Understanding investor preferences in sustainable energy stocks: emotions and biases

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ABSTRACT,
The shift towards sustainable energy investments is not just a trend, but a crucial aspect of today's financial markets. This thesis has delved into the influence of emotions and biases on the investor's preferences for these investments, a topic of significant relevance and importance in the current financial developments. Specifically, this thesis has examined the role of positive and negative emotions along with cognitive biases such as herding and overconfidence.
The analysis was carried out through an online survey, which had 75 respondents. The respondents had to answer statements on a 5-point Likert scale, ordinal or distichous scale. The analysis revealed that positive emotions had a marginally significant positive impact on the preferences for sustainable energy investments, and in contrast, negative emotions showed a significant negative effect. Furthermore, biases such as herding and overconfidence were not significantly linked to the investment preferences. This knowledge could provide useful information to policymakers and finance professionals to nudge investors.

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Keywords
Behavioral Finance, Sustainable Energy Investments, Investor Emotions, Cognitive Biases, Investment Preferences, Survey Analysis

1. INTRODUCTION

The world is currently facing a critical challenge in the form of an energy crisis. The rapidly growing global population and the increasing industrialization of the world have led to an overall increase in energy demand (OECD, 2012). More recently, during the 2023 energy crisis across Europe, the European Union unveiled a new initiative for renewable energy. This initiative aims to increase the capacity of sustainable energy by threefold on a global scale. This plan highlights the importance of sustainable energy in solving the increasing global energy crisis. (European Commission, 2023)

In contrast, the continued use of non-renewable energy sources such as coal, oil, and gas would lead to a more negative impact on the environment (Fisher, 2023). This is where new sustainable energy comes in as a potential solution to address the energy crisis while maintaining endurable sustainability. Sustainable energy involves using renewable energy sources, such as wind, solar, hydro, geothermal, and biomass, which are available in surplus and do not significantly impact the environment (Paraschiv & Paraschiv, 2023). Furthermore, during this thesis, we will refer to sustainable energy stocks as stocks from publicly traded companies that specialize in providing renewable energy and energy-efficient solutions (Stein, 2024).

The focus on sustainable energy markets has increased significantly in recent years in Europe, with many Member States of the European Union adopting new policies and measures to promote the usage of renewable energy sources through the Renewable Energy Directive (RED), which raised the target for renewable energies in 2030 to 45% from the previously set goal of 32%. (BMWK, 2023). However, achieving a transition towards sustainable energy requires substantial investments, which have been defined as between $5 and 7$ trillion per year. This transition is impossible to fund through only governments and public funds. Thus, the private sector and the capital markets must bridge this gap. Meaning, that the investor's preferences will heavily influence this transition (Van De Putte et al., 2020).

Therefore, it is essential to understand investors' preferences in the sustainable energy sector. Hence, policymakers and investors must recognize that the investor's preferences may not be rational. Emotions and biases will often influence them. While biases can be seen as harmful intents, it is essential to acknowledge their role in shaping investors' behavior (Madaan & Singh, 2019). For example, the nudging of investors can change their behavior towards more desirable outcomes (Pilaj, 2017).

Several academic studies have already explored the factors influencing preferences for sustainable energy, such as standard financial factors, financial return risks, and environmental concerns (Aslan & Posch, 2022). However, there is a gap. Studies have yet to explore the influences of emotions and biases on investor preferences in the sustainable energy sector.

Additionally, analyzing the gap between biases and emotions is also important. There is a distinction in treating emotions and biases in the literature on behavioral finance (Bazerman & Moore, 2009). For investors, emotions can be displayed in several ways: fear, hope, regret and greed (Shefrin, 2002). Furthermore, biases, such as overconfidence and herding, can also severely impact investors' decisions (Sapkota, 2023).

1.1 RESEARCH OBJECTIVE AND QUESTIONS

Understanding investors' preferences in sustainable energy stocks through emotions and biases remains an area with limited research. This research will aim to fill this gap by analyzing the effect of specific emotions and biases on investors' preferences in the sustainable energy sector. This will be done through the utilization of a survey that is distributed to current or potential investors in sustainable energy stocks, providing clear insights into the key factors influencing the investors' behavior.

Central Research Question:

What is the effect of emotions towards investments and investment biases on investors' preferences for sustainable energy investments?

Sub research questions:

1. How are positive emotions (hope, greed) and negative emotions (fear, regret) influencing investors' preferences in sustainable energy investments?
2. How are biases herding and overconfidence influencing investors' preferences in sustainable energy investments?

By analyzing and answering these questions, this thesis will be able to provide an analysis of behavioral finance correlating with sustainable energy stocks investments. This understanding will bridge the current research gap and will offer new valuable insights for policymakers and investors alike who seek to promote sustainable energy investments.

1.2 Practical relevance:

Understanding how emotions and biases influence investment decisions in the sustainable energy sector is essential for practical implications. According to Van De Putte et al. (2020), an estimated $5 to $7 trillion annually is needed from investors to fund the transition to more sustainable energy systems. This massive financial requirement, as established, cannot be met by considering public funding alone, thus needing private sector investments. Logically, biases such as herding and overconfidence and the emotions of hope, fear, regret, and greed will impact the decisions of investors. For example, investors who are more prone to herding will tend to follow the majority, while investors with overconfidence would overestimate their abilities. Furthermore, emotions and biases can also drive or deter these possible investments. Thus, this study will show findings on how these biases and emotions are correlated with investors' preferences for energy stocks. By analyzing this data, policymakers and investment professionals will be able to develop strategies with the goal of nudging investors towards better investment choices that are more rational and sustainable (Pilaj, 2017). For example, this can be done by the creation of educational campaigns or by raising awareness about the risks of herding and overconfidence, as well as regulatory measures to promote better investment diversifications and risk assessment practices for investors (Madaan & Singh, 2019).

2. LITERATURE REVIEW AND HYPOTHESES

The conceptual framework for this study is based on the theories: behavioral finance and utility theory. By combining these

theories, we can identify the factors influencing investors' preferences in sustainable energy investments.

2.1 Behavioral Finance Theory and Emotions

Behavioral finance challenges traditional economic theories like utility theory. It states that investors cannot make investment decisions purely based on rational decision-making. Investors have psychological influences, such as emotions and biases, that influence how they invest. (Kahneman & Tversky, 1979; Kumar & Goyal, 2015). Hersh Shefrin, in "Beyond Greed and Fear," has been able to provide an extensive analysis of how emotions such as hope, fear, regret, and greed influence investor decisions (Shefrin, 2002).

Hope, is an emotion that causes investors to pursue higher returns. Investors who are driven by hope are often more willing to invest in more speculative ventures, for this thesis, sustainable energy stocks, because they are more likely to anticipate positive future outcomes. This optimistic view can thus increase investment in renewable energy sources, reflecting the broader expectation of growth and environmental benefits (Puri & Robinson, 2007). Shefrin highlights that this hope can also lead to overoptimism a bias, where investors might overlook potential risks due to their positive expectations of assets (Shefrin, 2002).

Secondly, fear has a significant effect on investors. It plays a crucial role in deterring investments, especially in more volatile markets, such as the sustainable energy sector (Igeland et al., 2024). Fear of financial losses will result in investors shying away from fully fossil-free portfolios, preferring traditional energy stocks' safety (Sanzillo, Cohn, & Chung, 2022). Fear will lead investors towards a more conservative investment strategy and loss aversion. Investors will not be able to see possible gains, but they will only focus on avoiding losses (Shefrin, 2002).

Furthermore, regret is another emotion that influences investors' investment decisions. Investors who are more likely to experience regret after making bad investments could lead them to keep holding their bad investments in the hope that they might break even, so called "get-evenitis' (Shefrin, 2002). Although good investments can create a phenomenon called "investor remorse", which occurs when investors regret taking profits from investments that continue to perform well (Shefrin, 2002). Investors who experience regret tend to invest in investments with a proven track record (Shefrin, 2002). Looking at this from the perspective of sustainable energy stocks, the fear that investors might experience regret could prevent them from switching from traditional energy stocks to sustainable energy stocks, which are newer and less proven technologies.

Lastly, greed is an emotion distinguished by the desire for wealth and profit in a negative way. It could drive investors who experience greed to take excessive risks. Applying this to renewable energy stocks, the possibility of high returns could attract investors to these stocks despite this sector's uncertainties. This greed could lead to speculative bubbles if investors chase after high returns together without seeing the actual underlying value (Shefrin, 2002).

This study grouped emotions into positive and negative categories to better understand the influence of emotions on investment decisions. Positive emotions like hope and greed were categorized together because they drive investors towards high-risk, high-reward opportunities, often leading to increased investments in speculative ventures like sustainable energy stocks (Puri & Robinson, 2007; Shefrin, 2002). On the other hand, negative emotions, such as fear and regret, were grouped as they tend to induce risk-averse behaviors, steering investors away from newer, less-proven technologies in favor of safer, traditional investments (Igeland et al., 2024; Shefrin, 2002). This categorization allows for a more precise analysis of how overall emotional states affect investor preferences in the sustainable energy sector.

2.2 Utility Theory

Utility theory is essential for this thesis to understand how individuals make choices based on their preferences to maximize their satisfaction and well-being. The classical utility theory considers that investors will only think rationally to maximize their investments, neglecting other aspects (Akkaya, 2021). However, for sustainable energy investments, we expand utility theory to include non-financial preferences.

For this expansion, we will acknowledge that investors not only derive their utility from financial returns but also from aligning their investments with their personal values regarding social responsibility. The study by (Riedl & Smeets, 2017) shows how investors consider these broader aspects, suggesting that the traditional utility models should be expanded to capture these preferences.

Investors who place a higher value on environmental conservation will prioritize investments in companies that demonstrate a strong commitment to reducing their carbon footprint or engaging in sustainable practices (Borchers et al., 2007). Thus, we expand the utility theory to include environmental benefits as a component. As a result, investors might be more willing to pay for sustainable energy stocks than for energy stocks from oil and gas companies.

Similarly, the utility of investments may also be enhanced by the social outcomes they produce. Investors might get satisfaction from investments in companies with strong governance practices, contributing to community development, or engaging in fair labor practices (Pattit, 2009). This dimension of utility is especially relevant in decisions related to socially responsible investing, where the social impact of investments plays a crucial role in investment choices. This includes the sustainable energy sector.

Furthermore, the decision to invest in more sustainable ventures is viewed as a utility-maximizing choice. When investors start to value the world's long-term sustainability, this is supported by the growth of the trend towards ESG investing in companies where more aspects are evaluated when considering investments (Riedl & Smeets, 2017). Lastly, investors also perceive ESG investments as lower risk, meaning that ESG practices are better positioned to manage future uncertainties and challenges within the company (Bell, 2021).

2.3 Behavioral Finance Theory and Investment Biases

This subsection focuses on two prominent biases in the behavioral finance theory, which will be assessed for the conceptual framework: herding and overconfidence (Bazerman & Moore, 2009). These two impact investment decisions, also in the context of sustainable energy stocks.

Herding bias occurs when investors follow the actions of the majority, disregarding their own analysis and fundamentals (Qasim et al., 2019). This bias can also be adapted to the rapidly evolving and highly uncertain sustainable energy sector (Igeland et al., 2024). Herding behavior is also connected to emotions such as fear and greed. Fear of missing out (FOMO) on investments could lead investors to follow the crowd, even when

their own analysis explains to not invest. The emotion of greed can do the same because investors will also rush to get a piece of the pie of perceived lucrative investments.

Furthermore, overconfidence bias shows that investors have too much faith in their own reasoning and predictive abilities for lucrative stocks. Investors might believe that they know it all and possess superior knowledge about their stock picks, causing them to underestimate the risks and overestimate potential returns (Iacurci, 2023). This bias can also be fueled by emotions such as hope and greed. The emotion of hope will drive the investor to believe in the best possible outcome while also considering that greed will push them to take risks to maximize possible rewards. From an investor perspective, this behavior is unfavorable because they are more likely to do excessive trading and bad diversification, harming their portfolio (Shefrin, 2002). Although recent research highlights that anticipatory emotions are able to increase attention and engagement. For example, that suggests that emotions such as hope and excitement are able to enhance cognitive processing and focus, which will potentially lead to more informed and more deliberate investment decisions by investors (Hinvest et al., 2021). This means that the influence of emotions on investment behavior can be both positive and negative depending on context and how the emotions are being managed.

2.4 Hypotheses

For this research, we have defined three hypotheses to provide answers and assumptions for the research questions. The hypotheses will try to explore how emotions and biases affect preferences in sustainable energy investments.

2.4.1 Hypothesis 1 and 2:

Assuming that investors deal with emotions during their investment decision-making process; these emotions influence them, creating deviations from their standard choices. Positive emotions like hope and greed will influence investors in a way that will help them develop more confidence in their investments and thus also in future returns; this is particularly strong in innovative or emerging sectors like the sustainable energy sector where there are more uncertainties. These emotions could increase the investments, which also lead to an inflated valuation of these companies' stocks and the sector overall (Bird et al., 2023). For example, it found that individuals who are more hopeful are more likely to engage with riskier investments; this supports the idea that hope will drive investors to more speculative ventures (Puri & Robinson, 2007). On the other hand, negative emotions such as fear and regret can have an adverse effect on investments. These emotions could influence investors to avoid higher-risk investments like the sustainable energy stock sector. We could rephrase this to so-called risk aversion, which could result in the undervaluation of companies in these sectors (Igeland et al., 2024; Shefrin, 2002).

Hypothesis 1: "Positive emotions (such as hope and greed) towards investments are positively correlated with preferences for sustainable energy investments."

Hypothesis 2: "Negative emotions (such as fear and regret) towards investments are negatively correlated with preferences for sustainable energy investments."

2.4.2 Hypothesis 3:

Investors deal with biases when investing. Biases like overconfidence and herding, especially, could distort the decision-making process of investors. These two biases could lead to irrational financial choices that do not align with ordinary investment theories. Overconfident investors tend to overestimate their own knowledge and predictive abilities in stocks, which leads them to take more risky trading positions (Bazerman & Moore, 2009). This behavior could drive higher investments in sectors perceived as having higher growth, such as the sustainable energy sector (Iacurci, 2023; Shefrin, 2002). Herding behavior when investors blindly follow other people's actions could result in market inefficiencies and bubbles. So, if sustainable energy investments become more popular among investors (Gooden & Graham), the sector will attract new capital and investors through herding (Igeland et al., 2024; Qasim et al., 2019).

Hypothesis 3: "Investment biases are positively correlated with preferences for sustainable energy investments."

2.5 Conceptual framework

The conceptual framework of this research can be found below summarizing the information above:

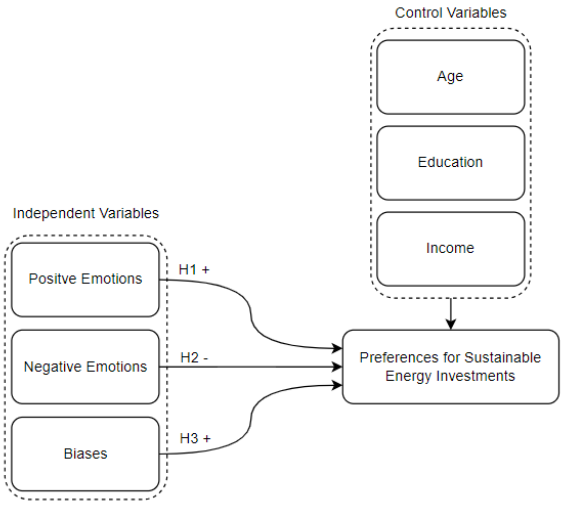

Figure 1 – Conceptual framework

3. METHODOLOGY

3.1 Sample of the survey

For the thesis survey, 75 participants responded to the questionnaire that was distributed online. The survey was distributed via the Qualtrics program in English as the language of instruction and sent through the author's personal networks, including Instagram, WhatsApp, and word of mouth. To ensure that the survey complies with the ethics committee of Utwente standards, the following applied:" the participants could withdraw from the research at any time without justification. Participant privacy and confidentiality will be maintained throughout the study. Data will be secured securely and only accessible to authorized researchers. Lastly, the results will be reported in an aggregate form, thus protecting the participants' anonymity."

Of the total of 75 respondents, 65 were able to complete the questionnaire completely. Furthermore, respondents who did not

agree with the terms and conditions of this research were removed, resulting in a final sample size of 63 respondents.

3.2 Method of analysis

After analyzing the literature, survey questions were established to quantify the variables of this research, test the defined hypotheses, and finally answer the research questions for this thesis.

The survey questions are based on the mentioned literature and are measured following a 5 Likert scale where (1= strongly disagree, 5= strongly agree) or measured following a dichotomous variable (1= no, 2= yes). Following, the control variables are ordinal values with the exception of age. Age is measured as a continuous variable. The survey can be found in the Appendix, and the operationalization table can be found below, as shown in Table 1.

Composite variables were constructed to measure the impact of variables as single constructs. This approach drastically simplified the analysis of the overall influence of variables on investment decisions by using a single metric. For instance, if a respondent rated two Likert scale questions about the emotion hope as follows: Q1: 4 and Q2: 3. The composite score for hope would be calculated in a straightforward manner by averaging these responses: composite score=4+2=6 6/2=3.

The survey consisted of four parts. In the first part, the participant was shown a prompt with their rights and explained this research. Then, after accepting this survey's terms and conditions, the participant was led to the next section. In this section, the participant was asked for his socio-demographic information to operationalize the control variables. Later, the participant was shown another prompt explaining that they should see themselves as investors and try to evaluate opportunities to invest in sustainable energy stocks. This has been done to overcome the issue of needing more participants with sufficient investment experience.

Furthermore, the terminology of sustainable energy stocks was explained to less experienced investors. This terminology can confuse the participant. After this, the participants were asked questions regarding emotions and biases. These questions were statements on which the participants, following the 5-Likert scale, had to fill in how much they agreed with them. Lastly, the participant was shown another set of 4 statements regarding their preferences for sustainable energy investments, which have been established as the dependent variable. These questions were answered on a distichous scale, which later will be turned into a 5 Likert scale.

3.2.1 Operationalization table:

Variable	**Source**	**Number of items**	**Scale Type**
Emotions towards investments (IV)	Adapted from Shefrin, 2002	4 ; 8 questions	5-point Likert scale
Investment biases (IV)	Adapted from Bazerman & Moore, 2009; Agarwal & Singh, 2023; Kahneman & Tversky, 1979	2 ; 4 questions	5-point Likert scale
Preferences for sustainable energy investments (DV)	Adapted from Riedl & Smeets, 2017	4	Binary scale – later transformed into a 5-point Likert scale
Age (CV)		1	Continuous variable formatted to Ordinal
Education, Income (CV)		1	Ordinal

Table 1 – Operationalization table

3.2.2 Control variables

Several control variables that will likely influence the questionnaire's outcome have been determined to avoid third variables influencing this research. For instance, previous research has shown that investment behavior can be influenced by a person's age, level of education, and income. Thus, the following control variables will be taken into account: age, education, and income.

In particular, age is an important control variable for this research. It can affect the risk tolerance and investment preferences. Young investors are more willing to take higher risks and invest in sustainable energy stocks than older investors, who tend to go for more stable investments like conventional energy stocks. (Korniotis & Kumar, 2009). More specifically, risk tolerance decreases with age (Bucciol & Miniaci, 2011). Thus, younger survey participants are expected to show a higher preference for sustainable energy investments due to their longer investment horizon in combination with their bigger risk tolerance. However, it is also essential to recognize that sustainable investments are considered low risk over a longer investment horizon, which might influence older investors to

prefer them as well, given the stability and steady returns they could give (Capotă et al., 2022).

Another variable is education, which influences investors' knowledge and understanding of sustainable investments. Participants who have a higher level of education would have a greater awareness of environmental issues and a better understanding of the broader benefits of sustainable energy investments (Zheng et al., 2023). Therefore, I expect that individuals with higher education levels have a stronger preference for sustainable energy investments.

Income level will furthermore impact an investor's ability to invest in sustainable energy stocks. High-income individuals will have more disposable income to allocate towards these investments and thus also be willing to invest in these slightly higher-risk, higher-reward opportunities and sustainable investments (Bauer et al., 2021). Thus, it is expected that from the survey, high-income participants will be positively correlated with a bigger preference for sustainable energy investments.

3.3 Analysis

The collected survey data will be analyzed through RStudio. First, the data will be transferred from Qualtrics to RStudio via a .csv file. After this data has been appropriately cleaned, we will start an analysis to check whether the data is normally distributed using a Shapiro-Wilk test and a Chi-Squared test. If the survey data is normally distributed, when can we continue with the Pearson correlation coefficient to test the correlation between the defined variables. If the data is not normally distributed, we must rely on other measures. In that case, we will use Spearman's Rank Order to analyze the data. Hereafter, the scales will also be validated using Cronbach's alpha. This analysis will use a rule of thumb, which states that if the variable shows an alpha of 0.7 or higher, it would be acceptable to assume that the items of the variable are internally consistent (Nunnally, 1978). So after, the calculations of Cronbach's Alpha, we will continue with the regression analysis. We will first measure the correlation of the defined variables. This analysis can go both ways depending on the outcome of the first Shapiro-Wilk test. Thus, the regression analysis will be used to see if there are significant relationship present between the dependent variable, the preferences for sustainable energy investments and the independent variables, emotions and investment biases.

To make this regression analysis possible we had to make some changes. So, to better understand the influence of emotions and biases on the investor's preferences, we first grouped the related emotions into positive and negative categories. In the positive emotions category, we will include hope and greed, while in the negative category, we include fear and regret. We made these so-called composite variables for these groups by using averages of the relevant measures. Biases, overconfidence, and herding are topics we did not put together due to their own distinct cognitive patterns. Furthermore, looking at the control variables, we included these as separate variables in the analysis, but we were not able to split them into detailed subcategories, for example, age 18-24, which would overcomplicate and overfit this model, unfortunately, made it impossible to understand and give null results. Also, the lack of results was an issue, making the need only to do the variable age, as the same unfortunate thing can be said about income and education. Our dependent variable preferences went through a makeover where through a scoring system (table 6), We were able to transform our distichous variable to a Likert scale variable, which could be used to perform regression analysis since logistical regression came across issues due to a low sample size.

After this, we could start with the regression analysis to see if there are significant relationships between our independent and dependent variables.

4. RESULTS

After cleaning the data and removing the incomplete responses, normality tests were performed to determine whether the data was normally distributed. The Shapiro-Wilk test was conducted for the independent variables, which include emotions and biases, while a Chi-Square test was used for the dependent variable, preferences for sustainable energy stocks because it is dichotomous.

From the results (table 4), we have the following findings: most individual emotional biases, combined biases and preferences for sustainability significantly deviate from normality (p-value < 0.005). This means that we are able to reject the null hypothesis of normal distribution for these variables. With this, the combined emotions gave a result that did not significantly deviate from normality. Thus, we cannot assume a normal distribution. So, as a result, we will be using Spearman's rank order correlation to analyze the relationships between these variables, as it does not require the data to be normally distributed for analysis. This will allow us to assess correlations between the independent and dependent variables accurately.

4.1 Respondents Profile

The following table shows the socio-demographic information of the survey participants as a frequency—and percentage-based value. We have measured age, education, and monthly income.

Main Category	Subcategory	Frequency	Percentage
Age	18 – 24	38	60.317
Age	25 – 34	8	12.698
Age	35 – 44	2	3.175
Age	45 – 54	3	4.762
Age	55 – 65	11	17.46
Age	Over 65	1	1.587
Education	Lower secondary education	1	1.587
Education	Upper secondary education	31	49.206
Education	Bachelor's degree	19	30.159
Education	Master's degree	11	17.46
Education	PhD	1	1.587
Monthly Net Income	Less than €1.000	31	49.206
Monthly Net Income	€1.000 – €1.500	7	11.111
Monthly Net Income	€1.501 – €2.000	3	4.762
Monthly Net Income	€2.001 – €2.500	7	11.111

Monthly Net Income	€2.501 – €3.000	4	6.349
Monthly Net Income	Over €3.000	11	17.46

Table 2 – Respondents Profile

4.2 Descriptive analysis

In table three we can observe the following, the first category of emotions towards investments, we can see many different means and standard deviations. Starting with hope, we can observe a range from 3.317 to 3.381, with standard deviations between 1.099 and 1.268. Next, for the emotion fear, the means were 3.302 and 3.397, and the standard deviations were 0.993 and 1.315. The regret items exhibit means of 2.905 and 3.302, with standard deviations ranging from 1.026 to 1.364. Lastly, greed items display means of 3.413 and 3.619, with standard deviations of 1.145 and 1.325. Regarding investment biases, herding items have means of 2.746 and 3.365, and standard deviations of 1.164 and 1.097, respectively. Overconfidence items show some lower means of 2.429 and 2.556, with standard deviations of 1.088 and 1.215.

Lastly, the preferences for sustainable energy investments have been divided into 4 sub questions asking different aspects. These are as follows: The mean for preference item statement 1 is 1.810, with a standard deviation of 0.396, while statement 2 has a mean of 1.841 and a standard deviation of 0.368. statement 3 shows a mean of 1.714 with a standard deviation of 0.455, and statement 4 has a mean of 1.365 with a standard deviation of 0.485.

Category	**Mean**	**SD**	**a**
Emotions towards investments			
Hope (Q10_1)	3.381	1.099	0.78
Hope (Q10_5)	3.317	1.268	
Fear (Q10_2)	3.397	0.993	0.67
Fear (Q10_6)	3.302	1.315	
Regret (Q10_3)	3.302	1.026	0.76
Regret (Q10_7)	2.905	1.364	
Greed (Q10_4)	3.413	1.145	0.81
Greed (Q10_8)	3.619	1.325	
Investment biases			
Herding (Q9_1)	2.746	1.164	0.69
Herding (Q9_2)	3.365	1.097	
Overconfidence (Q9_3)	2.429	1.088	0.55
Overconfidence (Q9_4)	2.556	1.215	
Preferences for sustainable energy investments			0.74
Preference (Q11_1)	1.81	0.396	
Preference (Q11_2)	1.841	0.368	
Preference (Q11_3)	1.714	0.455	
Preference (Q11_4)	1.365	0.485	

Table 3 – Descriptive statistics

4.3 Scale validation

4.3.1 Cronbach's Alpha

Cronbach's Alpha was calculated for each variable to test the reliability of these measurement scales.

In the first category of emotions, we have the following results: emotion, hope, scored a Cronbach alpha of 0.78. The next emotion, fear, scored a Cronbach alpha of 0.67. regret scored a Cronbach alpha of 0.76. Lastly, greed scored a Cronbach alpha of 0.81. In the second category of biases, we have the following results: bias herding scored a Cronbach alpha of 0.69, and overconfidence scored a Cronbach alpha of 0.55. Lastly, in the final category about preferences for sustainable energy investments, we observe a Cronbach alpha of 0.74. According to Nunnally (1978), a Cronbach's alpha of 0.7 or higher, calculated for each pair of questions used for emotions and biases and a quartet for preferences, indicates internal consistency between items.

Therefore, all the emotions themselves are able to score very near to this 0.7 measurement value, meaning that they all suggest near consistency; for the bias Herding, it scores near enough to the desired 0.7 score. On the other hand, the overconfidence bias could not score a high Cronbach alpha, suggesting that the two questions needed better consistency. Thus, we have to be careful when analyzing this bias. Lastly, the preferences for sustainable energy investment were able to score an excellent internal consistency score.

4.4 Correlation

From the correlation analysis, we have the following significant findings.

Firstly, a significant correlation exists between preferences and hope at (0.426). This means that higher levels of hope are associated with a stronger preference for sustainable energy stocks. Secondly, the correlation between preferences and regret is significantly negative at a value of (-0.266). This explains that higher levels of regret are linked to a lower preference for sustainable energy stocks. Looking at relationships between the independent variables, we can see that hope negatively correlates with regret (-0.270). This explains that individuals with stronger hope emotions have lower levels of regret. Furthermore, hope significantly correlates with income and education; this indicates that hopeful participants tended to have more income (0.256) and higher levels of education (0.278). Fear has a significant positive correlation with regret (0.278), explaining that participants who experience higher levels of fear also tend to have higher levels of regret. Lastly, positive emotions have a marginally significant positive correlation with preferences; this explains that individuals with higher levels of positive emotions tend to show stronger for sustainable energy stocks. Regarding the biases, we cannot see a significant correlation between any of our variables, so we keep them separate.

	Preferences	Hope	Fear	Regret	Greed	Positive Emotions	Negative Emotions	Herding	Overconfidence
Preferences	1.000	0.427*	-0.064	-0.266*	-0.073	0.234·	-0.197	0.180	0.112
Hope	0.427*	1.000	-0.097	-0.270*	-0.054	0.649*	-0.213·	0.043	0.177
Fear	-0.064	-0.097	1.000	0.278*	0.221·	0.114	0.787*	0.019	0.138
Regret	-0.266*	-0.270*	0.278*	1.000	0.191	-0.013	0.801*	-0.033	0.015
Greed	-0.073	-0.054	0.221·	0.191	1.000	0.683*	0.271*	0.083	0.025
Positive Emotions	0.234·	0.649*	0.114	-0.013	0.683*	1.000	0.082	0.096	0.161
Negative Emotions	-0.197	-0.213·	0.787*	0.801*	0.271*	0.082	1.000	-0.035	0.083
Herding	0.180	0.043	0.019	-0.033	0.083	0.096	-0.035	1.000	0.155
Overconfidence	0.112	0.177	0.138	0.015	0.025	0.161	0.083	0.155	1.000
Age	0.274*	0.203	-0.035	0.012	-0.065	0.080	-0.007	0.171	-0.020
Income	0.276*	0.256*	-0.001	0.019	-0.095	0.078	0.015	0.056	0.096
Education	0.340*	0.278*	0.069	-0.019	0.044	0.201	0.034	0.157	0.057

* indicates $p < 0.05$, ** indicates $p < 0.01$, *** indicates $p < 0.001$, and · indicates $p < 0.1$. Correlation is statistically significant at 0.001, 0.01, and 0.05, respectively (two-tailed).

Table 5 – Correlation statistics

4.5 Hypotheses analysis

Table 7 shows the regression results of the relationship between the independent and dependent variables, the dependent being preferences for sustainable energy investments and the grouped positive emotions, hope and greed, the group's negative emotions, which are fear and regret, and the separate biases herding and overconfidence, on the preferences. Several models have been compiled to look for interesting relationships between the variables. After careful consideration, the analysis of model one will be pursued since it shows that the intercept is significant the positive emotions is marginally significant and negative emotions are significant.

The adjusted R-squared for the regression model has been determined at 0.185, which means that this model accounts for 18.5% of the variance in preferences for sustainable energy investments.

4.5.1 Hypothesis 1:

The results in regression table (Table 7) show a ($\beta = 0.375$) for the relationship between positive emotions (hope and greed) and preferences for sustainable energy investments. This indicates a marginally significant positive relationship between positive emotions and investment preferences. Although the p-value is slightly above the conventional 0.05 threshold, the direction and strength of the relationship suggest that positive emotions do indeed have an impact. Accordingly, this evidence supports H1, suggesting that positive emotions are marginally ($p < 0.1$) positively correlated with composite score of preferences for sustainable energy investments.

4.5.2 Hypothesis 2:

For the relationship between negative emotions (fear and regret) and preferences for sustainable energy investments, Table 7 shows a ($\beta = -0.384$). This indicates a significant negative relationship between negative emotions and investment preferences, as the p-value is below the 0.05 threshold. Therefore, sufficient evidence supports H2, confirming that negative emotions are negatively correlated with composite score of preferences for sustainable energy investments.

4.5.3 Hypothesis 3:

For the relationship between investment biases (herding and overconfidence) and preferences for sustainable energy investments, the results show that herding has a ($\beta = 0.181$). In contrast, overconfidence has a ($\beta = -0.208$). Both biases do not show significant relationships with investment preferences, as indicated by their high p-values. Thus, insufficient evidence supports H3, suggesting that investment biases are not significantly correlated with the composite score of preferences for sustainable energy investments in this study.

	Model 1	Model 2	Model 3
Intercept	2.173* (2.09)	1.965· (1.92)	1.868* (2.05)
Positive Emotions	0.375· (1.89)	x	x
Negative Emotions	-0.384* (-2.15)	x	x
Hope	x	0.396** (2.67)	0.396** (2.72)
Fear	x	-0.037 (-0.24)	x
Regret	x	-0.198 (-1.36)	-0.209 (-1.52)
Greed	x	-0.006 (-0.05)	x
Herding	0.181 (1.00)	0.204 (1.14)	0.198 (1.11)
Overconfidence	-0.208 (-1.02)	-0.233 (-1.14)	-0.230 (-1.13)
Age	0.112 (0.85)	0.117 (0.90)	0.120 (0.95)
Income	0.030 (0.28)	0.000 (0.00)	0.000 (0.00)
Education	0.327 (1.48)	0.262 (1.20)	0.256 (1.20)
Adjusted R-squared	0.185	0.235	0.250
N	63	63	63

* indicates $p < 0.05$, ** indicates $p < 0.01$, *** indicates $p < 0.001$, and · indicates $p < 0.1$. Correlation is statistically significant at 0.001, 0.01, and 0.05, respectively (two-tailed).

Table 7 – Regression statistics

4.6 Control variables

The control variables of age, income, and education were included in the regression analysis to examine their potential influence on preferences for sustainable energy investments. For age on the table, the results showed a ($\beta = 0.112$), and it indicates that age does not statistically significantly impact investment preferences within this model.

Secondly, for income, this also does not show a non-significant relationship with the preferences for sustainable energy investments, with a ($\beta = 0.030$). This suggests that the variation in income does not significantly influence the investment preferences in this context.

Lastly, for education, while we could not reach the conventional level of statistical significance, we could see somewhat more of an effect with a ($\beta = 0.327$). Although the p-value is above the 0.05 threshold, the positive coefficient implies that wit higher levels of education could still potentially be associated with a greater preference for sustainable energy investments. However, we were not able to say this from this sample.

To conclude, none of the control variables significantly impacted the preferences for sustainable energy investments in this study, thus indicating that within this analysis, the primary drivers were emotions and biases.

4.7 Summary of results

he results of the first test, which was a Shapiro Wilk and a Chi-square test, were to check for normality. We were able to reject normality. Thus, for the spearman's rank order was needed to calculate the correlation of variables. Next, to check for the reliability of the measurement scales of the survey, we confirmed through the Cronbach alpha that most variables were able to score close to the acceptable threshold of 0.7. Hope scored a Cronbach's Alpha of 0.78, fear 0.67, regret 0.76, greed 0.81, herding 0.69, overconfidence 0.55, and preferences for sustainable energy investments 0.74. Although overconfidence did not meet the 0.7 threshold, the other variables demonstrated acceptable internal consistency.

The correlation analysis found that the higher level of hope was significantly correlated with a stronger preference for sustainable energy investments, with a correlation coefficient of 0.427. In contrast, we could see that regret showed a significant negative correlation with preferences, with a correlation coefficient of -0.266. Fear and greed had no significant correlation with preferences, meaning that these emotions did not significantly correlate with the investment preferences in this survey.

Lastly, we did the regression analysis, which included the positive emotions of hope and greed, the negative emotions of fear and regret, and the separate biases of herding and overconfidence. It showed that the positive emotions had a marginally significant positive impact on investments with a ($\beta = 0.375$), while negative emotions had a significant negative impact ($\beta = -0.384$). However, herding ($\beta = 0.181$) and overconfidence ($\beta = -0.208$) did not show significant relationships with investment preferences. The adjusted R-squared for the regression model was 0.185, indicating that the model explained 18.5% of the variance in preferences for sustainable energy investments. The F-statistic also indicated that the independent variables significantly impacted the dependent variable. Looking at the control variables, age ($\beta = 0.112$), income ($\beta = 0.030$), and education ($\beta = 0.327$) did not show significant impacts on investment preferences. This is showing that within this research, the primary drivers of investment preferences were the emotional and cognitive factors explored in the hypotheses.

5. DISCUSSION

This thesis aimed to assess and analyze the relationship between emotions and biases in investor preferences for sustainable energy investments. It pursued this objective by testing three set hypotheses relating to positive and negative emotions and two biases. The regression analysis and correlation matrix results provided interesting insights into these relationships of variables.

For the first hypothesis, "Positive emotions (such as hope and greed) towards investments are positively correlated with preferences for sustainable energy investments," the regression analysis showed a ($\beta = 0.375$). This indicated that there was a marginally significant positive relationship between positive emotions and investment preferences, which suggested that hope and greed do, in fact, have an impact on the investor's decisions in the sustainable energy sector. This conclusion also aligned with existing literature, which found that hopeful individuals are more likely to engage in riskier investments due to their optimistic outlook (Puri & Robinson, 2007). Furthermore, additional research supported this by highlighting hope can drive over-optimism, leading investors to overlook the potential risks (Shefrin, 2002).

The second hypothesis, "Negative emotions (such as fear and regret) towards investments are negatively correlated with preferences for sustainable energy investments," was supported by significant results from the regression analysis, showing a ($\beta = -0.384$). The negative relationship suggested that higher levels of fear and regret significantly deters investors from sustainable energy investments. This is also consistent with previous studies mentioned in this paper (Igeland et al., 2024; Shefrin, 2002) which emphasize the impact of fear and regret on promoting risk-averse behavior and preventing the shifts towards newer, less-proven technologies like sustainable energy.

The third hypothesis, "Investment biases are positively correlated with preferences for sustainable energy investments," did not find sufficient support in this study. The regression results for herding and overconfidence indicated no significant relationships with investment preferences. These results suggested that, as opposed to the expectations of behavior finance literature (Iacurci, 2023; Qasim et al., 2019) biases like herding and overconfidence, in fact, do not significantly influence investment decisions in the context of sustainable energy stocks.

Furthermore, we expected some correlation relationships between our chosen biases and emotions. However, the analysis found that this was not present, so we are not able to state that emotions and biases are correlated in our dataset.

Lastly, the analysis of the control variables showed that age), income, and education did not significantly impact investment preferences. This meant that the demographic factors of survey participants were definitely not the primary drivers of preferences in sustainable energy investments when other variables like emotions and biases were considered for this thesis.

6. CONCLUSION

The central research question of this thesis was, "What is the effect of emotions towards investments and investment biases on investors' preferences for sustainable energy investments?". The

study results indicated that negative emotions such as fear and regret together significantly negatively affect the investment preferences for sustainable energy stocks. In contrast, the positive emotions, which we define as hope and greed, have a marginally significant positive effect. These results suggest that investors who experience higher levels of the set positive emotions are more likely to prefer sustainable energy investments. In contrast, those investors who experience strong negative emotions are less likely to favor these investments. This conclusion highlights the importance of addressing emotions and biases in promoting sustainable energy investments, which can be done through strategies such as nudging, subtly influencing investors towards more rational decision-making.

Section 6.1 will discuss the study's theoretical and practical implications, outline the research's limitations, and make recommendations for future studies to conclude this thesis.

6.1 Implications

6.1.1 Theoretical implications

In the current literature on investment decisions, emotions and biases have been extensively studied in various contexts (Shefrin, 2002; Kahneman & Tversky, 1979). However, this thesis was set up to specifically research their impact on the preferences for sustainable energy investments, providing a valuable addition to the current understanding of the investor's behavior in this emerging sector. The positive and negative emotions were found to significantly influence these investment preferences, with previous research highlighting the role of factors in financial decision-making (Puri & Robinson, 2007; Igeland et al., 2024). By categorizing emotions into positive and negative, this study offered a perspective that enhances the theoretical framework of behavioral finance. Furthermore, this thesis extended the application of utility theory by incorporating non-financial preferences such as environmental concerns. Traditional utility models focus more on financial returns, but this thesis highlights the importance of integrating broader social and environmental aspects into this utility framework (Riedl & Smeets, 2017). This expanded view of the utility theory will help capture the complexity of investors' preferences in a better context of sustainable energy investments, contributing to a better understanding of investors' behaviors.

6.1.2 Practical implications

From a managerial perspective, this thesis's findings are helpful for policymakers and financial advisors who aim to promote sustainable energy investments through nudging. Understanding that positive emotions like hope and greed can drive investors towards sustainable energy stocks through marketing and communication strategies highlighting the potential high returns and positive future outcomes associated with sustainable energy investments. From the other perspective, they should address negative emotions such as fear and regret, which involves mitigating perceived risks through transparent communication about sustainable energy investments' stability and long-term benefits. For investment professionals, it is helpful to recognize the role of biases, although this thesis did not show significant results on the relationships. Educating investors about the potential problems of biases will be beneficial in guiding them towards more rational and sustainable investment choices. Moreover, this thesis's insights could help design better educational campaigns. With a deeper understanding of this thesis, investment professionals can curate strategies for their investors, aligning with their client's preferences.

6.2 Limitations

6.2.1 Limitations

This study has encountered several limitations that need to be addressed. Firstly, the sample size was relatively small, thus making it challenging to analyze the data thoroughly. Furthermore, the sample size was also biased due to the distribution of control variables, with most respondents being younger, low-income, and having similar education levels, mostly bachelor students. This demographic limits the generalizability of the results, which means that this research cannot accurately reflect it on a broader population of investors. Secondly, converting the preference variable from a dichotomous format to a Likert scale was necessary to perform regression analysis, given the small sample size. While essential for the analysis, this transformation could lead to an issue of not being able to capture the original binary responses. One of this study's limitations is the low Cronbach's alpha for the overconfidence questions, which indicates poor internal consistency. This suggests that the responses have not reliably captured overconfidence, affecting the accuracy of related results. Future research should revise how overconfidence is measured to improve reliability. Additionally, for the regression analysis, we did not include the different ordinal values of age, income and education separately; instead, we grouped these variables together to simplify the model due to the small sample size also resolving the issue of overfitting, meaning that we lost the more subtle effect of the model. Furthermore, combining greed and hope into a single positive emotions category could be considered controversial. In contrast, greed is often perceived negatively. It was grouped with hope in this study to reflect its potential to drive high-risk, high-reward investment behavior. This decision, however, might not align with the perspectives of academic literature and could influence the interpretation of results.

Lastly, not all respondents were investors in the financial market, and even fewer had experience with energy stock markets. This lack of experience made it more difficult for the respondents to interpret and respond accurately to the survey statements, reducing the findings' reliability. To combat this, the survey provided a prompt to help the respondents imagine themselves as investors; thus, the choice was to compromise to ensure an adequate number of participants.

6.2.2 Future research

Future research in this area should address the limitations by first increasing the sample size and ensuring a more diverse and representative demographic distribution. This would help the robustness and generalizability of potential findings. Also, a bigger sample would create the possibility for an analysis of different ordinal values of age, income, and education, creating a more nuanced understanding of their possible effect on each group. Furthermore, exploring alternative methods for handling binary variables without converting them to a Likert scale could help preserve the integrity of the original data. Future studies might also consider separating the analysis of emotions and biases to examine their distinct impacts on investment behavior better. Conducting similar research with actual investors and professionals, particularly those with experience in the energy sector, would improve the reliability of results. If possible with an addition of real-world investment data to be able to validate the survey findings.

7. ACKNOWLEDGMENTS

First of all, I would like to express my gratitude to my supervisors, Dr. Polina Khrennikova and Dr. Xiaohong Huang, who helped me while writing this thesis. When there were issues during the writing, they were always there to help assess the situation and give critical feedback. As a second thank you, thank all the participants who helped me make this study possible by filling in my survey and trusting me with their data. As a last thank you, thank you to my family and close friends who were a big support during this challenging time of writing this thesis and were willing to brainstorm ideas.

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9. APPENDICES

9.1 Survey

Demographic Information (CV)

Question

Age: _____

Education Level:

- Primary (1)
- Lower secondary education (2)
- Upper secondary education (3)
- Bachelor's degree (4)
- Master's degree (5)
- PhD (6)

Monthly Income (in Euro):

- Less than 1000 (1)
- 1001-1500 (2)
- 1501-2000 (3)
- 2001-2500 (4)
- 2501-3000 (5)
- More than 3000 (6)

Emotions Towards Investments (IV)

Hope

When thinking about investing in sustainable energy stocks, I feel hopeful/optimistic about the potential gains and am encouraged to take risks for substantial returns. (1 = Strongly Disagree, 5 = Strongly Agree)

Considering investments in sustainable energy stocks, I am optimistic about the future gains and feel motivated to pursue high returns, even if it involves taking risks. (1 = Strongly Disagree, 5 = Strongly Agree)

Emotions Towards Investments (IV)

Fear

Fear of potential losses in sustainable energy investments leads me to adopt conservative strategies (safer strategies) to avoid these risks. (1 = Strongly Disagree, 5 = Strongly Agree)

The possibility of losing money on sustainable energy investments makes me prefer safer strategies to mitigate these risks. (1 = Strongly Disagree, 5 = Strongly Agree)

Regret

Concern about future regret influences me to make conservative investment choices in sustainable energy to avoid making potentially poor decisions. (1 = Strongly Disagree, 5 = Strongly Agree)

Worrying about regretting my choices later, I opt for conservative investments in sustainable energy to prevent poor decisions. (1 = Strongly Disagree, 5 = Strongly Agree)

Greed

My focus on maximizing returns drives my interest in investments, but this is often moderated by my fear of potential losses and concern about future regret. (1 = Strongly Disagree, 5 = Strongly Agree)

While maximizing returns is my primary goal in investing, I often temper this with caution due to my fear of losses and potential regret. (1 = Strongly Disagree, 5 = Strongly Agree)

Investment Biases (IV)

Herding

I often find myself investing in energy stocks because other investors are doing so. (1 = Strongly Disagree, 5 = Strongly Agree)

When many investors favour a particular sustainable energy stock, I am more likely to invest in it myself. (1 = Strongly Disagree, 5 = Strongly Agree)

Overconfidence

I feel that my ability to select profitable sustainable energy stocks is better than that of most investors. (1 = Strongly Disagree, 5 = Strongly Agree)

I am confident that my investment decisions in sustainable energy stocks will usually be successful even without extensive research. (1 = Strongly Disagree, 5 = Strongly Agree)

Preferences for Sustainable Investments (DV)

Preferences

I prefer investments that have a positive environmental impact. (1 = No, 2 = Yes)

I am likely to invest in a company that prioritizes social responsibility. (1 = No, 2 = Yes)

My investment decisions are influenced by whether the investment contributes to sustainability. (1 = No, 2 = Yes)

I prioritize environmental benefits over financial returns in my investments. (1 = No, 2 = Yes)

9.2 Tables:

Category	Statistic	P Value	Significance
Hope	0.946	0.008	**
Fear	0.936	0.003	**
Regret	0.931	0.002	**
Greed	0.903	0.0	***
Herding	0.935	0.002	**
Overconfidence	0.945	0.007	**
Preferences_1	24.143	0.0	***
Preferences_2	29.349	0.0	***
Preferences_3	11.571	0.001	***
Preferences_4	4.587	0.032	*
All Emotions	0.971	0.143	
All Biases	0.943	0.006	**

All Preferences	19.302	0.001	***

Table 4 – Normality table

Q11_1	Q11_2	Q11_3	Q11_4	Sum	Likert Scale
1	1	1	1	4	1
1	1	1	2	5	2
1	1	2	2	6	3
1	2	2	2	7	4
2	2	2	2	8	5

Table 6 – Score system for preferences