainable Beliefs*.

4.3.2. Alternative definitions of pro-sustainable preferences

In the second part of our robustness checks, we test whether our variable *Pro-sustainable Preferences* is robust to alternative definitions. The results are shown in Table 6.

First, we define *Pro-sustainable Preferences* as the average treatment group effect, which is a binary variable equal to 1 if a participant is part of a treatment group and 0 if a participant is part of the control group. The only difference between the treatment groups and the control group is the sustainability information. Thus, any difference in investment decisions between participants in the treatment groups and the control group is due to the preferences for the shown sustainability information. The variable for *Pro-sustainable Beliefs* is defined as in chapter 3.2. Specification (1) of Table 6 shows that the results remain qualitatively unchanged. Both coefficients for *Pro-sustainable Preferences* and *Pro-sustainable Beliefs* are positive and statistically significant.

Second, we use an alternative measure for pro-sustainable preferences, called *Strong Pro-sustainable Preferences*, which is defined as a binary variable equal to one if the participant responds "Strongly agree" or "Somewhat agree" to the statement about the importance of the sustainability performance for the investment decision (see chapter 3.2), and zero otherwise. Specification (2) of Table 6 shows that the results remain qualitatively unchanged. Both coefficients for *Pro-sustainable Preferences* and *Pro-sustainable Beliefs* are positive and statistically significant.

Table 6
Robustness of Pro-sustainable Preferences.

	(1)	(2)	(3)	(4)
Dependent Variable: Inv. firm B				
Measure	Preferences based on TG	Strong Preferences Binarized Likert	Preferences BRS (2021)	Strong Preferences BRS (2021)
Sample	TG	TG	TG	TG
Pro-sustainable Preferences	71.243***	132.448***	30.504	60.416**
	(21.742)	(28.382)	(51.828)	(26.972)
Pro-sustainable Beliefs	198.670***	208.930***	213.769***	212.812***
	(25.895)	(28.527)	(30.242)	(30.070)
Positive Sus. Performance		80.597***	65.409**	60.769**
		(27.399)	(27.456)	(27.110)
Visual		−40.182	−29.876	−27.547
		(25.695)	(26.403)	(26.259)
Importance Financial Information	−92.840***	−93.292***	−96.142***	−94.435***
	(19.548)	(22.417)	(24.029)	(23.897)
Financial Literacy	−23.631	4.747	−16.489	−15.619
	(24.132)	(26.940)	(28.173)	(28.089)
Constant	358.620***	338.071***	391.418***	360.608***
	(79.664)	(87.813)	(103.279)	(97.055)
Observations	375	306	306	306
Adj. R^2	0.302	0.348	0.292	0.299

This table reports robustness tests considering alternative measures for Pro-sustainable Preferences. The dependent variable is the investment in firm B. Column (1) shows Pro-sustainable Preferences as the average treatment group effect; the variable is 1 if a participant is part of a treatment group, and 0 otherwise. Column(2) shows Pro-sustainable Preferences as a binary indicator equal to one if the participant responds "Strongly agree" or "Somewhat agree" to the statement "The sustainability performance was important to me in making the investment decision.", and zero otherwise. Column (3) shows Pro-sustainable Preferences based on the untransformed measure for pro-social preferences by Bauer et al. (2021), i.e. "How willing are you to give to good causes without expecting anything in return?" (1 Strongly disagree, ..., 5 Strongly agree). Column (4) shows Pro-sustainable Preferences based on the binarized measure for pro-social preferences by Bauer et al. (2021), which is equal to 1 if a participant responded "Strong agree" or "Somewhat agree" to the aforementioned question, and 0 otherwise. The remaining variables are defined in Table A.1 in the Appendix. We estimate the regression using OLS with robust standard errors that are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

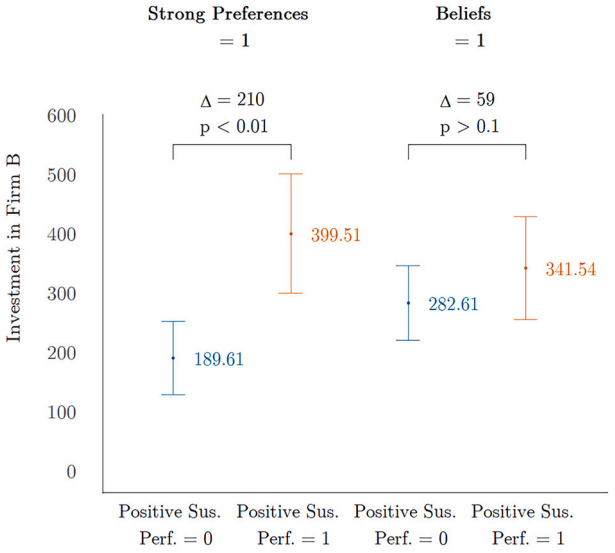

Fig. 2. Mean Investments for Strong Preferences, Beliefs, and Sustainability. This figure illustrates the mean investment amounts in firm B given that participants have strong pro-sustainable preferences or beliefs and given positive or negative sustainability performance. The dots show the mean investment in firm B while the error bars indicate the 95%-confidence interval of the mean. Strong Pro-sustainable Preferences is a binary indicator equal to one if the participant responds "Strongly agree" or "Somewhat agree" to the "The sustainability performance was important to me in making the investment decision." (1 Strongly disagree, ..., 5 Strongly agree). Pro-sustainable Beliefs is a binary indicator equal to one if the participant has pro-sustainable beliefs, and zero otherwise, following the procedure described in chapter 3.2. Positive Sus. Perf. is a binary indicator equal to one if the participant receives positive sustainability performance for firm B, and zero if the participant receives negative sustainability performance for firm A.

Fig. 2 summarizes the results and shows the investment amounts in firm B given that a participant has strong pro-sustainable preferences (Strong Preferences = 1) or beliefs (Beliefs = 1) and given positive (Positive Sus. Perf. = 1) or negative (Positive Sus. Perf. = 0) sustainability performance. On the one hand, participants with strong pro-sustainable preferences invest significantly more ($\Delta = 210$ coins, $p < 0.01$) in firm B if the sustainability performance is positive than if it is negative. On the other hand, participants with pro-sustainable beliefs do not invest significantly more in firm B if the sustainability performance is positive than if it is negative ($\Delta = 59$ coins, $p > 0.1$).

Third, we use an alternative measure for pro-sustainable preferences, which is an established measure to elicit pro-social preferences (e.g., Bauer et al., 2021; Falk et al., 2018, 2023). In a survey, Bauer et al. (2021) let participants respond to the question "How willing are you to give to good causes without expecting anything in return?" on a 10-point Likert scale. The results in specification (3) of Table 6 show that if we use the participants' responses to the measure by Bauer et al. (2021) based on the standardized Likert scale as a measure for pro-sustainable preferences, the coefficient is positive, as expected, but not statistically significant.

Fourth, we also include the variable based on Bauer et al. (2021) as a binary variable for strong pro-sustainable preferences. Here, *Strong Pro-sustainable Preferences* is a binary indicator equal to one if the participant responds "Completely willing" or "Somewhat willing" to the question above. In specification (4) of Table 6, the coefficient of strong pro-sustainable preferences is positive, as expected, and statistically significant. Most importantly, the coefficient of pro-sustainable beliefs is still positive and statistically significant. Thus, the effect of pro-sustainable beliefs is not subsumed by strong pro-sustainable preferences using the measure by Bauer et al. (2021).

The difference in statistical significance of the variable *Pro-sustainable Preferences* between specifications (3) and (4) might be due to two reasons. The first reason for the lack of statistical significance is the participants' actual responses in our experiment. Some participants categorize themselves as not having pro-sustainable preferences (according to the measure by Bauer et al. (2021)) but still invest a significant fraction of their investment budget in the more sustainable firm. One would expect that participants without pro-sustainable preferences invest the majority of their budget in the less sustainable firm. Such responses lower the signal-to-noise ratio of the variable. Together with the limited number of observations ($N = 306$), the variable ultimately becomes not statistically significant. The second reason might be the different methodology. Bauer et al. (2021) use this measure based on more than 1,600 field survey responses. Their survey is directly targeted at active members of a Dutch pension fund. In contrast, we use this measure in a survey in the course of an experiment. Thus, survey participants in our experiment may think less about how important sustainability is to them. This means that the answers in the survey may not match their behavior in the experiment, which in turn reduces the signal-to-noise ratio.

Nevertheless, overall we think that the analysis using strong pro-sustainable preferences as a dummy variable is a valid alternative to our main specification and shows that our proxy for pro-sustainable preferences is robust to alternative definitions.

4.3.3. Interaction of (strong) pro-sustainable preferences and beliefs

As a last robustness check, we analyze the effect of investors having both pro-sustainable preferences *and* beliefs on investment decisions. This robustness check facilitates a better understanding of how pro-sustainable preferences and beliefs interact. We test whether the interaction between pro-sustainable preferences and beliefs leads to even higher investments in more sustainable assets. To be precise, we expect the effect to be strongest if an investor has both pro-sustainable preferences and pro-sustainable beliefs leading to the highest investments in more sustainable assets.

Fig. 3 illustrates the mean effect sizes on the investment amount in firm B, the more sustainable firm. Participants can be subdivided into four categories following the combination of strong pro-sustainable preferences (0 or 1) and beliefs (0 or 1).[24] *Strong Pro-sustainable Preferences* is defined as a binary variable equal to one if the participant responds "Strongly agree" or "Somewhat agree" to the statement about the importance of the sustainability performance for the investment decision (see chapter 3.2), and zero otherwise. The average investment in firm B is 30 coins when participants have neither strong pro-sustainable preferences nor beliefs. This means that they invest most of their budget in firm A, the firm with positive financial information. Participants with strong pro-sustainable preferences invest on average 41 coins more in firm B than participants without pro-sustainable preferences, and participants with pro-sustainability beliefs invest on average 180 coins more in firm B than participants without pro-sustainable beliefs. Clearly, the effect of strong pro-sustainable beliefs is larger than the one of pro-sustainable preferences. This difference in effect size is important, as previous research has focused primarily on investors' preferences toward sustainability. Finally, participants who have both strong pro-sustainable preferences and beliefs invest on average 133 coins more in firm B than participants without preferences *or* beliefs. This corresponds to a combined effect of 354 ($= 41 + 180 + 133$) coins that participants with both strong pro-sustainable preferences and beliefs invest *more* in firm B than participants without both preferences *and* beliefs. Thus, participants with both preferences and beliefs invest on average 385 coins in firm B.[25] This finding provides initial but valuable insights into considering both pro-sustainable preferences and beliefs for investment decisions.

Table 7 confirms the descriptive findings in Fig. 3. *Pro-sustainable Preferences* is included here as a linear variable with values between 0 and 1 as in our main analyses. Specification (1) includes the interaction effect between *Pro-sustainable Preferences* and *Pro-sustainable Beliefs*, which is positive and statistically significant ($\beta = 235.5$, $SE = 91.2$, $p < 0.05$). However, the interaction effect is

[24] There are 121 participants with neither strong pro-sustainable preferences nor beliefs, 92 with only pro-sustainable beliefs, 78 with only strong pro-sustainable preferences, and 84 with both strong pro-sustainable preferences and beliefs, while 33 participants responded "do not know" in the belief elicitation question. This leads to the total of 408 participants.

[25] The difference to the sum of the individual values is due to rounding.

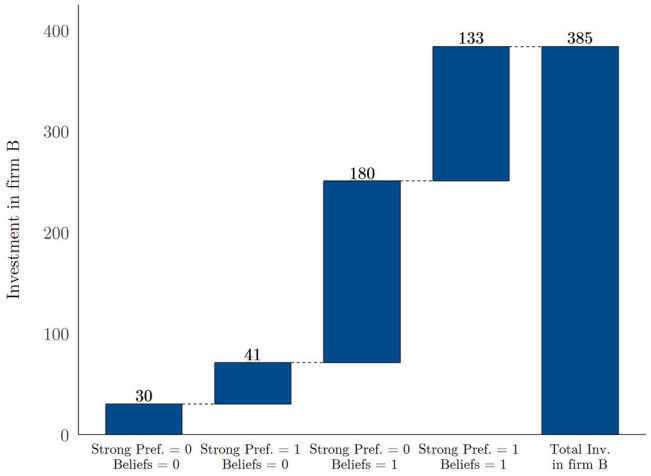

Fig. 3. Mean Effect Sizes of the Interaction of Strong Preferences and Beliefs. This figure illustrates the mean effect sizes of the investment amount in firm B given that a participant has strong pro-sustainable preferences and/or beliefs. The bars show the mean effect sizes of the investment amount in firm B conditional on having neither strong pro-sustainable preferences nor beliefs, having strong pro-sustainable preferences but no pro-sustainable beliefs, having pro-sustainable beliefs but no strong pro-sustainable preferences, and having both strong pro-sustainable preferences and beliefs, respectively. The last bar shows the mean total investment amount in firm B (difference to the sum of individual values due to rounding). Strong pro-sustainable preferences are defined as a dummy variable equal to one if the participant responds "Strongly agree" or "Somewhat agree" to the statement "The sustainability performance was important to me in making the investment decision.", and zero otherwise. Pro-sustainable Beliefs is a binary indicator equal to one if the participant has pro-sustainable beliefs, and zero otherwise, following the procedure described in chapter 3.2.

Table 7
The Interaction Effect of (Strong) Pro-sustainable Preferences and Beliefs on Investment Decisions.

	(1)	(2)	(3)	(4)
Dependent Variable: Inv. firm B				
Sample	All	TG	All	TG
Pro-sustainable Preferences	62.637*	127.255**		
	(36.500)	(53.647)		
Strong Pro-sustainable Preferences			41.263*	79.993**
			(23.892)	(33.307)
Pro-sustainable Beliefs	113.688**	120.430**	180.144***	163.946***
	(49.678)	(56.929)	(28.119)	(32.834)
Pro-sustainable Preferences × Beliefs	235.513**	174.900		
	(91.155)	(106.100)		
Strong Pro-sustainable Preferences × Beliefs			133.261***	109.091*
			(51.242)	(58.846)
Positive Sus. Performance		73.260***		75.670***
		(26.739)		(27.907)
Visual		−33.743		−33.672
		(26.168)		(26.543)
Importance Financial Information		−91.104***		−91.205***
		(21.566)		(22.630)
Financial Literacy		1.328		1.591
		(26.274)		(26.408)
Constant	15.450	320.411***	30.137***	350.661***
	(15.341)	(85.721)	(9.379)	(86.552)
Observations	375	306	375	306
Adj. R^2	0.271	0.351	0.268	0.355

This table reports the interaction effect of (Strong) Pro-sustainable Preferences and Beliefs. The dependent variable is the investment in firm B. Pro-sustainable Preferences is a variable based on the participant's response to the statement "The sustainability performance was important to me in making the investment decision." (1 Strongly disagree, ..., 5 Strongly agree), normalized to values between 0 and 1. Strong Pro-sustainable Preferences is a binary indicator equal to one if the participant responds "Strongly agree" or "Somewhat agree" to the former statement. Pro-sustainable Beliefs is a binary indicator equal to one if the participant has pro-sustainable beliefs, and zero otherwise. The remaining variables are defined in Table A.1 in the Appendix. We estimate the models using an OLS regression with robust standard errors that are reported in parentheses. *, **, *** indicate significance at the 10, 5, and 1 percent levels, respectively.

not robust to including treatment dummies and control variables in specification (2) and becomes marginally insignificant ($\beta = 174.9$, $SE = 106.1$, $p = 0.1003$).

Specification (3) shows the results including the interaction between the binary variables *Strong Pro-sustainable Preferences* and *Pro-sustainable Beliefs*. The coefficient of the interaction is positive and statistically significant ($\beta = 133.3$, $SE = 51.2$, $p < 0.01$).

In specification (4), the results remain qualitatively the same if we include treatment dummies and control variables ($\beta = 109.1$, $SE = 58.8$, $p < 0.1$). Investors with both pro-sustainable preferences and beliefs invest significantly more (~ 354 coins) in the more sustainable firm than investors with only pro-sustainable beliefs (~ 180 coins) or pro-sustainable preferences (~ 41 coins). Overall, we find empirical evidence (in most of the specifications) that the presence of both pro-sustainable preferences *and* beliefs significantly increases the investment in the more sustainable firm. As expected, the combination of both pro-sustainable preferences *and* beliefs leads to the highest investment in the more sustainable firm.

5. Conclusion

This study investigates the effect of investors' pro-sustainable beliefs on investments in sustainable assets and whether this effect holds after controlling for pro-sustainable preferences. We also analyze whether the effect is sensitive to the sustainability performance and the presentation format of the sustainability information.

Prior research has shown that pro-sustainable preferences influence why investors invest in sustainable assets (e.g., Riedl and Smeets, 2017; Bauer et al., 2021), but the effect of pro-sustainable beliefs is still unexplored. Given that investors try to anticipate future economic developments and seek to outperform the market, they form beliefs not only about future cash flows and discount rates but also about other investors' expectations, thereby affecting investment decisions and stock prices (Allen et al., 2006; Egan et al., 2014; Hommes et al., 2005; Brunnermeier and Nagel, 2004).

This study reports several results. First, some investors form beliefs about other investors' pro-sustainable preferences and invest more in sustainable assets, even after controlling for pro-sustainable preferences. Second, pro-sustainable preferences are sensitive to a firm's sustainability performance. This finding suggests that investors with pro-sustainable preferences derive higher utility from a positive sustainability performance compared to a negative sustainability performance. Third, we do not find evidence that the investment in sustainable assets based on pro-sustainable beliefs is sensitive to a firm's sustainability performance. One reason for this result might be that investors gain higher (non-pecuniary) utility from investing in sustainable assets, which is not proportional to the sustainability performance in line with Heeb et al. (2023). Another reason might be that investors gain higher (pecuniary) utility from investing in sustainable assets. Assuming they were able to perfectly anticipate other investors' pro-sustainable preferences, they would not only invest more in sustainable assets but also proportionally more in firms with positive sustainability performance. Following this logic and given our results, the investors in our experiment were not able to perfectly anticipate the other investors' pro-sustainable preferences. This difference in sensitivity to sustainability performance suggests that pro-sustainable preferences and beliefs are complements, not substitutes. Finally, the effect of pro-sustainable beliefs and preferences on investments in sustainable assets is not sensitive to the presentation format of the sustainability information.

This study is subject to two main limitations. First, participants do not receive an explicit financial disadvantage for investing in the more sustainable firm, potentially leading to a hypothetical choice bias. However, we see the hypothetical choice bias as only a minor concern in our setting. Some participants consciously invest in the more sustainable firm although they know that the other participant could invest in the firm that performs better financially. This implies that participants in treatment groups, provided with sustainability information, deliberately depart from the financially better-performing firm as a coordination device. This decision, in turn, could reduce their payoff. Second, this experiment aims to simulate investors' formation of beliefs in stock markets but is carried out as a one-shot game, which limits participants learning about the other participants' preferences or beliefs. Since the primary goal of the coordination game is to elicit pro-sustainable beliefs while controlling for individual preferences, we designed a setting that keeps a balance between incentive compatibility and simplicity and reflects investors' beliefs formation in one period.

There are several avenues for future research. First, one aspect that could explain our results is social norms, which are commonly agreed-on rules about appropriate behavior (e.g., Krupka and Weber, 2013) that affect investment decisions (Hong and Kacperczyk, 2009), expectations (Costa-Gomes et al., 2014), and preferences (Kimbrough and Vostroknutov, 2016). McBride and Ridinger (2021) demonstrate that the relationship between following rules and acting pro-socially depends on the beliefs about other investors' behavior. However, in our study, if any effect of norms exists, it should affect pro-sustainable preferences and beliefs symmetrically, so that our results are not biased in any direction. Future studies could disentangle the effect of social norms on both pro-sustainable preferences and beliefs. Second, we find suggestive evidence that beliefs in the sustainability context can lead to increased demand and prices for sustainable assets, which might, on the one hand, explain parts of the positive green premium in recent years and, on the other hand, provide the starting point for a bubble path. Future research could find out whether beliefs do lead to inflated prices of sustainable assets that are not justified by their fundamental values and ultimately to the emergence of bubbles. Third, future research could extend the coordination game to a multi-period game, where pro-sustainable beliefs are relevant, participants can learn about prices, and individual return expectations depend on the preferences toward sustainability.

In conclusion, this study highlights the significance of pro-sustainable beliefs in addition to pro-sustainable preferences and provides a more comprehensive understanding of the factors that drive investors' sustainable investing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Valentin Luz reports financial support was provided by Münchener Universitätsgesellschaft e.V., Munich, Germany [Project-ID 10414]. Victor Schauer reports financial support was provided by Münchener Universitätsgesellschaft e.V., Munich, Germany [Project-ID 10414]. Martin Viehweger reports financial support was provided by Münchener Universitätsgesellschaft e.V., Munich,

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Data availability

Data will be made available on request.

Appendix A. Variable definition

Table A.1
Variable Definitions.

Variable	Definition
Dependent Variable	
Investment Firm B	Investment in the relatively more sustainable firm B.
Independent Variables – Main Analyses	
Pro-sustainable Preferences	The participant's response to the statement "The sustainability performance was important to me in making the investment decision." (1 Strongly disagree, ..., 5 Strongly agree), normalized to values between 0 and 1.
Pro-sustainable Beliefs (binary)	Binary indicator equal to one if the participant has pro-sustainable beliefs, and zero otherwise, following the procedure described in chapter 3.2.
Positive Sustainability Performance (binary)	Binary indicator equal to one if the participant receives positive sustainability information for firm B, and zero if the participant receives negative sustainability information for firm A.
Visual (binary)	Binary indicator equal to one if the participant receives the sustainability information in a visual presentation format, and zero if the participant receives the sustainability information in a narrative presentation format.
Importance Financial Information	The participant's response to the statement "The financial performance was important to me in making the investment decision." (1 Strongly disagree, ..., 5 Strongly agree).
Financial Literacy (binary)	Binary indicator equal to one if the participant has above-median financial literacy, and zero otherwise. Financial literacy is assessed using ten items from Fernandes et al. (2014)'s 13-item financial literacy test.
Pro-sustainable Beliefs, Robustness Measures	
Pro-sustainable Beliefs (Control Group Estimation, binary)	Pro-sustainable Beliefs used in Table 5 specification (1) is a robustness measure. It compares a participant's estimation of the investment in firm B to the actual mean of all estimations in the control group. Further details are described in chapter 4.3.
Pro-sustainable Beliefs (Lower Bound, binary)	Pro-sustainable Beliefs used in Table 5 specification (2) is a robustness measure. It is a binary indicator of whether the participant has pro-sustainable beliefs or not. We take the lower bound of each answer range as the participant's estimation, further details are described in chapter 4.3.
Pro-sustainable Beliefs (Upper Bound, binary)	Pro-sustainable Beliefs used in Table 5 specification (3) is a robustness measure. It is a binary indicator of whether the participant has pro-sustainable beliefs or not. We take the upper bound of each answer range as the participant's estimation, further details are described in chapter 4.3.
Pro-sustainable Beliefs (Based on Answer Range, trinary)	Pro-sustainable Beliefs used in Table 5 specification (4) is a robustness measure. It is a trinary variable, which is 0 if the participant correctly estimates the answer range, which contains the other participants' mean investment in firm B. The variable is 1 if the participant overestimates the other participants' investment in firm B, and -1 if the participant underestimates the other participants' investment in firm B. Further details are described in chapter 4.3.
Pro-sustainable Beliefs (Based on Answer Range, discrete)	Pro-sustainable Beliefs used in Table 5 specification (5) is a robustness measure. It is a discrete measure indicating by how many answer ranges the participant misestimates the actual mean investment. The variable is 0 if the participant correctly estimates the answer range, which contains the other participants' investment in firm B. If the participant does not correctly estimate the other participants' investment in firm B, the variable is equal to the difference in the number of answer ranges between the answer range, which contains the average investment in firm B of the respective treatment group, and the answer range, which contains the participant's estimation. Further details are described in chapter 4.3.
Pro-sustainable Preferences, Robustness Measures	
Pro-sustainable Preferences (Treatment Group Effect, binary)	Pro-sustainable Preferences used in Table 6 specification (1) is a robustness measure. It is a binary variable that measures the average treatment group effect; the variable is 1 if a participant is part of a treatment group, and 0 otherwise.
Strong Pro-sustainable Preferences (5-point Likert, binary)	Strong Pro-sustainable Preferences used in Table 6 specification (2) is a robustness measure. It is a binary indicator equal to one if the participant responds "Strongly agree" or "Somewhat agree" to the statement "The sustainability performance was important to me in making the investment decision.", and zero otherwise.
Pro-sustainable Preferences (Measure by Bauer et al. (2021), untransformed)	Pro-sustainable Preferences used in Table 6 specification (3) is a robustness measure. It is an untransformed 5-point Likert scale measure for pro-social preferences by Bauer et al. (2021), i.e. "How willing are you to give to good causes without expecting anything in return?" (1 Strongly disagree, ..., 5 Strongly agree).
Pro-sustainable Preferences (Measure by Bauer et al. (2021), binary)	Pro-sustainable Preferences used in Table 6 specification (4) is a binary robustness measure. It is equal to 1 if a participant responded "Strong agree" or "Somewhat agree" to the measure for pro-social preferences by Bauer et al. (2021), and 0 otherwise.

Appendix B. Experiment flowchart

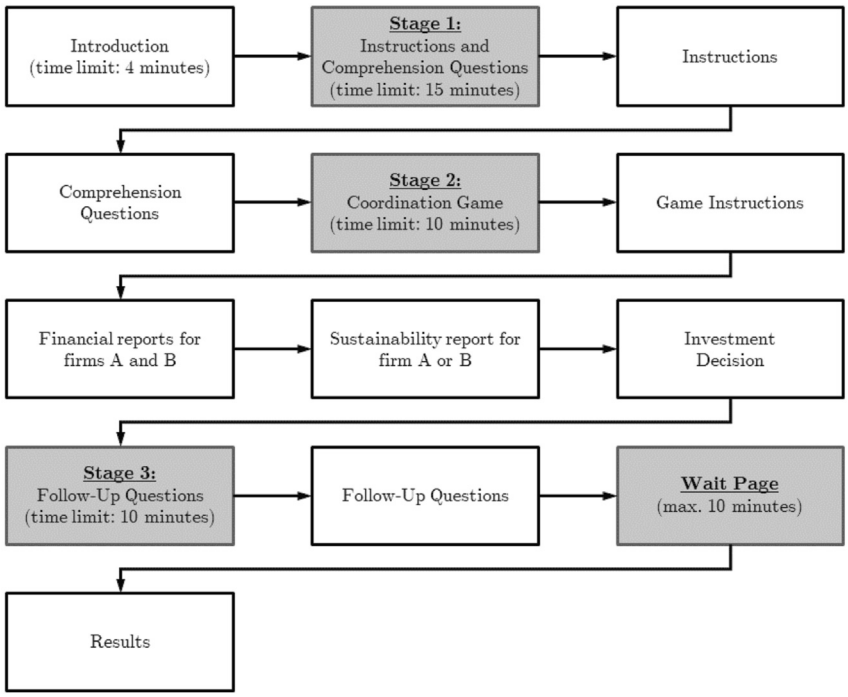

Fig. B.1. Experiment Flowchart. This figure shows the flowchart of the experiment. There are four main stages consisting of *1. Instructions and Comprehension Questions*, *2. Coordination Game*, *3. Follow-Up Questions*, and the *4. Wait Page* at the end of the experiment.

Appendix C. Experiment payoff structure

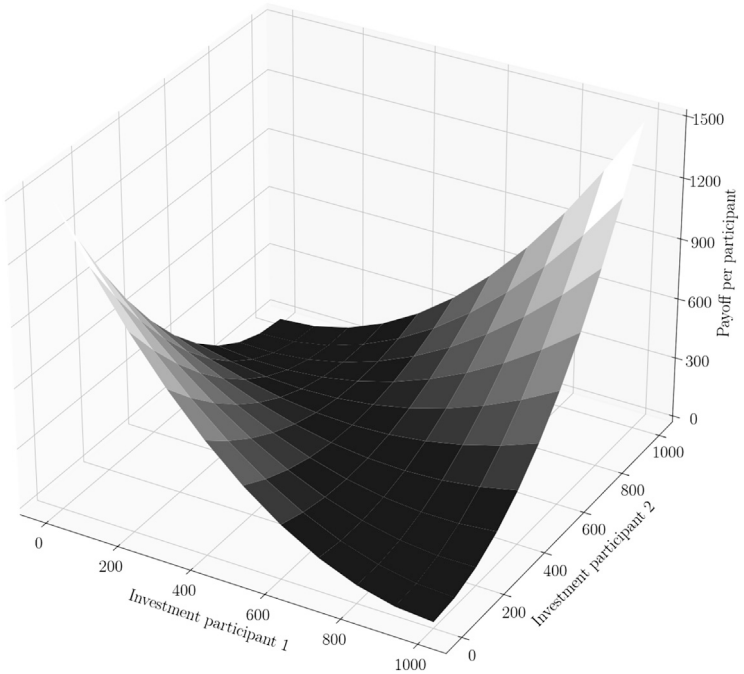

Fig. C.1. Payoff Structure. This figure shows the payoff structure in our experiment. The investment amount of participant 1 is plotted on the x-axis. The investment amount of participant 2 is plotted on the y-axis. The payoff per participant is calculated according to formula (1) and is plotted on the z-axis.

Appendix D. Correlation of participants' estimated investment and own investment

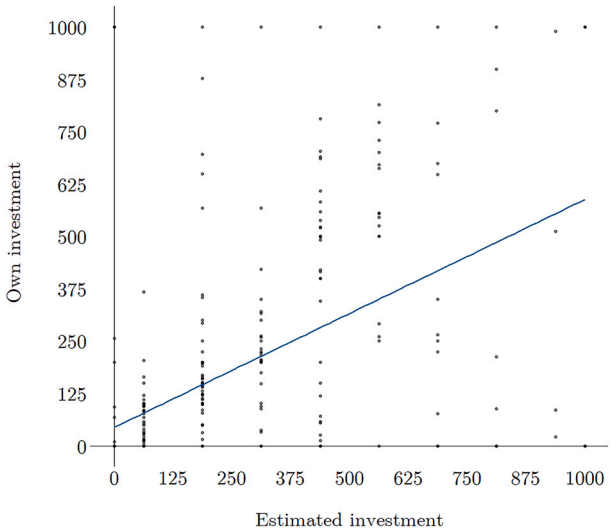

Fig. D.1. Correlation of participant's estimation of other participants' investment and participant's own investment. This figure plots the correlation between a participant's estimation of other participants' investment (x-axis) in firm B and the participant's own investment in firm B (y-axis). As described in chapter 3.2, the values on the x-axis are obtained by taking the midpoint value of the upper and the lower bound of each answer range as the participant's estimation of the investment in firm B. The values on the y-axis are each participant's own investment in firm B.

Appendix E. Detailed summary statistics

Table E.1
Summary Statistics of Participants' Investment, Expected Investment, and Importance of Sustainability Information.

Experimental Group	Variable	N	Min	P25	Mean	Median	P75	Max	SD
Whole Sample									
	Investment in firm B	408	0.000	0.000	165.902	0.000	201.750	1000.000	273.414
	Estimation of others' investment	375	0.000	0.000	204.000	62.500	312.500	1000.000	252.471
	Importance Sustainability Information	408	0.000	1.000	2.056	2.000	3.000	4.000	1.218
Control Group									
	Investment in firm B	76	0.000	0.000	106.592	0.000	110.750	1000.000	209.590
	Estimation of others' investment	69	0.000	0.000	154.891	62.500	187.500	1000.000	240.062
	Importance Sustainability Information	76	0.000	1.000	2.368	3.000	3.000	4.000	1.305
Treatment Group 1									
	Investment in firm B	90	0.000	0.000	172.789	0.000	227.000	1000.000	255.066
	Estimation of others' investment	83	0.000	0.000	235.693	187.500	437.500	1000.000	255.713
	Importance Sustainability Information	90	0.000	1.000	2.000	2.000	3.000	4.000	1.290
Treatment Group 2									
	Investment in firm B	79	0.000	0.000	139.747	0.000	157.000	1000.000	250.432
	Estimation of others' investment	75	0.000	0.000	181.667	62.500	312.500	1000.000	225.855
	Importance Sustainability Information	79	0.000	1.000	2.051	2.000	3.000	4.000	1.085
Treatment Group 3									
	Investment in firm B	76	0.000	0.000	254.342	49.500	490.250	1000.000	354.308
	Estimation of others' investment	67	0.000	0.000	240.672	187.500	437.500	1000.000	277.437
	Importance Sustainability Information	76	0.000	1.000	1.895	2.000	3.000	4.000	1.239
Treatment Group 4									
	Investment in firm B	87	0.000	0.000	157.080	12.000	191.000	1000.000	266.473
	Estimation of others' investment	81	0.000	0.000	203.704	62.500	312.500	1000.000	258.031
	Importance Sustainability Information	87	0.000	1.000	1.989	2.000	3.000	4.000	1.136

Table E.2
Summary Statistics of Preferences, Beliefs, Financial Literacy, Importance Financial Information, and Demographic Variables.

Experimental Group	Variable	N	Min	P25	Mean	Median	P75	Max	SD
Whole Sample									
	Pro-sustainable Preferences	408	0.000	0.250	0.514	0.500	0.750	1.000	0.304
	Pro-sustainable Beliefs	375	0.000	0.000	0.443	0.000	1.000	1.000	0.497
	Personal Preferences	408	0.000	0.500	0.630	0.750	1.000	1.000	0.319
	Personal Beliefs	408	0.000	0.250	0.509	0.500	0.750	1.000	0.336
	Financial Literacy	408	0.000	0.000	0.566	1.000	1.000	1.000	0.496
	Imp. Fin. Info	408	0.000	3.000	3.581	4.000	4.000	4.000	0.837
	Education	400	2.000	3.000	3.955	4.000	4.000	6.000	0.793
	Net Income	400	0.000	2.000	4.085	5.000	6.000	6.000	2.150
	Female	399	0.000	0.000	0.479	0.000	1.000	1.000	0.500
	Age	407	0.000	29.000	38.757	37.000	47.500	84.000	14.309
Control Group									
	Pro-sustainable Preferences	76	0.000	0.250	0.592	0.750	0.750	1.000	0.326
	Pro-sustainable Beliefs	69	0.000	0.000	0.391	0.000	1.000	1.000	0.492
	Personal Preferences	76	0.000	0.250	0.595	0.750	1.000	1.000	0.353
	Personal Beliefs	76	0.000	0.250	0.490	0.500	0.750	1.000	0.368
	Financial Literacy	76	0.000	0.000	0.526	1.000	1.000	1.000	0.503
	Imp. Fin. Info	76	0.000	3.000	3.566	4.000	4.000	4.000	0.869
	Education	74	2.000	3.000	4.054	4.000	5.000	6.000	0.920
	Net Income	74	0.000	2.000	4.000	5.000	6.000	6.000	2.120
	Female	74	0.000	0.000	0.527	1.000	1.000	1.000	0.503
	Age	76	0.000	30.500	37.592	36.500	45.250	70.000	12.749
Treatment Group 1									
	Pro-sustainable Preferences	90	0.000	0.250	0.500	0.500	0.750	1.000	0.322
	Pro-sustainable Beliefs	83	0.000	0.000	0.542	1.000	1.000	1.000	0.501
	Personal Preferences	90	0.000	0.500	0.625	0.750	0.750	1.000	0.321
	Personal Beliefs	90	0.000	0.250	0.494	0.500	0.750	1.000	0.329
	Financial Literacy	90	0.000	0.000	0.556	1.000	1.000	1.000	0.500
	Imp. Fin. Info	90	0.000	3.000	3.356	4.000	4.000	4.000	1.115
	Education	88	2.000	3.000	3.977	4.000	4.000	6.000	0.871
	Net Income	88	0.000	2.000	3.693	4.000	6.000	6.000	2.301
	Female	88	0.000	0.000	0.477	0.000	1.000	1.000	0.502
	Age	90	0.000	29.000	38.256	38.000	47.000	78.000	13.933
Treatment Group 2									
	Pro-sustainable Preferences	79	0.000	0.250	0.513	0.500	0.750	1.000	0.271
	Pro-sustainable Beliefs	75	0.000	0.000	0.467	0.000	1.000	1.000	0.502
	Personal Preferences	79	0.000	0.500	0.655	0.750	0.750	1.000	0.290
	Personal Beliefs	79	0.000	0.250	0.525	0.500	0.750	1.000	0.327
	Financial Literacy	79	0.000	0.000	0.633	1.000	1.000	1.000	0.485
	Imp. Fin. Info	79	2.000	3.000	3.709	4.000	4.000	4.000	0.510
	Education	78	2.000	3.000	3.872	4.000	4.000	6.000	0.779
	Net Income	77	0.000	3.000	4.364	6.000	6.000	6.000	2.083
	Female	77	0.000	0.000	0.481	0.000	1.000	1.000	0.503
	Age	79	0.000	29.000	40.101	38.000	50.500	84.000	16.362
Treatment Group 3									
	Pro-sustainable Preferences	76	0.000	0.250	0.474	0.500	0.750	1.000	0.310
	Pro-sustainable Beliefs	67	0.000	0.000	0.343	0.000	1.000	1.000	0.478
	Personal Preferences	76	0.000	0.250	0.589	0.750	0.750	1.000	0.313
	Personal Beliefs	76	0.000	0.250	0.536	0.500	0.750	1.000	0.333
	Financial Literacy	76	0.000	0.000	0.487	0.000	1.000	1.000	0.503
	Imp. Fin. Info	76	0.000	3.000	3.566	4.000	4.000	4.000	0.806
	Education	74	3.000	3.000	3.959	4.000	4.000	5.000	0.730
	Net Income	75	0.000	2.000	4.107	5.000	6.000	6.000	2.103
	Female	74	0.000	0.000	0.568	1.000	1.000	1.000	0.499
	Age	76	0.000	29.500	40.263	39.000	50.000	72.000	15.628
Treatment Group 4									
	Pro-sustainable Preferences	87	0.000	0.250	0.497	0.500	0.750	1.000	0.284
	Pro-sustainable Beliefs	81	0.000	0.000	0.444	0.000	1.000	1.000	0.500
	Personal Preferences	87	0.000	0.500	0.678	0.750	1.000	1.000	0.316
	Personal Beliefs	87	0.000	0.250	0.500	0.500	0.750	1.000	0.328
	Financial Literacy	87	0.000	0.000	0.621	1.000	1.000	1.000	0.488
	Imp. Fin. Info	87	0.000	4.000	3.724	4.000	4.000	4.000	0.694
	Education	86	3.000	3.250	3.919	4.000	4.000	5.000	0.655
	Net Income	86	0.000	3.000	4.291	5.000	6.000	6.000	2.102
	Female	86	0.000	0.000	0.360	0.000	1.000	1.000	0.483
	Age	86	19.000	28.000	37.744	35.000	45.000	74.000	12.803

Appendix F. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jebo.2024.02.018.

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