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FINANCIAL ECONOMICS | RESEARCH ARTICLE

More than money? An empirical investigation of socio-psychological drivers of financial citizen participation in the German energy transition

Dominik L. Schall^{1*}

Abstract: While financial citizen participation plays an increasing role in renewable energy, there is a lack of understanding which socio-psychological factors correlate with a decision to privately invest in renewable energy. Based on a conceptual model and an extensive literature review, a survey among retail investors of renewable energy projects in Germany was conducted and compared to existing population samples using logistic regressions and factor analysis. This research finds that the typical retail investor in renewable energy in Germany is more likely to be male with a higher income, to have a higher education, and to live in a more rural area compared with the overall population. The typical investor exhibits strong proenvironmental beliefs and behaviors as well as a predisposition for active citizenship. Furthermore, getting a form of non-financial or “psychic return” from the investment seems to be important for the investment decision. Strategic adaptations for public and private actors to increase retail investment in renewable energy are discussed.

Subjects: Behavioral Sciences; Economic Psychology; Corporate Finance; Investment & Securities

Keywords: energy transition; renewable energy; socio-psychological factors; citizen participation; behavioral finance; investment decisions

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Dominik Schall holds a doctoral degree in behavioral economics from the Technical University of Munich (TUM). His research interests include investment in renewable energy, incentives for and drivers of sustainable behavior, and the reduction of overconfidence in a business context.

PUBLIC INTEREST STATEMENT

The goal of this research is to improve the understanding which socio-psychological factors correlate with a decision to privately invest in renewable energy. A survey among retail investors of renewable energy projects in Germany was conducted and compared to existing population samples. This research finds that the typical retail investor in renewable energy in Germany is more likely to be male with a higher income, to have a higher education, and to live in a more rural area compared with the overall population. The typical investor exhibits strong proenvironmental beliefs and behaviors as well as a predisposition for active citizenship. Furthermore, getting a form of non-financial or “psychic return” from the investment seems to be important for the investment decision. Based on these results, potential measures to increase retail investment in renewable energy are discussed.

1. Introduction

In order to reach the ambitious renewable energy (RE) targets of the European Union and many countries around the world on their closely observed transition to low-carbon economies (Araújo, 2014; Burke & Stephens, 2018), huge investments in RE are needed over the next decades. Private finance has to play a major role in the deployment of RE (Curtin et al., 2017). Consequently, an increasing importance of financial citizen participation in RE projects via energy cooperatives and similar business models in countries with ambitious RE targets like Germany can be observed (Ebers Broughel & Hampl, 2018; Yildiz, 2014; Yildiz et al., 2015).

Despite the growing importance of private finance and especially financial citizen participation in the RE sector, there is still a lack of understanding which sociodemographic and psychographic factors correlate with retail investors' actual decision to invest (not intentions or willingness to invest) in RE (Bauwens, 2019; Bergek et al., 2013; Gava Gastaldo et al., 2019; Holstenkamp & Kahla, 2016; Yildiz, 2014).

Looking at socially responsible investment (SRI) in general, previous research found that ethical and social factors can play an important role in the investment decision-making process (Escrig-Olmedo et al., 2013; Nilsson, 2008; Scholtens & Sievänen, 2012; Williams, 2007), but there are several shortcomings: existing studies often only compare socially responsible (SR) investors to “conventional investors” (Junkus & Berry, 2010; Nilsson, 2009; Tippet & Leung, 2001), not to the overall population, or analyze investments in rather intangible and anonymous mutual funds or “green shares” (Bauer & Smeets, 2014; Jansson & Biel, 2011; Nilsson, 2008, 2009; Scholtens & Sievänen, 2012).

Similarly, previous research specifically on private RE investments supports the notion of non-financial factors being of large importance as well (Bauwens, 2019; Curtin et al., 2017). But the vast majority of existing studies are either focused on institutional investors (Masini & Menichetti, 2013), based on attitudes or investment intentions rather than actual investment decisions (Ebers Broughel & Hampl, 2018; Gamel et al., 2016; Karasmanaki et al., 2019; Salm et al., 2016), or mostly descriptive survey summaries without inferential statistics on different sociodemographic and psychographic characteristics (Degenhart & Nestle, 2014; Radtke, 2014; Volz, 2012).

This study attempts to address the identified gap in the literature by focusing on which socio-demographic and psychographic characteristics distinguish private RE investors (“citizen investors”) from their fellow citizens. Based on a simple conceptual model and hypotheses that are derived from the existing related research, a survey was conducted among 266 private citizens who have actually invested in RE in Germany. Using representative data from national surveys as control groups and applying logistic regression analysis including exploratory factor analysis, characteristic sociodemographic and psychographic traits that correlate with financial citizen participation in RE projects are identified.

This research makes three main contributions. First, based on a unique and extensive empirical framework, the results show which socio-psychological factors found to influence investment decisions in related fields such as SRI also correlate with RE investment decisions. Second, complementing the research on proenvironmental behavior change (Bonsall et al., 2009; Byerly et al., 2018; Dietz et al., 2005; Stern et al., 1999) the results facilitate a better understanding of individual RE investors' decision-making by investigating the notion of a “psychic return” of investments in RE. Third, policy makers and private actors concerned with increasing the diffusion of and securing financing for RE technologies can draw on the results to develop better tailored policies and marketing instruments.

1.1. *Non-financial drivers of private renewable energy investments*

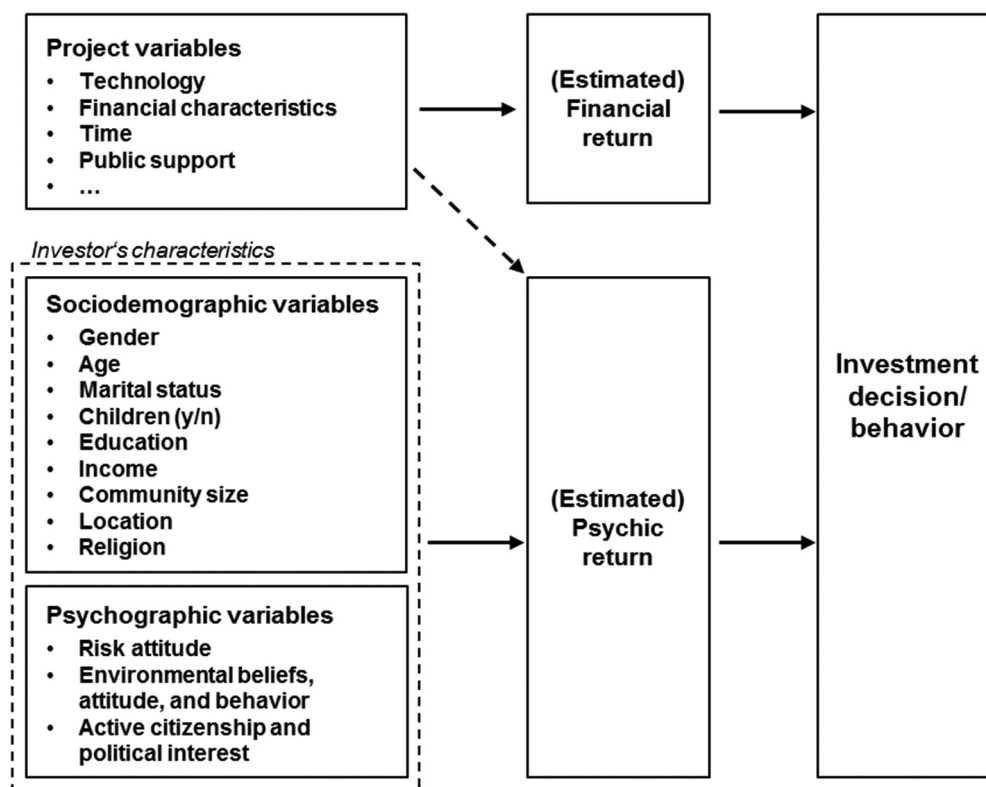
Standard theories of investor behavior often assume a model of the perfectly rational and strongly finance-oriented investor based on the notion that investors (almost) exclusively aim to maximize

their risk-adjusted financial returns (Statman, 2004; Williams, 2007). Most of the literature on RE investment evaluation takes the same view (Fraune, 2015). Contrary, research on SRI, which includes among others ethical, social, green, responsible, sustainable, societal, impact, and clean investments (Eurosif, 2012), leads to a different conclusion. Beal et al. (2005) argue that investors receive more than only a financial return from SRI, resulting in a flow of pleasure and social status. Hence, in addition to the pure financial gain, investors get some form of “psychic return” from investing in SRI which Beal et al. (2005) suggest to be thought of as equivalent to the gambler’s fun of participation, as the level of ethicality of an investment in the investor’s utility function, or as equivalent to the happiness or well-being derived from other pleasurable activities. Similarly, e.g., Holstenkamp and Kahla (2016) and Statman (2004) claim that in addition to utilitarian benefits of low risk and high expected returns, investors want expressive benefits resulting from, e.g., status, patriotism, and social responsibility.

Research on SRI in general (Escrig-Olmedo et al., 2013; Nilsson, 2008; Scholtens & Sievänen, 2012; Williams, 2007) and SRI in Germany (Dorfleitner & Utz, 2014; Holstenkamp & Kahla, 2016) found that sociodemographic and psychographic factors influence the SRI decision-making process. This indicates that, in contrast to a mainly mathematically derived (expected) financial return, the additional (expected) “psychic return” of a SRI can differ individually depending on the sociodemographic and psychographic characteristics of the investor. Consequently, there is a need to incorporate behavioral and social aspects when analyzing decision-making in the RE sector (Bauwens, 2019; Holstenkamp & Kahla, 2016) because a “rational techno-economic analysis of energy alternatives seems not sufficient to explain RE diffusion and RE adoption barriers” (Masini & Menichetti, 2013, p. 512).

The conceptual model shown in Figure 1 summarizes the notion of an additional “psychic return” or additional “expressive benefits” of SRI depending on sociodemographic and psychographic

Figure 1. Conceptual model of influential variables of private SRI decision-making.



characteristics of an individual as discussed in detail in Sections 1.2 and 1.3. While techno-economic “project variables” of RE projects seem not sufficient to explain decisions of private investments in RE (Curtin et al., 2017), they certainly have an influence on the financial return and perhaps also on the additional “psychic return” of a project (e.g., because of technological preferences of an investor). However, this study focusses on sociodemographic and psychographic variables. Following the conceptual model, this study reviews the existing knowledge about non-financial influences on SRI decision-making and adapts it to the specific situation of tangible RE projects in order to develop and test hypotheses about how sociodemographic and psychographic variables correlate with decisions of financial citizen participation in RE projects.

1.2. Sociodemographic drivers of socially responsible retail investments

Sociodemographics exert an important influence on ecological consumer and investment behavior and thus should be considered when investigating SRI (Getzner & Grabner-Kräuter, 2004; Karasmanaki et al., 2019; Nilsson, 2008). An extensive review of existing research on predictors for SRI and socially responsible consumption (SRC) serves as basis for this study on RE investment:

Bauer and Smeets (2014) and Haigh (2008) identified more men than women in their samples of SR investors. In addition, a large survey among members of energy cooperatives in Germany found that around 80% of them are male (Yildiz et al., 2015). Fraune (2015) and Ebers Broughel and Hampl (2018) confirmed gender differences in citizen participation in German and Austrian RE projects pointing in the same direction.

Hypothesis 1: Men are more likely to invest in RE projects than women.

Williams (2007) discovered a positive relation between age and SRI and Radtke (2014) found people involved in financial citizen participation in RE projects to be predominantly older. This view is supported by several studies (as summarized by Diamantopoulos et al., 2003) that come to the conclusion that older people display higher levels of green behavior.

Hypothesis 2: Older people are more likely to invest in RE projects than women.

Looking at the marital status, Diamantopoulos et al. (2003) found no evidence that married people are more environmentally conscious than singles in terms of their environmental attitudes and behaviors. Also Perez-Gladish et al. (2012) and Rosen et al. (1991) cannot confirm a difference between married and single persons in terms of SRI investment.

Hypothesis 3: Marital status is not related to investing in RE projects.

There are several examples of a positive relationship between having children and SRC, possibly due to discussions about ecology brought home from school and the pressure on parents to fulfill the expectations of their children (Diamantopoulos et al., 2003). In addition, Laroche et al. (2001) confirms a positive relationship for consumers with at least one child.

Hypothesis 4: People with children are more likely to invest in RE projects.

A positive relation between the level of education and SRI has been confirmed in the vast majority of studies on SRI (e.g., Escrig-Olmedo et al., 2013; Junkus & Berry, 2010; Nilsson, 2008; Tsantopoulos et al., 2014). Radtke (2014) describes 51% of a sample of retail RE investors in Germany to have a university degree.

Hypothesis 5: People with higher education are more likely to invest in RE projects.

Diamantopoulos et al. (2003) and Getzner and Grabner-Kräuter (2004) report a positive relationship between income and green behavior. Curtin et al. (2017) and Williams (2007) find a positive association between someone's level of income and his/her likeliness to invest in SRI for several countries. The descriptive statistics of Radtke (2014) indicate that German citizen investors of RE projects have a relatively high gross income.

Hypothesis 6: People with higher income are more likely to invest in RE projects.

Research on SRI could either not confirm a significant impact of community size on SRI behavior (Nilsson, 2008; Perez-Gladish et al., 2012) or found that SRI decreases with community size (Kalkbrenner & Roosen, 2016; Michelsen & Madlener, 2016; Williams, 2007 for Australia). Since people living in rural areas might have a more immediate connection to and understanding of RE because of their proximity to more RE plants (especially wind and biomass), this study follows the notion of an inverse relation between community size and RE investment.

Hypothesis 7: People living in rural areas are more likely to invest in RE projects than people living in urban areas.

There are indications for an uneven geographic distribution of financial citizen participation in Germany. The southern states of Germany have the largest number of energy cooperatives (also reflected in the capacity of RE installations) and high growth rates compared to other federal states (Yildiz et al., 2015).

Hypothesis 8: People living in southern Germany, especially Bavaria, are more likely to invest in RE projects.

Peifer (2011) suggests that religious morality can have a strong impact on financial decisions. In line with this view are the results of several SRI studies, indicating that members of religious groups are more likely to consider social responsibility in their investment decisions because they are more likely to experience "psychic returns", i.e. gain utility from non-financial aspects (Lewis, 2001; Lewis & Mackenzie, 2000; Owen & Qian, 2008).

Hypothesis 9: People belonging to a religious group are more likely to invest in RE projects.

1.3. Psychographic drivers of socially responsible retail investments

It has long been established that sociodemographic variables alone are usually not sufficient to explain proenvironmental or green behavior in general (e.g., Oreg & Katz-Gerro, 2006; Samdahl & Robertson, 1989) and SR investment behavior in particular (e.g., Gamel et al., 2016; Williams, 2007). Instead, especially the extensive research on SRC behavior found that psychographic variables are equally or even more important in explaining ecologically friendly and SR behavior compared to sociodemographic variables (Getzner & Grabner-Kräuter, 2004; Nilsson, 2008; Straughan & Roberts, 1999). Studies analyzing SRI specifically in Germany confirm the view that psychographic variables should be included in an analysis of the motivational factors that drive SRI (Dorfleitner & Utz, 2014; Holstenkamp & Kahla, 2016; Williams, 2007). Taking these results into account, this study also includes psychographic variables in its analysis. Since the foundation of the hypotheses regarding psychographic variables is less straightforward than for sociodemographic variables, their basis is explained in more detail in the following subsections.

1.3.1. Risk attitude

Investors' risk attitudes have only very rarely been included in research on the motivation to make a SRI. However, past studies identified the need to include risk characteristics of SRI investors in SRI research (Nilsson, 2008; Williams, 2007) in order to be able to draw a more detailed profile of SR investors. While Rosen et al. (1991) state that SR investors tend to be slightly risk averse,

without statistically testing their result, Perez-Gladish et al. (2012) predict a positive association of risk tolerance and SRI based on a review of literature on SRI and investment decision-making, but cannot back their hypothesis with any statistically significant results. Since investments in tangible RE projects might require a more entrepreneurial mindset compared to investing in anonymous “green shares”, the hypothesis of Perez-Gladish et al. (2012) appears more suitable:

Hypothesis 10: Risk tolerant people are more likely to invest in RE projects.

1.3.2. *Environmental beliefs, attitudes, and behavior*

Ecological and environmental issues are among the most frequently given answers when investors are asked about their understanding of or motivation to invest in SRI (Beal & Goyen, 1998; Reiner, 2012; Rosen et al., 1991) or RE projects (Radtke, 2014; Volz, 2012). Congruently, research found that, despite the existence of an attitude behavior gap between environmental attitudes and according behavior (e.g., Kollmuss & Agyeman, 2002), environmental or “green” attitudes are important predictors or moderators of ecologically friendly behavior and green SRI (Getzner & Grabner-Kräuter, 2004; Lewis & Webley, 1994; Nilsson, 2008).

However, attitudes are a latent construct of underlying hypothetical mental states and cannot be observed directly (Heberlein, 1981; Milfont & Duckitt, 2010), making them difficult to grasp and measure directly. There is no unanimous definition of environmental attitudes and a very large number of different environmental attitudes measures exist (Dunlap & Jones, 2002; Milfont & Duckitt, 2010). Leaving the discussion about the different approaches to defining environmental attitudes to qualified psychologists and social scientists, to operationalize attitudes for this analysis, this study only adopts a broadly accepted and very general view on attitudes called “vertical structure” (Heberlein, 1981, 2012): The foundation of an individual’s attitudes is a series of basic values such as, e.g., paternalism, which are not directed to a certain object, very hard to change, and used as standards to evaluate whatever we are confronted with. On top of a value sits a belief about the specific object in question, e.g., environmentalism. Such a belief does not have to be correct, but it simply is what the individual believes about the object. The combination of a value and a belief results in an evaluative belief about the object, for example, implying that the object is better than something else. However, attitudes are not only driven by values and beliefs, but also by emotion or affect. In sum, the organization of beliefs, evaluative beliefs, and affect about the object forms an attitude (Heberlein, 2012; Rokeach, 1968).

Most influential studies on proenvironmental behavior are based on the fundamental idea that people’s behavior is related to their thoughts and feelings about the environment and proenvironmental actions, essentially trying to link attitudes with behavior in some form or another. While a lot of different approaches and concepts exist, research trying to link attitudes with proenvironmental behavior has largely converged into two frameworks (Kaiser et al., 2005; Oreg & Katz-Gerro, 2006): (i) the Theory of Planned Behavior and (ii) the Value-Belief-Norm Theory. According to the Theory of Planned Behavior (Ajzen, 1991), behavior is best predicted by behavioral intentions, which are anteceded by a favorable attitude toward the behavior, the perceived social pressure or perceived importance to perform the behavior (i.e. subjective norms), and the perceived level of difficulty of performing the behavior (i.e. perceived behavioral control). Based on the Value-Belief-Norm Theory (Stern et al., 1999), proenvironmental actions come from the acceptance of particular personal values, beliefs that things important to those values are under threat, and beliefs that actions initiated by the individual can help alleviate the threat and restore the values, which activate a sense of obligation (i.e. personal norms) to take proenvironmental actions. Both theories share the notion that beliefs antecede behavioral intentions (i.e. behavioral norms), which in turn antecede actual behavior (Oreg & Katz-Gerro, 2006).

This study adopts the shared view of these concepts and analyzes some beliefs, evaluative beliefs, and norms that might be part of an individual’s environmental attitude and might correlate

with proenvironmental behavior, in this case in the form of investing in RE projects. First, the impact of (i) beliefs about the state of the environment that might represent the perceived importance to perform proenvironmental behavior (Theory of Planned Behavior) and (ii) beliefs that things important to the person are under threat (Value-Belief-Norm Theory) is studied. This also coincides with the finding of research on SRI and SRC that environmental concerns have a positive association with environmentally friendly behavior and carry through in investment decisions (Braito et al., 2017; Karasmanaki et al., 2019; Owen & Qian, 2008; Straughan & Roberts, 1999).

Hypothesis 11: People who are concerned about the environment are more likely to invest in RE projects.

Second, in their article on the Value-Belief-Norm Theory, Stern et al. (1999) state that “personal proenvironmental norms—the belief that the individual and other social actors have an obligation to alleviate environmental problems—are the only social-psychological element common to all three types of non-activist environmentalism.” (Stern et al., 1999, p. 91) In addition, norms were by far the strongest predictor of two of the three types. A similar relation between personal proenvironmental norms and private investments in RE projects as a specific form of environmentalism is assumed here:

Hypothesis 12: People with strong personal proenvironmental norms are more likely to invest in RE projects.

Third, previous studies identified a higher willingness to pay for ethical products among (some) SR consumers compared to other consumers (Auger et al., 2003; Laroche et al., 2001). Similarly, research on SRI found that the probability to invest in “green shares” depends significantly on a person’s willingness to pay more for ecological products (Getzner & Grabner-Kräuter, 2004). The same relation is assumed for investments in RE projects:

Hypothesis 13: People with a higher willingness to pay for ecological products are more likely to invest in RE projects.

In addition to the developed hypotheses on the correlation of environmental beliefs and norms (as elements of an individual’s environmental attitude) with the decision to invest in RE projects, other proenvironmental behavior is considered as a proxy for environmental attitude and in turn as a potential predictor for investments in RE projects. Contrary to conventional wisdom in attitude research, Kaiser et al. (2007) found that people’s attitudes are traceable from people’s reported and/or overt behavior. Specifically, someone’s environmental attitude can be reliably derived from (self-reported) conservation behaviors in the domains energy conservation, mobility and transportation, waste avoidance, recycling, consumerism, and vicarious behaviors toward conservation. Thus, a correlation between related proenvironmental behaviors and investments in RE projects is assumed:

Hypothesis 14: People exhibiting other proenvironmental behavior are more likely invest in RE projects.

1.3.3. *Active citizenship and political interest*

Besides their distinct environmental attitudes and behavior, citizen investors in RE projects might also be different from the overall population with regards to other SR activities and interests. Research on SRI repeatedly identified SR investors to have a strong social conscience (Perez-Gladish et al., 2012) and desire for social change (Beal et al., 2005). Lewis (2001) and Lewis and Mackenzie (2000) describe SR investors as “activists” in the sense that they are often active in politics, their community, charities, or cause-related interest groups. This is in line with more recent

findings of Holstenkamp and Kahla (2016) and Proudlove et al. (2020) that beliefs about community benefits are an important motive to invest in RE.

Beal et al. (2005) suggest that achieving social change is a motivation for SRI which might be pursued by supporting a non-governmental organization (NGO). Previous research found that over 80% of SR investors (Rosen et al., 1991) or private investors in RE projects (Radtke, 2014) are a member of a cause-related group, a club, or an association, and that many SR investors volunteer time.

Hypothesis 15: People who are a member of a cause-related group (or similar) or do honorary activities are more likely to invest in RE projects.

There is abundant empirical evidence that people are not only concerned about their own well-being but do also care about the well-being of others (see, e.g., Riedl & Smeets, 2014 for an overview of relevant literature). Straughan and Roberts (1999) ascribe significant importance to the concern for the welfare of others as a form of altruism in predicting environmentally conscious consumer behavior. This characterization might also hold true for SRI and specifically for investments in RE projects:

Hypothesis 16: People who exhibit a strong concern for the welfare of others in their activities are more likely to invest in RE projects.

2. Materials and methods

2.1. Data collection

2.1.1. Sampling

Using publicly available databases and online information, an own database consisting of 468 different organizations involved in financial citizen participation in RE projects in Germany has been compiled. These organizations are mainly energy cooperatives and closed-end funds whose members have invested in RE projects (see Yildiz, 2014 for an overview of different equity based models of financial citizen participation). Usually, the RE investors are not employed by these organizations and do not have any further contractual relation besides their RE investment. Degenhart and Nestle (2014) find 529 energy cooperatives in Germany with a focus on wind, solar, or biomass. This suggests that this study's data basis covers the vast majority of relevant actors. All identified contacts within these 468 organizations received an e-mail with a link and a request to participate anonymously in an online survey on financial citizen participation in RE projects in Germany and to kindly distribute the request to the RE investors associated with their organization.

The online platform Unipark,¹ which also employs protection mechanisms against bots, was used to conduct the survey with a self-administered questionnaire format (participants could go back and forth). On the first page (landing page), the participants were informed about the general focus of the survey (renewable energy investments), the academic institution behind it, and the data protection measures. The specific focus of the study on sociodemographic and psychographic traits was not mentioned. In addition, the participants were informed that their participation and the analysis of the data would be completely anonymous and that everyone who finishes the questionnaire can take part in a lottery for a tablet computer if they like (optional). The questions (not randomized) were designed in a way that the participants had to choose one of the pre-defined answers (nominal variables) or as likert scale item, except for date of birth, number of kids, household size, and zip code (for those, the participants had to manually enter a number).

In total 806 persons followed the link to the first page of the questionnaire (multiple visits of the same person were identified by the survey platform via IP address and cookies and have only been counted once). Thereof, 360 persons started the survey and 266 private investors of RE energy projects

in Germany finished the survey,² equaling 33% of all that followed the link to the first page. However, it is not possible to calculate the actual response rate, which is probably significantly lower, because it was not possible to track how many of the contacts distributed the request to other RE investors and, if they did, to how many. The median of the time to fully complete the survey was 15 minutes.

To be able to appropriately evaluate the results, several well-known issues with responses to survey questions and common-method variance have to be addressed. First, there is no indication for a non-response bias in the sample. Pairwise comparisons of the first and fourth quartiles of responses for differences in demographics and other variables (e.g., age, number of children, household income, willingness to take risks, RE type, invested amount, distance to RE project, proenvironmental behavior, and personal environmental norm) did not show any significant difference.

Second, despite their anonymity, participants' answers—especially self-reported behavior and willingness to pay—may suffer from socially desirable response bias in the way that they may be exaggerated towards political or ecological correctness (Diekmann & Preisendörfer, 2003; Getzner & Grabner-Kräuter, 2004; Nilsson, 2009). In addition, differences between the samples regarding the questionnaires (e.g., appearance, structure, number of questions, and order of questions) and the data collection may have influenced the participants' answers (see, e.g., Strack, 1992), even though a self-administered questionnaire format was used (participants could go back to previous questions) that attenuates the impact of question order (Schwarz & Hippler, 1995).

While the use of different data collection methods for the different samples and the low scale congruence of predictor and criterion variables in this study might have reduced the potential influence of (common-)method variance (Podsakoff et al., 2012), the magnitude of the reported factors has to be viewed with caution. Post hoc statistical detection and correction techniques for common-method variance have not been used since research extensively tested their efficacy and does not recommend using them due to a lack of reliability (Richardson et al., 2009). Instead, in order to minimize the influence of potential biases in the analysis this study was focused on identifying similarities in the *general direction* of the variables' relation with RE investment decisions *across* the different datasets.

2.1.2. Questionnaire and control groups

Similar to Williams (2007), Tables 1 and 2 present the items and metrics of all variables used in the analysis. To identify differences in personal traits between citizen investors of RE projects and the overall population this study uses representative data from the 2010, 2011, and 2012 waves of the German SOEP survey³ and the 2012 version of the biannual survey of the BMUB and the UBA on environmental consciousness in Germany⁴ to form two control groups. The advantage of having large representative control groups for the analysis comes with the restriction to use items in the questionnaire that were also used in these surveys in order for the answers to be comparable. Hence, most of the items in this study's questionnaire for RE citizen investors were identical with items from the SOEP survey and/or the BMUB/UBA survey (some items are only part of one of the two surveys, some are part of both surveys). Some additional questions about the RE project(s) and the background of the investors have also been included.

Since the BMUB/UBA survey also asked whether the person has already invested in RE, one can clearly distinguish between private RE investors and the rest in this sample. However, conducting an own survey of RE investors and also using SOEP data as a second control group was still necessary because the BMUB/UBA survey (i) focuses on being representative for the overall population (not for German RE investors), (ii) does not give any additional information on the RE investments of the participants and (iii) does not cover all relevant sociodemographic and psychographic aspects.

Other than the BMUB/UBA survey, the SOEP survey does not contain any item specifically on investments in RE. But all owners of homes with photovoltaics or another RE system can be identified in the SOEP sample. Since 1.4 million of the 1.48 million RE plants in Germany at the

Table 1. Summary of all used questions and metrics on sociodemographic characteristics

Characteristic (hypothesis)	Question/s (summarized)	Metric
Gender (H1)		Binary = 1 if male
Age (H2)		Numeric value
Marital status (H3)		(1) Married, together; (2) Married, separated; (3) Single; (4) Divorced; (5) Widowed
Children (H4)	Do you have children?	Binary = 1 if yes
Education (H5)	What is your highest educational level?	(1) Still in school to (8) University degree
Income (H6)	How high is your monthly personal net income? How high is your monthly household net income?	Eight categories with highest category >7,500 EUR
Community size (H7)	In which area do you live?	(1) <5,000 inhabitants; (2) 5,000–20,000; (3) 20,000–100,000; (4) >100,000
Location (H8)		16 Federal States of Germany (derived from first digits of zip)
Religion (H9)	Are you a member of a church or a religious group? If yes, of which?	(0) No; (1) Catholic; (2) Evangelical; (3) Other Christian; (4) Islam; (5) Other
Number of children (control variable)		Numeric value
Household size (control variable)		Numeric value (# persons)
Occupational status (control variable)	Which occupational status do you have currently?	(1) Self-employed; (2) Employed; (3) In training; (4) Unemployed; (5) Retired; (6) Homemaker; (7) Other

time of the study were photovoltaics plants (BDEW, 2015) and almost all of the citizen financed photovoltaics projects are/were fully owned by a single person (trend:research, Leuphana Universität Lüneburg, 2013) and very often built on the person’s own home (Richter, 2013), a large fraction of all private RE investors are captured. However, the distinction is not as clear as in the BMUB/UBA sample.

Since we cannot rule out an overlap of RE investors in this study’s own sample and the SOEP and BMUB/UBA samples, as a robustness check all analyses are conducted with inclusion and exclusion of the RE investors that were identified in the BMUB/UBA dataset and the SOEP dataset.

2.1.3. Items and scale construction

This study adopts the shared view of the Theory of Planned Behavior and the Value-Belief-Norm Theory (see Section 1.3.2) to identify beliefs, evaluative beliefs, and norms that are part of an individual’s environmental attitude and predict proenvironmental behavior, in this case in the form of investing in RE projects. Due to restrictions from the items available in the SOEP questionnaire and the BMUB/UBA survey and to separately analyze these potentially relevant beliefs and norms, single-item indicators and additive scales of few items for specific beliefs/norms are analyzed rather than one large multi-item scale for environmental attitudes as a whole. Thus, this study follows the approach of sociologists who often rely on single-item indicators as in a number of statewide and national surveys in the US, rather than multi-item environmental attitude scales that have been constructed mainly by social psychologists (Heberlein, 1981, 2012). Where several items are available, principal component analysis with a factor analysis is used, followed by a varimax rotation to develop scales. Following Stern et al. (1999), all items loading above 0.4 on a factor are included and scales are constructed as the average of all non-missing responses

Table 2. Summary of all used questions and metrics on psychographic characteristics

Characteristic (hypothesis)	Question/s (summarized)	Metric
Risk tolerance (H10)	How would you rate your willingness to take risks in financial matters?	Scale: (0) Not at all willing to take risks to (10) very willing to take risks
Environmental concern (H11)	Are you concerned about the protection of the environment? How would you rate the current environmental quality in (a) your proximal environment and (b) in Germany?	(0) No; (1) Somewhat concerned; (2) Very concerned Scale (for each question): (1) very bad to (4) very good
Personal proenvironmental norms (H12)	Do the following stakeholders do enough for climate protection?(a) Federal Government, (b) Regional Governments, (c) Citizens, (d) Industry	Scale (for each question): (1) Enough to (4) Not enough
Willingness to pay (H13)	To what extent are you personally willing to pay higher prices for (a) less environmentally harmful products, (b) more energy-efficient products, and (c) fair trade products?	Scale (for each question): (1) Not at all to (4) Very strongly
Proenvironmental behavior (H14)	Which of the following behaviors do you practice in your everyday life?(a) Minimizing water and electricity consumption, (b) Minimizing heating costs, (c) Waste prevention and (d) separation, (e) Green electricity, (f) Switching off unused appliances, and (g) Buying energy-efficient appliances	Binary = 1 if yes (for each question)
Member of cause-related group or honorary work (H15)	Are you member of a group or organization that advocates for the protection and preservation of the environment/nature? Are you a member of any other organization or club (e.g., sports)? Do you regularly do honorary work or volunteering?	Binary = 1 if yes (for each question)
Concern for welfare of others (H16)	Have you donated money in the last year (no membership fees)? Have you donated blood in the last 10 years?	Binary = 1 if yes (for each question)
Political interest and activism (control variable)	How strongly are you interested in politics? Do you lean towards a certain political party? If yes, how strongly?	Scale: (1) Not at all to (4) Very strongly (1) CDU/CSU; (2) SPD; (3) Die Linke; (4) FDP; (5) B90/Gruene; (6) Other; (7) No answer Scale: (1) Weakly to (5) Very strongly

(i.e. adding together all non-missing responses and dividing by the number of all non-missing responses). This approach is generally acceptable and applicable for exploratory research approaches (Hair, 2010; Tabachnick & Fidell, 2013) and has the advantages that the resulting scale has the same range as the original variables (in this case 1–4 or 0–1) and that the resulting scores are still valid even when some items are missing.

Regarding environmental concern (hypothesis 11), concerns about the environment are directly addressed in one item (from BMUB/UBA survey) and potential negative beliefs about the current environmental quality are elicited by using the two items on the evaluation of the current

environmental quality in the proximal environment and in Germany in general (from SOEP survey). The additive scale of these two items has a Cronbach's alpha of 0.65.

To elicit personal proenvironmental norms (hypothesis 12), Stern et al. (1999) use an additive scale of nine items on beliefs about personal moral obligations, obligations of government, obligations of the industry for the environment and climate protection (e.g.: "The government should take strong action to reduce emissions and prevent global climate change."). While the SOEP and BMUB/UBA surveys do not include the exact same items, the BMUB/UBA survey includes four similar items on the question whether the federal and regional governments, the citizens (that implicitly includes the survey participants), and the industry should do more for climate protection. Similar to Stern et al. (1999), a factor analysis determined that all items loaded on a single factor, all factor loadings were 0.5 or larger, and the additive scale of these items has a Cronbach's alpha of 0.72. Thus, following Stern et al. (1999), these four items are used to operationalize personal proenvironmental norms.

To analyze the willingness to pay more for sustainability (hypothesis 13), this study employs three items of the BMUB/UBA survey on the self-reported willingness to pay higher prices for products that are less harmful to the environment, more energy-efficient, or come from fair trade with developing countries (Cronbach's alpha is 0.72 for the additive scale). A factor analysis indicated that all three items loaded on a single factor with all factor loadings larger than 0.6.

According to Kaiser et al. (2007), someone's environmental attitude can be reliably derived from self-reported conservation behaviors. They employed 40 behavior items from six domains (energy conservation, mobility and transportation, waste avoidance, recycling, consumerism, and vicarious behaviors toward conservation) and found that this set of behavior-based environmental attitudes can be transformed into a single attitude dimension without much loss of fit. Only the attitude towards mobility appears to be less strongly connected to the other attitudes (Kaiser et al., 2007). Many of these aspects of self-reported environmental behavior and others are covered in the BMUB/UBA survey: Minimizing water and electricity consumption, minimizing heating costs, waste prevention and separation, green electricity, switching off unused appliances, and buying energy-efficient appliances. A factor analysis determined that all items loaded on a single factor and all factor loadings except one (that was below 0.4) were 0.55 or larger. The additive scale of these items has a Cronbach's alpha of 0.66. Based on the factor analysis, a single scale was created with those items to compare this study's data with the BMUB/UBA survey data regarding hypothesis 14. In the SOEP data, only the first two behaviors are included and they are analyzed separately because of a low alpha reliability.

To analyze the membership in cause-related groups, clubs, and associations or honorary activities in general (hypothesis 15), several items are used. First, a binary variable on membership in a group or organization that advocates for the protection of the environment is used. Second, a single scale of two items on membership in any other club or association and volunteering time in honorary activities is created (Cronbach's alpha: 0.62).

Based on the Value-Belief-Norm framework, Clements et al. (2015) found financial support for environmental movement organizations to have validity as a measure of environmentally significant behavior. More generally, Rosen et al. (1991) indicate that a higher disposition to donate can be a manifestation of a high concern for the welfare of others. To analyze the relation of this social preference with RE investment decisions (hypothesis 16), separate items from the SOEP survey on monetary and blood donation are included in this analysis.

2.2. Data analysis

2.2.1. Logistic regression model

This study hypothesizes that the decision of private citizens to invest in RE projects is related to different sociodemographic and psychographic factors. By using information on actual investment

decisions instead of behavioral intentions as dependent or choice variable (binary variable *invest*) the problem of inflated intentions, that has been a problem in many previous studies on SRI decision-making (Nilsson, 2008), is avoided. Following the approach of many empirical studies on SRI decision-making (e.g., Dorfleitner & Utz, 2014; Escrig-Olmedo et al., 2013; Getzner & Grabner-Kräuter, 2004; Nilsson, 2008), this investment choice is parameterized with a binary logit regression model⁵ in order to analyze which factors predict the (log) odds of investing in a RE project:

$$\ln\left(\frac{P(\text{invest} = 1|X)}{1 - P(\text{invest} = 1|X)}\right) = \beta_0 + X\beta = \beta_0 + \sum_i \beta_i \text{Sociodemographic}_i + \sum_j \beta_j \text{Psychographic}_j \quad (1)$$

or

$$\begin{aligned} P(\text{invest} = 1|X) &= G(\beta_0 + X\beta) \\ &= G\left(\beta_0 + \sum_i \beta_i \text{Sociodemographic}_i + \sum_j \beta_j \text{Psychographic}_j\right), \text{ with } G(z) = \frac{e^z}{1 + e^z} \end{aligned} \quad (2)$$

where $P(\text{invest} = 1|X)$ is the probability of investing in RE projects and X denotes the full set of the independent variables. Being a part of X , $\text{Sociodemographic}_i$ are all sociodemographic independent variables and Psychographic_j denotes all psychographic independent variables as summarized in Tables 1 and 2.

Since not all variables are included both in the BMUB/UBA survey and the SOEP survey but only in one of them, the general regression model (1) is used to analyze (i) a model of all independent variables available in a combined dataset of the BMUB/UBA data and this study's sample and (ii) a model of all independent variables available in a combined dataset of the SOEP data and this study's sample of RE investors. For all independent variables that exist in both combined datasets (e.g., almost all sociodemographic variables), this also adds additional reliability to the results because their relation with investment decisions in RE projects is analyzed with two different control groups. As a further robustness check, both models are estimated with inclusion and exclusion of the RE investors that were identified in the BMUB/UBA dataset and the SOEP dataset (see Section 2.1.2).⁶

2.2.2. Diagnostics and robustness

A maximum likelihood estimation of the logistic model, i.e. the standard approach, is used. This approach seems suitable because estimations with samples larger than 200 observations (Schaefer, 1983) and a minimum of 10 outcome events per predictor variable (or even less; see Vittinghoff & McCulloch, 2007) should generally not suffer significantly from small sample bias or encounter other problems (such as unreliable confidence interval coverage or problems with model convergence). But according to King and Zeng (2001), maximum likelihood estimates can be biased when very rare events are analyzed, i.e., a binary dependent variable with dozens to thousands of times fewer ones ("events") than zeros ("non-events"). In this study's combined datasets, the number of investor observations ("events") is much lower than the number of non-investor (i.e., general population) observations ("non-events"). However, this rare event bias mainly occurs in situations with much rarer events than in this sample (e.g., decisions of citizens to run for political office or infections by uncommon diseases) and the bias—if even existing—would result in this study's estimates being too conservative instead of exaggerating (King & Zeng, 2001). Nevertheless, the robustness of the results is tested by applying suitable remedies for this rare event bias (Leitgöb, 2013), namely the bias correction method proposed by King and Zeng (2001)⁷ and the Penalized Maximum Likelihood Estimation or Firth method (Firth, 1993). Both alternative methods yield very similar results compared with the standard maximum likelihood estimation reported here (no changes of significances and only minor changes of the coefficients) and thus indicate a high robustness of the results.

Due to the possibility of interdependencies between the independent sociodemographic and psychographic variables in models of "green behavior" or "green investment", one has to account for multicollinearity in the empirical estimations (Getzner & Grabner-Kräuter, 2004). However,

a check of the correlation matrices and the fact that all variance inflation factors (VIF) are below 2 indicate no serious issues due to multicollinearity in the applied models. In addition, a link test for model specification indicates meaningful predictors (i.e. $\hat{\beta}$ is significant on a 0.05 level) and no major specification problem (i.e. $\hat{\beta}^2$ is not significant on a 0.05 level) in the main logit regressions with the SOEP dataset and the BMUB/UBA dataset (if the personal net income is included in the later; however, inclusion/exclusion does not change the discussed results so the net household income is kept instead for reasons of comparability with the SOEP dataset). Hosmer's and Lemeshow's goodness-of-fit test shows that the model fits the data well ($p < 0.88$ for main regression with the BMUB/UBA dataset and $p < 0.98$ for main regression with the SOEP dataset). No empty or small cells that might potentially threat the stability of the model have been identified.

3. Results

3.1. Descriptive statistics

Out of the 266 RE investors of this study's survey, 62% have invested in photovoltaics, 21% in wind energy, and 27% in other RE technologies such as biomass and solar heating. Only 13% have invested less than EUR 1,000, 46% have invested between EUR 1,000 and EUR 10,000, and more than half of the investors (51%) have invested more than 10,000 Euros. About a third of the investors live in direct proximity to the RE plant (less than 500 meters), another third between 500 meters and 5 kilometers away, and the last third more than 5 kilometers away (but only 12% live more than 20 kilometers away). One third of all investors state that their geographical position played a role in their investment decision. Almost all investors (96%) believe to have good or very good knowledge about the RE project they have invested in and only 5% cannot imagine making another investment in RE.

Table 3 presents a statistical summary of the variables included in the analysis. The BMUB/UBA sample and the SOEP sample seem to be roughly congruent in many variables (e.g., gender and household income). However, there are also some differences between the two control samples for a few variables (e.g., children) which might be a result of sample attrition because not all participants in the surveys answered all questions that are relevant for this analysis. Thus, the control samples might not be perfectly representative for the overall population of non-investors. However, including both samples as control groups in the regression analysis increases the robustness of the results.

3.2. Regression results

The results of the logit estimations are shown in Table 4. All four estimations include this study's sample of RE investors. For the estimation of the first model ("Non-Invest BMUB/UBA") this study's sample of RE investors and all non-investors from the BMUB/UBA sample are included. The second model ("Full BMUB/UBA") includes not only the non-investors from the BMUB/UBA sample but also all RE investors that are part of the BMUB/UBA survey, thus the full BMUB/UBA sample. Similarly, the estimation of the third model ("Non-Invest SOEP") comprises this study's sample of RE investors and all observations from the SOEP sample that could not be identified as RE investors (even though this distinction is somewhat blurred as described in Section 2.1.2) and the fourth estimation ("Full SOEP") includes all available observations from the SOEP sample. For brevity, only reduced models with variables relevant for the hypotheses or that exhibit some significant connection with the dependent variable are shown. However, all other control variables mentioned in Tables 1 and 2 have also been analyzed and their inclusion does not change the results that are reported here. While some regression coefficients might change slightly, the significance, overall magnitude and direction of the reported relations does not change with the inclusion of these other variables.

3.2.1. Sociodemographic drivers of retail investments in renewable energy

Across the different models, there is a significant positive association between being male and investing in RE (hypothesis 1). Contrary to hypothesis 2, age does not seem to be important (also age^2 is not significant when included).

Table 3. Summary statistics of all independent variables

Variable	Proportion			Median			Mean (Stand. Deviation)		
	RE Invest.	BMUB/UBA ^a	SOEP ^a	RE Invest.	BMUB/UBA ^a	SOEP ^a	RE Invest.	BMUB/UBA ^a	SOEP ^a
Gender (male = 1) ^b	0.81	0.48	0.52						
Age							51.27 (12.784)	49.62 (15.599)	59.64 (15.965)
Married (together and separated) ^b	0.72	0.48	0.68						
Children ^b	0.82	0.33	0.79						
University degree ^b	0.48	0.08	0.15						
Household net income				6	5	5			
Community size				1	4	3			
Location: Southern Germany (Bavaria) ^b	0.59	0.16	0.12						
Member of church/religious group ^b	0.81		0.70						
Risk tolerance (financial matters)				4	-	2			
Environmental concern							1,72 (0.539)	-	1,24 (0.617)
Personal proenvironmental norms							3.16 (0.571)	2.73 (0.569)	-
Willingness to pay for ecological products							3.40 (0.482)	2.50 (0.638)	-
Proenvironmental behaviors				6	4	-			

(Continued)

Table 3. (Continued)

Variable	Proportion			Median			Mean (Stand. Deviation)		
	RE Invest.	BMUB/UBA ^a	SOEP ^a	RE Invest.	BMUB/UBA ^a	SOEP ^a	RE Invest.	BMUB/UBA ^a	SOEP ^a
Minimize heating costs (proenvironmental behavior) ^b	0.96	-	0.48						
Member in proenvironmental group ^b	0.53	-	0.07						
Member in other group(s) or honorary work				1	-	0			
Blood donation in last 10 years ^b	0.41	-	0.12						
Affinity with green party ^b	0.38	-	0.14						

Note: Summary includes only observations without missing values; BMUB/UBA: n = 1,602, SOEP: n = 3,623).
^a(Identified) RE investors are excluded. ^b Binary variable with 0/1 scale (gender: 0 = female, 1 = male; others: 0 = no, 1 = yes).

There is no consistent indication of the marital status predicting RE investments and thus hypothesis 3 assuming no relation cannot be rejected. However, parents are more likely to invest in RE than people without children (hypothesis 4).

The results show a relation of the educational level with the probability of RE investments of private citizens (hypothesis 5). People with a college or university education are much more likely to invest in RE projects.

As predicted by hypothesis 6, the household net income and also the personal net income (only available in BMUB/UBA sample, not shown in Table 4) have a positive association with RE investments. Hence, people with higher (household) income seem more likely to invest in RE.

Confirming hypothesis 7, the results show an inverse relation between the community size and the decision to invest in RE projects, regardless of the applied model or dataset. This means that a larger fraction of private RE investors in Germany live in small(er) communities compared to the distribution of the overall population. At the same time, the binary variable for being located in Bavaria is significant in regressions with both datasets,⁸ indicating that there are more Bavarian RE investors than justified solely by the geographical distribution of the German population. In line with the hypothesis 8, this suggests that people from southern Germany (Bavaria) are more likely to invest in RE projects than others.

Being religious seems not to have a relation with RE investment decisions (the same applies to affiliations with specific religions when included). Thus, hypothesis 9 has to be rejected.

3.2.2. *Psychographic drivers of retail investments in renewable energy*

While financial considerations have an influence on RE investment decisions (Nilsson, 2008; Statman, 2004; Williams, 2007), this study focusses on non-financial aspects of financial citizen participation. However, the applied models control for the willingness to take risks in financial matters. As predicted by hypothesis 10, the analysis shows a positive association between the willingness to take risks in financial matters and RE investment decisions.

Overall, the results show that a person's environmental beliefs, attitudes, and behaviors exhibit a relation to the decision to invest in RE projects. While the personal evaluation of the current environmental quality is not significant, the belief of being concerned about the protection of the environment shows a positive relation to the decision to invest in RE (hypothesis 11). Strong personal proenvironmental norms in the sense of Stern et al. (1999) exhibit a significant positive association with RE investments in the "Non-Invest BMUB/UBA" model as predicted by hypothesis 12, but the estimation in the second model ("Full BMUB/UBA") does not confirm this relation (not significant). All models and variables indicate a significant relation of the level of someone's willingness to pay more for sustainability and someone's general level of related proenvironmental behavior on the decision to invest in RE projects (hypotheses 13 and 14).

Representing proenvironmental beliefs and an affinity for active citizenship at the same time, a membership in a NGO that advocates for the preservation and protection of the environment seems to be a strong indicator for a predisposition to investing in RE. In addition, being a member of any other cause-related group or club and doing honorary work in general also exhibit a positive association with the decision to invest in RE (hypothesis 15). A concern for the welfare of others seems to be related to the decision to invest in RE as well (hypothesis 16). While having donated money in the last year is not significantly correlated with RE investment decisions (not reported in Table 4), the decision to donate blood at some point in the last ten years exhibits a significant relation to the decision to invest in RE. Thus, different aspects of active citizenship and actions based on concern for others seem to be important characteristics of many private RE investors. Contrary, a general interest in politics does not show any significant connection to RE investing (not reported in Table 4).

Table 4. Logit estimation results

invest	Non-Invest BMUB/UBA	Full BMUB/UBA	Non-Invest SOEP	FullSOEP
Gender (male = 1)	5.399***	2.062***	3.479***	1.145
	(1.848)	(0.278)	(1.249)	(0.117)
Age	1.027*	1.010	1.002	0.997
	(0.013)	(0.005)	(0.015)	(0.004)
Married (together and separated)	0.431*	0.770	0.899	1.433**
	(0.157)	(0.116)	(0.315)	(0.178)
Children	4.449***	1.652***		
	(1.494)	(0.244)		
University degree	4.980***	1.985***	139.5***	4.316***
	(1.682)	(0.349)	(68.77)	(0.973)
Household net income	3.203***	1.597***	1.133	1.574***
	(0.546)	(0.115)	(0.159)	(0.072)
Community size	0.218***	0.683***	0.237***	0.578***
	(0.035)	(0.041)	(0.042)	(0.028)
Location: Southern Germany (Bavaria)	3.902***	1.345	8.363***	2.468***
	(1.256)	(0.216)	(2.555)	(0.282)
Member of church/religious group			1.041	1.212
			(0.368)	(0.137)
Risk tolerance regarding financial matters			1.420***	1.075**
			(0.090)	(0.024)
Environmental concern			2.182**	1.087
			(0.572)	(0.090)
Personal proenvironmental norms	2.164**	0.970		
	(0.643)	(0.117)		
Willingness to pay for ecological products	7.136***	2.913***		
	(2.165)	(0.356)		
Proenvironmental behaviors	2.443***	1.338***		
	(0.426)	(0.075)		
Minimize heating costs (proenv. behavior)			28.96***	2.718***
			(14.67)	(0.285)
Member of proenvironmental group			5.018***	1.872***
			(1.599)	(0.272)
Other group/organization or honorary work			12.92***	1.476**
			(6.507)	(0.184)
Blood donation (in last 10 years)			3.282***	1.850***
			(1.043)	(0.225)
Affinity with green party			3.224**	1.779***
			(1.147)	(0.219)
N	1,811	2,037	3,803	4,320
McFadden's R2	0.758	0.290	0.755	0.252

Note: ***, **, * indicate the statistical significance at the 0.001, 0.01, and 0.05 level, respectively. Coefficients represent odds ratios. The numbers in parentheses represent standard errors (also exponentiated).

4. Discussion

Despite a large congruence of the results, the different logit estimations do not coincide regarding all potentially influential sociodemographic and psychographic characteristics, and several aspects are important when assessing the results and the reliability of the models. It is unclear whether the RE investors in the BMUB/UBA sample, who are included in the “Full BMUB/UBA” regression model, are (at least nearly) representative for all German RE investors because the survey does not contain any additional information on their investments. On the other hand, while the SOEP sample includes a lot more observations than the BMUB/UBA dataset, one cannot identify (and filter) all RE investors in the SOEP dataset and only a fraction of the SOEP participants answered all questions that are relevant for this study. These constraints threaten the sample’s representativeness for the general population of non-investors. Overall, both datasets and thus the different estimations have unique advantages and constraints.

4.1. Individual non-financial characteristics of financial citizen participation in renewable energy

Despite the different sample characteristics, many sociodemographic and psychographic variables exhibit a significant relation with RE investment decisions across the different regression models and datasets which indicates that they might play a role in RE investment decision-making, concurring with the theoretical considerations and the conceptual model outlined in Section 1. Some of these findings are consistent with research on SRI in general, others seem to be more specific to RE investments.

First, contrary to the majority of studies on intangible SRI such as “green shares” or mutual fund investments, this study finds that German men are more likely to invest in RE projects than German women. Despite the fact that women generally have a high affinity for SRI, certain aspects of RE investments seem to appeal more to men than women—a potential area of improvement for people concerned with raising financing for RE.

Second, in line with conventional wisdom about SRI, the higher a person’s education and income are, the more likely he/she is to invest in RE. On the one hand, advanced knowledge and skills might be necessary to reliably assess the RE investment options. On the other hand, the environment of a higher social class might bring up more opportunities to invest in RE since, unlike stocks or mutual funds, investments of this kind are mostly not offered to a broader public audience on a stock exchange or via banks.

Third, even though people living in urban areas generally have more favorable attitudes towards environmental issues, the smaller the size of the community that someone lives in, the more likely he/she is to invest in RE. The high fraction of private RE investors living in more rural areas might be a result of their more immediate connection to and understanding of RE because of their proximity to more RE plants. In addition, farmers and foresters often own land that can be a potential site for wind or photovoltaics plants. The fact that people living in urban areas are underrepresented among RE investors, even though they are likely to be more ecologically aware consumers and to have favorable attitudes towards environmental issues, indicates unused potential for RE financing.

Fourth, similar to findings of research on more anonymous SRI, a high willingness to pay for ecological products and proenvironmental behavior in different domains of everyday life (e.g., energy usage and waste) exhibit an association with the predisposition to invest in RE. In addition, this study finds indications that strong personal proenvironmental norms which Stern et al. (1999) have shown to predict different types of environmentalism very well, following the Value-Belief-Norm Theory, seem to be a characteristic of private RE investors as well. Thus, investment behavior regarding RE projects might be based on similar values and beliefs and give people a similar “psychic return” (see Section 1.1) like other proenvironmental behavior or SRI. In line with the idea of a “psychic return”, 93% of the RE investors in the sample confirm that they “feel good” when investing in a SR project.

Fifth, people engaging in different forms of active citizenship to support social change also seem to have a positive stance on investing in RE projects. Both exhibiting a concern for the welfare of others and being part of a cause-related group are characteristics of active citizenship that show a positive association with the decision to invest in RE. Some research on SRI indicates a similar mindset of SR investors in general, but not necessarily the same specific correlational behavioral patterns. Overall, concurring with Rosen et al. (1991), the alignment of other proenvironmental behavior and indicators of active citizenship with RE investment behavior suggests that investing privately in RE is an extension of a person's way-of-life rather than a compensation for hedonism in other parts of his/her life.

4.2. Plausibility and limitations

The findings indicate that sociodemographic and psychographic variables are connected with private investment in RE. In general, while diagnostics suggest that the applied model is well specified (see Section 2.2.2), the possibility that the results suffer from missing or omitted variable bias cannot be ruled out.

First, as also suggested in the conceptual model, financial considerations are likely to play a role in the investment decision-making process as well (see, e.g., Bauwens, 2019; Nilsson, 2008). The model controls for risk tolerance in financial matters, but the financial view (e.g., return expectation) of the survey participants is not included in the analysis because the control samples do not comprise suitable items. However, only 12% of the RE investors in the sample fully agree with the statement that they have invested primarily due to financial reasons. Further, it can be argued that financial considerations might often not be a main driver—not in the past few years anymore at least—for German citizens to invest in RE because of the generally rather low rates of return vis-à-vis the project risk (Richter, 2013; Yildiz, 2014).

Second, while some significant relations might also be technology-dependent, the sample of RE investors is not large enough to conduct meaningful analyses for different subgroups depending on the RE technology. Nevertheless, to reflect the full range of German RE investors, all different RE technologies are included in the survey and analyzing the motivation to invest in RE with a sample comprising a wide range of RE technologies still yields meaningful results (Masini & Menichetti, 2012).

Third, using two separate control samples (SOEP and BMUB/UBA sample) is clearly inferior to using one fully integrated sample. But in order to analyze a large range of sociodemographic and psychographic variables, both datasets are necessary. A comparison of the estimations for independent variables that are part of both samples and thus included in all regression models, shows a very high congruence which is an indicator for robust results despite the lack of one integrated dataset. In addition, the comparatively large sample of German RE investors makes the analysis more robust in comparison to previous studies with smaller sample sizes (e.g., combined with the investors identified in the BMUB/UBA survey, the dataset comprises around 500 individual RE investors).

Finally, the findings cannot be generalized without limits in several respects. First, while there are rather robust results for a correlation of many sociodemographic and psychographic variables with RE investment decisions, one cannot directly generalize from correlations to causal effects (Bonsall et al., 2009). Similar to Stern et al. (1999) the author refrains from making claims about the causal ordering, but the main results are consistent with what was hypothesized and with previous findings. Second, the results concur with research on SRI in many regards, but there are also significant deviations (e.g., regarding gender). This illustrates that one cannot apply results from research on SRI in general to a specific field of SRI such as financial citizen participation in RE projects and vice versa without additional analyses. Third, Williams (2007) identified differences across countries regarding SRI, which may be associated with contextual differences. Thus, while the results should reflect the situation in Germany well, they cannot be transformed to other areas or cultures without further investigation.

4.3. Conclusion and implications

Many studies on proenvironmental behavior change focus on the psychological determinants and relations (causal or correlative) of intention, social norms, personal values and attitudes with behavior (Bonsall et al., 2009; Byerly et al., 2018; Dietz et al., 2005; Stern et al., 1999) to develop effective policies for proenvironmental behavior. Asking the question which individual characteristics of private RE investors (observably) differentiate them from the rest of the population, this study attempts to complement this research field with empirical insights on which socio-psychological factors are correlated with proenvironmental investment decisions in general and RE investment decisions in particular.

Only partially congruent with the existing research on SRI, this study finds that the typical German citizen who invests privately in RE—a hypothetical construct—is more likely to be male with a higher (household) income, to have a higher education, and to live in a more rural area compared with the rest of the population. In addition, the typical investor exhibits a high willingness to pay for sustainable products, strong personal proenvironmental norms and behaviors, and a predisposition for active citizenship or personal engagement. Furthermore, being well-informed or at least believing to be well-informed about the project and experiencing a positive feeling in general, i.e. some form of non-financial or “psychic return” from the investment, seem to be important for the investment decision.

Several important conclusions can be drawn from these results. Overall, it is important to be aware that socio-psychological variables can play a major role in an individual’s decision to invest in RE. A better understanding of the important sociodemographic and psychographic characteristics of retail RE investors helps policy makers to design more effective policies to increase the acceptance, deployment, and diffusion of RE technologies.

Private actors concerned with securing financing and support for RE projects can draw on the results to develop better tailored products, communication, and marketing by considering the sociodemographic and psychographic traits that were found to correlate with the decision to privately invest in renewable energy. In addition, this study’s results suggest that a stronger focus on women (because they generally have a high affinity for SRI), classes of lower income and education (e.g., with project and investment explanations without unnecessary complex technical terms, simple products, and low minimum investment amounts), and young urban citizens (because they generally have a high ecological awareness and might be susceptible to the right framing of an RE investment) could help to tap unused potential and further increase the diffusion of RE and financial citizen participation in RE.

In addition, this study confirms that providing sufficient information about the project, or at least making the investor feel well-informed, and a proenvironmental framing of such investments (as already frequently done) should facilitate retail investment. It seems important to communicate and offer such investments as an option to extend a certain lifestyle that comprises proenvironmental behavior and personal engagement rather than promoting it as a sort of selling of indulgences or an option to balance a hedonistic lifestyle (as often done by offers to offset the individual carbon footprint).

This study complements the existing literature on SRI and RE financing, but lays also the ground for further analyses of an individual’s motivation to invest in RE projects. Methodically, it would be beneficial to validate the results with a single integrated dataset and additional validated multi-item measures of environmentalism and active citizenship. As regards content and generalizability, adding even more control variables such as financial expectations and conducting similar analyses in other countries can further increase the reliability of the results and facilitate the understanding of national specifics.

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Competing interests

There is no potential conflict of interest to report.

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Notes

1. <https://www.unipark.com/en/>.
2. They are distinguished from sporadic survey participants who have not invested yet by explicitly asking whether the participant has already invested in a RE project.
3. The SOEP is one of the largest (>20,000 interviews in 2012, see Kroh & Siegers, 2014) and longest running (started in 1984) ongoing annual household panel studies in the world and covers topics ranging from economic conditions, work environment and household characteristics to health and everyday behavior (see Wagner et al., 2007 for details). It representatively covers the adult population, age 17 and older, living in Germany. Data from the SOEP used in this publication were made available by the German Institute for Economic Research (DIW), Berlin.
4. The study's center of attention is a representative survey of the adult population (>18 years age) in Germany in 2012 about the current state of environmental consciousness, attitudes in everyday life as well as the acceptance of environmental policy concerning present environmental and sustainability politics and topics (see BMUB and UBA, 2013 for details). The Institute for Social Innovation (Berlin) and the Philipps-University (Marburg) together led the study. TNS Emnid (Bielefeld) was in charge of the data collection with 2,000 interviews. The raw data is available for scientific research projects (Rückert-John et al., 2013).
5. See, e.g., Wooldridge (2013), pp. 560–563 for a general specification of the model and Escrig-Olmedo et al. (2013) for a discussion of the model's attributes with regards to SRI decision-making.
6. If one does not distinguish between RE investors and non-investors in the BMUB/UBA and SOEP samples, but simply use all of these observations as control groups, the results (not reported here) are essentially the same.
7. The religit package for Stata provided by Tomz et al. (1999) is used.

8. A binary variable for southern Germany (Bavaria and Baden-Wuerttemberg) shows similar results.

Data availability statement

- (1) The data from the German Socio-Economic Panel (SOEP) that support the findings of this study are openly available in the German Institute for Economic Research (DIW) repository at https://www.diw.de/en/diw_02.c.221180.en/research_data_center_soep.html.
- (2) The data from the biannual survey of the BMUB and the UBA that support the findings of this study are openly available in the gesis repository at <https://dbk.gesis.org/dbksearch/sdesc.asp?no=5693>.
- (3) The renewable energy investor survey dataset generated and analyzed during the current study is available from the corresponding author, Dominik Schall, upon on reasonable request.

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