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Individual Investors and Socially Responsible Investments – Attitudes and Preferences in the Context of Wind Energy Investments

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SUMMARY

This thesis deals with individuals' (retail investors') investments in renewable energies. The thesis investigates factors influencing individuals' attitudes towards investments in renewable energies, factors influencing individuals' intentions to invest in wind energy and individuals' preferences regarding different forms of direct wind energy investments.

All publications associated with this thesis are based on the same data, which were collected in June 2014. The target population was made up of German individuals aged 18 or above. Respondents were recruited using a sub-contracted market research company. A total of 18,736 adult panel users were invited to participate in the survey via e-mail. 11,726 individuals accepted the invitation. Exclusion of incomplete responses and respondents who had predictable answer patterns resulted in a final sample of 2,024 individuals, which was then used for the statistical analyses.

The first publication provides the main factors influencing individuals' attitudes towards investments in renewable energies. Individuals' attitudes are good moderators of individuals' intention to make renewable energy investments. This publication fills an existing research gap by contributing to the understanding of factors influencing individuals' investment behavior in renewable energies. Individuals' social norms, their confidence in NGOs, and their evaluation of the relevant regulatory framework are significant influencing factors of individuals' attitudes towards investments in renewable energies. Furthermore, it reveals that German retail investors can be separated into two groups, namely "Supporters" and "Skeptics", based on their attitudes towards investments in renewable energies.

Based on the results of the first publication the second publication examines individuals' investment intentions in a specific type of renewable energies, namely wind energy. To deepen the understanding of individuals' intentions to invest in wind energy the Theory of Planned Behavior was tested and expanded by two more constructs. In contrast to previous research the results indicate that the Theory of Planned Behavior is not the best framework to predict individuals' investment intentions in wind energy. But the extended model used in this publication turns to be very suitable. It is revealed that general factors may outweigh more specific factors at least in the context of investment intentions in wind energy since individuals' investment experience was found to be the best predictor for the behavioral intention. Further, an individual's subjective norm may be a better predictor for direct RE investments (e.g. wind energy production) than for indirect SRI investments (like e.g. energy saving behavior).

In order to examine the subject of the study in a holistic and complete manner, the third publication investigates individuals' preferences for different forms of direct wind energy investments. Therefore, computer-administered choice experiments are evaluated. The third publication reveals

that typical investment criteria like investment sum, investment term, and return on investment are the most important attributes for wind energy investments. The minimum investment amount necessary to enter into a specific wind energy investment is the most important attribute for retail investors and should be relatively low in order to increase the interest of potential individual investors but individuals with more financial resources are more willing to invest in wind energy in general. It is further revealed that individuals with more concern for the environment are more likely to invest in wind energy and they even seem willing to accept financial disadvantages for environmentally-friendly investment projects.

The results of this thesis make a valuable contribution to a better understanding of individuals' investment behavior in the context of renewable energies. This understanding is of great relevance to politics and market actors and can serve as the basis for further research in countries where there is both a political or an individual interest in supporting the diffusion of renewable energies with financial investments. By shedding light on the attitudes of private individuals with respect to renewable energies, their investment intentions and their investment preferences in wind energy this doctoral thesis further contributes to the corresponding scientific literature.

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LIST OF ABBREVIATIONS

ACBC	Adaptive choice-based conjoint analysis
BYO	Build Your Own
CPI	Climate Policy Initiative
CE	Conjoint experiment
EU	European Union
EVI	Electric Vehicles Initiative
GWEC	Global Wind Energy Council
IEA	International Energy Agency
NGO	Non-governmental organization
PLS	Partial-Least-Squares
RE	Renewable energies
SEM	Structural Equation Modeling
SRI	Socially responsible investments
UNFCCC	United Nations Framework Convention on Climate Change
USSIF	US Forum for Sustainable and Responsible Investment

1 Introduction

1.1 Socially responsible investments

A recent study examining global consumption patterns revealed that approximately 50 % of consumers are concerned about the environmental sustainability of their consumption (Nielsen 2014a). It was further shown that these concerns have a significant influence on individuals' purchasing behavior (Nielsen 2014a). The social and environmental consequences of individuals' consumption patterns are becoming increasingly important for consumer decisions and this is considered to be one of the most important trends in consumption behavior (Otto GmbH & Co KG 2013a). This trend mainly affects the markets for socially responsible products, which are growing worldwide across all sectors (eurostat 2015a; Fairtrade International 2014; OECD/IEA 2015).

Initially, this trend was predominantly limited to Fair-trade-food, which now has a global market volume of $5.5 billion annually (Fairtrade International 2014). These days, however, there are hardly any sectors which are not affected by the growing importance of the social and environmental consequences of individual consumption patterns (Fairtrade International 2014). For example, the market share of green energy rose from 8.5 % in 2004 to 16 % in 2014 in the EU (eurostat 2015a). The number of electric vehicles increased by 95 % from 2014 to 2015 in Electric Vehicles Initiative (EVI) countries[1] (OECD/IEA 2015). Recent market data indicate that this trend is not only limited to socially responsible consumption. Consumer ethics is developing into a holistic business ethic, which expects companies to act holistically and in a socially responsible and ethical manner (Otto GmbH & Co KG 2013a).

Socially motivated investments in ethical companies are becoming more and more common in the financial sector. Such investments are commonly known as socially responsible investments (SRI) but are also referred to as ethical, sustainable, or socially conscious investment. SRI is an investment strategy which complies with ethical, social, environmental or corporate governance criteria (Sandberg et al. 2009b). The US Forum for Sustainable and Responsible Investment[2] (USSIF) defines SRI as an "*investment discipline that considers environmental, social and corporate governance criteria to generate long-term competitive financial returns and positive societal impact*" (US Forum for Sustainable and Responsible Investment 2016).

[1] EVI countries: Canada, China, Denmark, France, Germany, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, UK, US

[2] USSIF is a nonprofit organization with the mission of rapidly shifting investments practices towards sustainability as well as focusing on long-term investment and the generation of positive social and environmental impacts.

The number of sustainable investment assets globally has expanded substantially in recent years. The SRI-sector increased from $639 billion in 1995 to $2.29 trillion in 2005, which amounted to an increase of 258 % (Global Sustainable Investment Alliance GISA 2015). This fast growth rate is far from ending. The continued interest of market actors in SRI led to a 61 % increase in global sustainable investments between 2012 and 2014, reaching a total of $21.4 trillion (Global Sustainable Investment Alliance GISA 2015). This increase even outpaced growth of professionally managed assets globally. A global trend away from classical investment strategies towards more socially responsible investment has been observed and is likely to continue into the near future. The relative contribution of worldwide SRI assets by the United States increased to 30.8 % from 28.2 % in 2012. Europe, however, is still the market leader with a global market share of 63.7 %. In 2013, €9.8 trillion were invested in sustainable investments in EU 13[3]-countries including Germany, which has one of the biggest SRI-markets, with total investments of €897 billion in 2013 (Eurosif A.I.S.B.L. 2014b).

1.2 Renewable energy investments

The 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) contains binding targets for the reduction of greenhouse gas emissions in industrialized countries, which aim to slow down global warming and mitigate its consequences (UNFCCC 2015b). The Kyoto Protocol is an important first step in reaching the global climate targets of the UNFCCC (2015c).

In December 2015, all 196 parties to the UNFCCC adopted by consensus an additional instrument referred to as Paris Agreement which aims to reach the following goals:

- Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.
- Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production.
- Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

In order to reach the minimum goal of keeping global warming below 2 °Celsius, $39 trillion worth of cumulative investments will be required by 2035 (International Energy Agency 2014a). Even more

[3] EU 13: Austria, Belgium Finland, France, Germany, Italy, Netherlands, Norway, Poland, Spain, Sweden, Switzerland, United Kingdom

investments will be necessary in future if the temperature increase is to be limited to 1.5 °Celsius above pre-industrial levels. Many of these investments will fall within SRI investment strategies, also referred to as sustainability themed investment. These cover various sectors from forestry and water supply to climate change, energy efficiency and renewable energies (RE) (Eurosif A.I.S.B.L. 2014b).

Worldwide, average annual investments in RE between 2000 and 2013 were $153 billion .The International Energy Agency (IEA) estimates that further investment of $9 trillion in renewable energies will be necessary by 2035 (International Energy Agency 2014a). In EU 13, sustainability themed assets increased by 11 % per year from 2011 to 2013, reaching €59 billion (Eurosif A.I.S.B.L. 2014b). If one considers a longer time scale, the growth rate of investment is even more impressive. Since 2005, these investments have grown on average 30.7 % per annum in EU 13 (Eurosif A.I.S.B.L. 2014b). The increase in RE investments in the EU is predicted to continue according to IEA as further investments of $1.5 trillion are needed by 2035 (2014a). Between 2005 and 2015, investors poured over €150 billion into renewable energy in Germany alone (Climate Policy Initiative 2016b). The Climate Policy Initiative (CPI) argues that there is still a huge need for annual investment of approximately $15.5 billion in renewable energies in Germany in the coming decades (Climate Policy Initiative 2016b).

1.3 Wind energy investments

A particularly important part of RE investments is the wind energy sector. Wind is a renewable source of energy and can be used worldwide. It has other advantages too. First, wind turbines achieve a positive energy balance within three to seven months of installation. For the remaining operating period, the energy balance grows positively, something which is not possible for fossil fuels, which require continual energy inputs (Agentur für Erneuerbare Energien e.V. 2016). Second, wind energy contributes the most (40%) to reducing greenhouse gas emissions of all types of electricity generation, giving it a positive environmental balance (Agentur für Erneuerbare Energien e.V. 2016). Third and probably most important from an investor's perspective, the costs of electricity produced from wind energy are comparably low (e.g. €6.7 ct/kWh in average in Germany) while returns on investment can be e.g. 8% per year (Lüers et al. 2015).

According to the Global Wind Energy Outlook (Global Wind Energy Council 2014), global investments in wind energy reached $44 billion in 2013. According to a "Moderate" scenario[4]

[4] The Moderate scenario takes into account "all policy measures to support renewable energy either already enacted or in the planning stages around the world, and at the same time assuming that the commitments for emissions reductions agreed by governments at Cancun will be implemented, although on the modest side. At the same time it takes into account existing and planned national and regional targets for the uptake of renewable energy in general and wind energy in particular, and assumes that they are in fact met." (Global Wind Energy Council 2014)

proposed by the Global Wind Energy Council (GWEC), wind energy investments will steadily increase in future, starting at $80 billion in 2020 and reaching an annual value of $186 billion in 2050 (Global Wind Energy Council 2014). In another more advanced scenario, the GWEC assumed a stronger increase in annual wind energy investment, which would result in investments valued at $249 billion per year by 2050 (Global Wind Energy Council 2014). In Europe, the total amount of assets invested in wind energy from 2011 to 2012 was $17 billion according to the IEA (2014a). The IEA assumes a need for future cumulative wind energy investments totaling $727 billion by European countries by 2035 (International Energy Agency 2014a). For the German market, the CPI projects the need for $11 billion ($7 billion onshore; $4 billion offshore) annual investment in wind energy, which would represent approximately 70 % of the total investment needed in renewable energies in order for Germany to meet its renewable energy targets (Climate Policy Initiative 2016b).

Overall, it can be concluded that further investments in renewable energy and especially in wind energy production are necessary to reach global climate targets. The required investments can be provided by the public sector, e.g. through taxation and government expenditure, or by the private sector (Gamel et al. 2016c). Private finance from individuals has already provided an important source of finance for RE projects and specifically for wind energy (trend:research 2011b). For example, private households contributed a significant share of global climate finance in 2012, with investments of $33 billion in RE (Climate Policy Initiative 2013a).

1.4 Research subject

As shown above, further investments in energy efficiency and especially in RE are necessary in order to reach global climate targets. The private sector can play an essential role in providing the necessary financial resources in future (Ameli, Brandt 2015) because the investment sums needed cannot be provided through government investments alone. In recent years SRI investments have been predominantly driven by institutional investors. In the EU, about 97% of SRI is conducted by institutional investors, with the interest among retail investors (private consumers) is still low with only 3% (Eurosif A.I.S.B.L. 2014b). But this low share of retail investors offers a high potential in order to provide the high investment sums necessary in future. Therefore, it is interesting and necessary to investigate individuals' decision-making behavior with respect to RE investments and more specifically in wind energy.

Research on RE investments is considered necessary by an increasing number of academics. However, scientific literature provides only limited insights into individual decision-making behavior with regards to RE (Adam, Shauki 2014b). Academics agree that individual decision-making is not only influenced by financial goals but also by various additional factors (East 1993b; Hofmann et al. 2008b). The study of Nilsson (2008a) examined the impact of pro-social attitudes and

perceived financial performance. The study of Glac (2009c) provided empirical evidence that individuals' attitudes and perceptions toward sustainable investments have a significant influence on their decision-making behavior. However, further research is required in order to gain a thorough understanding of the predictors of individuals' attitudes towards RE investments so that this type of investment can be promoted (Adam, Shauki 2014b; Gamel et al. 2016c). Chapter 3.1 of this thesis concentrates on the following research question:

(I) WHAT ARE THE MAIN FACTORS INFLUENCING INDIVIDUALS' ATTITUDES TOWARDS RE INVESTMENTS?

Socially responsible investment is an investment strategy which complies with ethical, social, environmental or corporate governance criteria and provides various investment alternatives. A common SRI strategy is to invest in RE production or more specifically in wind energy. In the field of financial investment behavior in SRI, a large number of studies have already been conducted which deal with both institutional and market professionals' behavior on the stock market (Lim et al. 2013b; Pascual-Ezama et al. 2013b). There are, however, very few studies examining the intention of individuals to invest in SRI. Most of the existing studies examine SRI generally without focusing on a specific technology (Adam, Shauki 2014b) or use typical behavioral decision theory without extending the established framework to gain information about other factors that may influence decision making (Korcaj et al. 2015b). Moreover, there are no studies which have investigated the factors influencing individuals' intentions to invest in wind energy production, even though wind energy investments will represent the highest global investments (onshore $1,429 billion; offshore $560 billion) by 2035 (International Energy Agency 2014a) and individuals are expected to provide a substantial share of the financial resources needed (Wüstenhagen, Menichetti 2012b). Thus, further investigation is needed to gain a better understanding of the factors influencing individuals' intentions to invest in wind energy (Williams 2005b; Glac 2009c). Chapter 3.2 of this thesis focuses on the following research question:

(II) WHAT ARE THE MAIN FACTORS INFLUENCING INDIVIDUALS' INTENTIONS TO INVEST IN WIND ENERGY?

The scientific literature provides only limited insights into individual investment behavior in SRI as it applies to individual investment preferences in wind energy projects. Although studies investigating individuals' investment preferences exist, these studies focus on either individual preferences in stock markets and shares, or they focus on non-financial aspects of SRI e.g. effects on landscape, wildlife and air quality or the political aspects of RE production (Ku, Yoo 2010b; Lüthi, Wüstenhagen 2012a). So far there is no scientific literature which investigates individual preferences in direct wind energy investments. Insight into the influence of individual psychological characteristics on their preferences with respect to wind energy investments could be of particular

interest, particularly in the development of new investment products. Chapter 3.3 of this thesis deals with the following research question:

(III) WHICH ATTRIBUTES OF DIRECT WIND ENERGY INVESTMENTS ARE OF PARTICULAR IMPORTANCE TO PRIVATE INDIVIDUALS?

2 Conceptual model and methodical approach

2.1 Conceptual model

The conceptual research presented in Figure 1 was derived from the scientific literature. In a second step, the framework was empirically cross-checked through 10 expert interviews, which were conducted with financial service providers, renewable energies consultants and renewable energy project developers.

The research framework consists of three stages, with each one serving to answer one of the research questions presented in chapter 1.4. The first stage (Publication 3.1) examines the factors influencing individuals' attitudes towards RE investments. This stage relates to research question I: WHAT ARE THE MAIN FACTORS INFLUENCING INDIVIDUALS' ATTITUDES TOWARDS RE INVESTMENTS? Six variables were included in the theoretical framework: evaluation of the regulatory framework, confidence in politicians, confidence in non-governmental organizations (NGOs), social norms, risk aversion and attitudes towards RE investments. The model assumes that individuals' attitudes towards RE investments are influenced to various extents by these variables.

The second stage (Publication 3.2) analyzes individuals' investment intentions in a specific type of RE, namely wind energy. This stage intends to answer research question II: WHAT ARE THE MAIN FACTORS INFLUENCING INDIVIDUALS' INTENTIONS TO INVEST IN WIND ENERGY? The Theory of Planned Behavior (TPB) was used as a theoretical model. It was extended using two additional variables, which were included as a result of both the literature review and the expert interviews. The three variables of the TPB (subjective norm, perceived behavioral control, attitude) and the two additional variables (consumption profile, investor profile) are shown in Figure 1. The model assumes that an individual's intention to invest in wind energy is affected to various extents by these variables.

The third stage (Publication 3.3) examines individual preferences with respect to wind energy investments. It is assumed that an investment intention (second stage; Publication 3.2) leads to actual investment behavior but this assumption is not tested in this thesis. The third stage relates to research question III: WHICH ATTRIBUTES OF DIRECT WIND ENERGY INVESTMENTS ARE OF PARTICULAR IMPORTANCE TO PRIVATE INDIVIDUALS? A conjoint experiment (CE) was performed to evaluate various investment attributes identified from the literature and the expert interviews. These attributes are shown in the lower section of the diagram in Figure 1 and include: investment amount, term, return on investment, location, exit option, participation, repayment, issuer, and experience.

It is argued that the three stages of the conceptual framework presented in Figure 1 are necessary to gain a comprehensive understanding of individuals' attitudes towards RE investments, their intention

to invest in wind energy, and assuming that an investment actually takes place, their preferences for different types of wind energy investments.

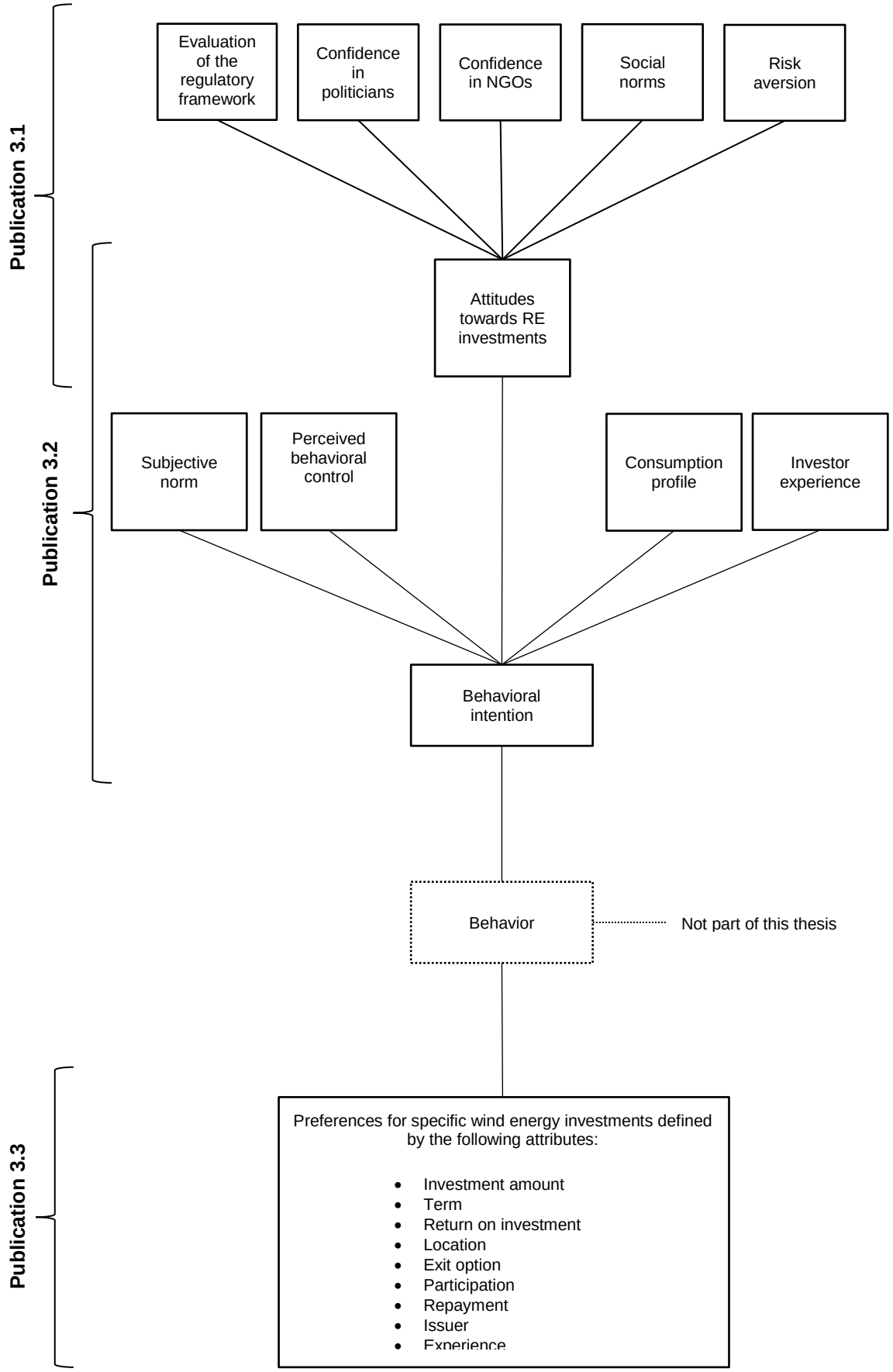

Figure 1: Conceptual framework of the thesis

2.2 Research design

A fundamental step in developing a scientific study is the research design (Yin 2003). A well-structured research design can minimize measurement errors and enhance the robustness of the results (Maxim 1999). Yin (2003) states that the research design is "*a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered and there is some set of conclusions about these questions*". In this thesis, the research design is the guideline for the three research questions presented in chapter 1.4. Due to the complexity of the research questions a combination of qualitative and quantitative methods was considered to be most appropriate.

The first phase of the research included screening and a systematical analysis of the available literature and information from scientific papers, professional journals, educational books, news magazines and online documents. Special attention was dedicated to the review of literature pertaining to renewable energy and behavioral finance in order to identify the main variables which would have to be investigated.

The second phase of the study involved expert interviews with selected financial service providers, consultants on renewable energies and renewable energy project developers, which validated the insights gained from the literature analysis. For the interviews with the market professionals, an interview guide with mostly open questions was developed. They were asked to list and explain (1) the essential factors influencing individuals' attitudes towards RE investments; (2) the main factors influencing individuals' intentions to invest in RE; (3) the most important attributes for private investments in wind energy projects. The interviews were recorded with a voice recorder and the audio files were then transcribed and evaluated using the qualitative data analysis software MAXQDA (Kuckartz 2012). At the same time, access to a database of survey recipients was gained by subcontracting a market research company.

In the third phase of the study, a preliminary version of the web-based questionnaire was tested with a limited sample of respondents fitting the target group. This pre-test was necessary to determine whether the questionnaire included redundant or misleading questions, the instructions were well formulated, the scales used were sufficiently differentiated, and the framework texts were understandable. The web-based questionnaire was subsequently adjusted, put online and distributed to a representative sample of the German population in order to collect the data.

The fourth phase of the research included the data analysis, which was done by way of a multiple regression analysis, structural equation modeling, and an adaptive conjoint analysis. All statistical methods are described in more detail below. The results were published in international scientific journals and presented at national and international conferences.

2.3 Survey instrument

2.3.1 Data collection

All publications associated with this thesis are based on the same data, which were collected in June 2014. Questionnaires need to reach the target population, and they should be easy for participants to understand and fill out. For this reason, an online questionnaire was chosen, especially as a clear majority of the population in Germany has continuous access to the internet (Statistisches Bundesamt 2015a). Online surveys offer a more flexible and faster way of collecting data, and they are more cost effective than traditional written surveys. Web-based access panels can also be advantageous as the respondents are more experienced at participating in such surveys and can be regarded as giving more precise and truthful answers (Dillman et al. 2009a).

The target population was made up of German individuals aged 18 or above. These people are legal adults and can apply for and use bank accounts in Germany[5]. To ensure that participants had basic understanding of financial investments, respondents' investment portfolios had to include real[6] or monetary[7] values at the time the survey was conducted. Very conservative financial products[8] in the investment portfolio also led to exclusion from the survey. Respondents were recruited using a sub-contracted market research company with a panel of 70,000 active users (100,000 total users). The panel users were recruited though social media marketing, search engine marketing, on-site surveys, and mingle Blogs as well as through affiliate partner companies. As an incentive, participants received compensation for participating in the survey, the amount of which depended on the time needed to complete the questionnaire. A total of 18,736 adult panel users were invited to participate in the survey via e-mail. This email did not include any indication of the survey topic. 11,726 individuals accepted the invitation. Exclusion of incomplete responses and respondents who had predictable answer patterns resulted in a final sample of 2,024 individuals, which was then used for the statistical analyses.

2.3.2 Characteristics of the sample

Each publication (cf. chapter 3) was based on a different subsample of the online-survey described above. Publication 3.1 investigates individuals' attitudes towards RE investments and was based on the sample including all 2,024 respondents. Publication 3.2 examines factors influencing individuals' intention to invest in wind energy. The conceptual framework (cf. Figure 1) and the variable

[5] Vgl. Bürgerliches Gesetzbuch §§ 676 f bis 676 h
[6] Property, shares, open equity funds, closed equity funds, real estate funds, raw materials, precious metals.
[7] Fixed-income securities, bonds, balanced funds, warrants, certificates.
[8] Fixed-term deposit, savings bond, savings book, savings plan, call money account.

Perceived behavioral control was measured partly based on individual financial resources. Only those individuals who voluntarily provided information about their financial assets were considered to be useful and therefore publication 3.2 was based on a subsample of 592 individuals. Publication 3.3 examines individuals' investment preferences for wind energy investments. In order to ensure that the intention to invest in wind energy was realistic, participants had to intend to invest in wind energy projects within the next three years. Publication 3.3 was therefore based on a subsample of 725 respondents.

2.3.3 Measurement scales

All scales used to measure the variables presented in Figure 1 are based on the literature and the information obtained from the expert interviews with financial service providers, renewable energy consultants and wind energy project developers. The variables and the corresponding statements are presented in Table 1.

The construct for conceptualizing individuals' confidence consists of two components, namely the affective component and the competence component of confidence. The variables *Confidence in politicians* and *Confidence in NGOs* were therefore operationalized using two statements that measured the affective component and the competence component of confidence. In order to operationalize the variable *Social norms*, a set of three statements were adapted from previous studies (Hofmann et al. 2008b; Knussen et al. 2004b). *Risk aversion* was measured based on a set of four questions from a questionnaire on investment typology developed by the German investment company "DekaBank" (2015b). The variable *Evaluation of the regulatory framework* was measured using a set of three statements which was developed based on information from the expert interviews. For the variable *Attitudes towards RE investments*, participants had to value a set of six statements regarding social and ethical investments particularly in renewable energies. These statements were also developed based on information given in the expert interviews. The variable S*ubjective norm* was operationalized by a set of six statements adopted from previous studies (Knussen et al. 2004b; Hofmann et al. 2008b). *Consumption profile* was measured using a set of six statements which define the Green Consumer Value according to Bearden et al. (2011b). To measure the variable *Behavioral intention*, respondents had to answer two statements about their intention to invest € 3,000 or € 12,000 in wind energy within the next 12 months. For all variables, answers were provided on a 5-point-Likert scale ranging from 1 to 5, corresponding to totally agree to totally disagree or most likely to very unlikely.

The variable *Perceived behavioral control* was operationalized through two items. First, individuals' financial resources were determined by asking participants to indicate the amount of their assets. The measurement scale was adopted from the German Federal Statistical Office (DESTASIS 2015a) and

included six levels ranging from less than 2,500 € to more than 500,000 €. The second item measured the extent to which an individual notices investment opportunities. Respondents were asked whether they had noticed a concrete opportunity to invest in wind energy in the past. The scale of this variable was nominal with answers including only “yes” or “no”.

The variable *Investor experience* was operationalized by two items. The first one elicited whether respondents had already made investments in renewable energies using a nominal scale with “yes” and “no”. The second item investigated individuals’ self-declared knowledge of financial products using a 4-point-Likert scale ranging from 1 to 4, corresponding to no experience through to a lot of experience. The measurement scale and the wording of the statements of this variable were adopted from a questionnaire on investment typology from the German investment company “DekaBank” (2015b).

Variables and statements	Source
Confidence in politicians • Local politicians always act credibly in terms of SRI. • Federal politicians always act credibly in terms of SRI. • Local politicians are very competent in terms of SRI. • Federal politicians are very competent in terms of SRI.	Steimer 2011; Siegrist et al. 2003b; Rösch, Kaltschmitt 1999b
Confidence in non-governmental organizations • NGOs always act credibly in terms of SRI. • NGOs are very competent in terms of SRI.	Steimer 2011; Siegrist et al. 2003b; Rösch, Kaltschmitt 1999b
Social norms • Most of my friends would invest in sustainable investments. • Most people who are important to me think that sustainable investments make sense. • My family members consider it important that parts of their assets are invested in sustainable projects.	Hofmann et al. 2008b; Knussen et al. 2004b
Risk aversion • The risk of losing money on the stock market causes me mental stress. • Stability and continuity of my investments are more important to me than the chance of a quick profit. • Even small financial losses make me nervous. • I am reluctant to take risks regarding financial matters.	DekaBank 2015b
Evaluation of the regulatory framework • Renewable energies have to be the main power source within a collective European electricity market. • The federal government should make a clear commitment to the implementation of the energy transition. • The guaranteed fixed feed for electricity from renewable energies (feed-in tariff) has to be continued.	Based on information provided during the expert interviews
Attitudes towards RE investments • When investing, it is important to me to invest in ethically correct companies. • Investments should be ethically and morally acceptable. • When investing, I pay attention to the environmental friendliness of companies and projects. • When investing, I would reject higher returns in favor of sustainability aspects. • Investments should be scrutinized for their environmental compatibility. • When investing in a company, it should be ecologically harmless.	Based on information provided during the expert interviews

Subjective norm • Most of my friends think positively about wind energy. • Most people who are important to me would approve of the construction of a wind turbine • My family members are disturbed by the view of a wind turbine. • Most of my friends would invest in sustainable investments. • Most of the people who are important to me think that sustainable investments make sense. • My family members consider it important that some of their assets will be invested in sustainable projects	Hofmann et al. 2008b; Knussen et al. 2004b
Consumption profile • It is important to me that the products I use do not harm the environment. • I consider the potential environmental impact of my actions when making many of my decisions. • My purchase habits are affected by my concern for our environment. • I am concerned about wasting the resources of our planet. • I would describe myself as environmentally responsible. • I am willing to be inconvenienced in order to take actions that are more environmentally friendly.	Bearden et al. 2011b
Behavioral intention • I intend to invest approximately 3,000 € in wind energy within the next 12 months. • I intend to invest approximately 10,000 € in wind energy within the next 12 months.	Ajzen 2011b
Perceived behavioral control • What is the value of your assets? • Have you noticed investment offers in wind energy within the previous 24 months?	DESTASIS 2015a; Parker et al. 1992a
Investor experience • Have you ever invested in renewable energies before? • What knowledge or experience do you have in the field of real assets (e.g. shares, open equity funds, precious metals)?	DekaBank 2015b

Table 1: List of all variables and corresponding statements

2.3.4 Questionnaire structure

The purpose of the questionnaire was to elicit individuals' attitudes towards RE investments, the influencing factors on their intention to invest in RE, and their preferences for wind energy investments through adaptive conjoint analysis. Valid psychometric measurements based on Likert-scales were used, with the scales being derived from the literature and double-checked on the basis of information obtained from expert interviews. The questionnaire included four main sections. The

first section was aimed at determining the spread of the demographic variables of gender and age as well as examining the selection criteria for publication 3.1 and 3.3 (cf. chapter 3).

The purpose of the second section was to assess the variables presented in Table 1. Thus, respondents' confidence in politicians and their confidence in NGOs were evaluated. The second section continued by investigating the respondents' risk aversion, evaluation of the regulatory framework, consumption profile, intention to invest in wind energy, investment experience, social norm, and the subjective norm, which refers to the perceived social pressure to perform or not to perform the behavior in question (Ajzen, Fishbein 1980b).

The third section was dedicated to eliciting respondents' preferences for direct wind energy investments using adaptive conjoint analysis (cf. chapter 2.6). Respondents were asked to compare a number of alternative wind energy investments with various levels of the selected attributes (cf. Table 2). To ensure that only the most relevant attributes were included in the experiment, the attributes were selected based on the results of the literature review and the expert interviews. Before the computer assisted conjoint experiment begun, detailed instructions were presented to all participants. Furthermore, the participants were asked to imagine themselves to be in a fictitious situation. At the beginning of the experiment, respondents had to create their most preferred wind energy investment product. In the second step, various product concepts (hypothetical investments based on the first section) were presented to the respondent in groups of three. The participants were then asked to indicate which of the three products they would consider to be a possibility for investment or not. In the last step, all concepts rated as "a possibility" were presented in choice-groups of three and the respondents had to indicate their most favored option. In this step, the winning alternatives were measured against each other until the preferred concept was identified.

Finally, in section four, the questionnaire included a series of socio-demographic questions covering respondents' educational background, job position, household income, household size and place of residence.

Attribute	Description	Levels
Investment	The minimum investment amount in € to enter the offer	500 € 3,000 € 10,000 € 50,000 €
Term	The duration of the investment offer in years	3 years 7 years 10 years 20 years
ROI	Return on investment per year	2.5 % 5.5 % 8.5 % 11.5 %
Location	Distance of the investment object (wind turbine) to the customer	Neighborhood (radius of 5km) Region (radius of 30km) Germany (outside 30km radius) Outside Germany
Exit	Possibility to exit the investment during the duration	Possible at any time Possible after the first year Possible from the mid-term Not possible
Participation	Investor participation in firm´s decision making process	One voice per stakeholder Weighted on business assets No voting rights (no participation)
Repayment	Date of the first payment return	After the first year After the third year At the mid-term At the end of the term
Issuer	Type of institution offering the investment	Citizens' cooperative Regional company/bank Nationwide company/bank National/international fund
Experience	The level of experience of the company in charge of implementing the investment	New entrants on the market (no experience) Recently entered the market (little experience) Established on the market (extensive experience)

Table 2: Attributes and attribute levels in the CE experiment

2.4 Multiple regression analysis

Multiple linear regression analysis was used to test research question (I) "WHAT ARE THE MAIN FACTORS INFLUENCING INDIVIDUALS' ATTITUDES TOWARDS RE INVESTMENTS?". Regression analysis is one of the most widely used statistical methods and is applicable in several domains of business decision making (Hair 1998b). A linear multiple regression analysis is a useful statistical technique to analyze the relationship between a single dependent (criterion) variable which is thought

to be related to two or more independent (predictor) variables. Regression is able to determine the probability that an inference can be accepted as it predicts changes in the dependent variable in response to changes in the independent variables (Menichetti 2010a).

The regression equation is designed to identify unknown parameters and values. The goal of the formula is to minimize the sum of the square vertical distances among the observed values within the predicted value. The formula is:

$$Y = \beta_0 + \beta_1 * X_1 + \beta_2 * X_2 + \ldots + \varepsilon$$

where Y is the metrically scaled dependent variable predicted by the independent variables. $X_1, X_2, \ldots, X_n$ are the predictor variables, while β defines a constant term. ε represents an error term which adjusts the gap between the predicted score and the actual score. Predicted values tend to be not exact.

In principle, multiple regression analysis should only be used when both the dependent and independent variables are metric. The variables used in this thesis were measured using Likert-scales, which yield ordinal data. However, in the literature it is argued that Likert-scales can be interpreted as quasi-metric and therefore can be used for multiple regression analysis (Backhaus et al. 2016). As with other multivariate techniques, regression analysis is a very useful tool for conducting theoretically significant research, and for analyzing the effects of naturally occurring parametric variations in the context they usually appear (Hardyck, Petrinovich 1976). Regression analysis is flexible and therefore can be used for predictive as well as for explanatory purposes. It allows quantitative estimation of the strength and character of the relationship between the dependent variable and the independent variables. It indicates the relative importance of each independent variable with respect to prediction of the dependent variable. Finally, it defines the dimension and direction (positive or negative) of the relationship between each independent variables.

Some conditions must be met before a regression analysis can be used. First, the independence of the residuals has to be assessed using the Durbin-Watson statistic (Field 2013a). According to Field (2013a), values between 1 and 3 indicate that the residuals are independent. Additionally, Cook's distance has to be smaller than 1, otherwise multivariate outliers exist. When testing for multicollinearity, VIF-values lower than 10 are acceptable. Before running the regression analysis in this study, all statistical requirements were tested and met.

The explained variance R^2 refers to the proportion of the variance of the dependent variable about its mean which can be explained by the independent variables (Hair 1998b). The adjusted R^2 considers the phenomenon that R^2 increases automatically when further explanatory variables are added to the model. This is especially useful for comparing R^2 values among models based on different samples or with different numbers of independent variables.

2.5 Structural equation modeling

Structural Equation Modeling (SEM) was used to test research question (II) "WHAT ARE THE MAIN FACTORS INFLUENCING INDIVIDUALS' INTENTIONS TO INVEST IN WIND ENERGY?". SEM is a well-established estimating technique which has been used widely in the economic and social sciences since the early 1970s (Schöps 2013b). SEM was successfully adopted by previous studies for the evaluation of cause-effect relationships in diverse areas such as the success of corporate governance (Henseler 2005b) and image research in marketing. SEM enables relationships among multiple independent and dependent constructs to be modeled simultaneously (Ringle, Spreen 2007b; Gefen et al. 2000a) in a single, systematic and comprehensive analysis. Today, SEM is considered to be a standard for the exploration of complex relationships between latent variables and expands well-established multivariate statistical methods like regression-, variance-, and factor analysis (Huber et al. 2007b).

SEM distinguishes between manifest and latent variables. Manifest variables are those that can be directly measured (e.g. age) and the relationships between manifest variables can be calculated. Latent variables, in contrast, are not directly measurable and have to be captured using suitable indicators (Bortz 2005). There are two main procedures for using latent variables in SEM: covariance-based modeling [9] and variance-based modeling which uses a partial least squares (PLS) estimation to predict the values of the output data matrix (Wold 1966). Both procedures can be referred to as second generation multivariate analysis (Fornell 1982). As described in chapter 3.2 of this thesis, PLS path modeling was used to examine the factors influencing individuals' intentions to invest in wind energy production. Therefore, the focus of this chapter is on PLS path modeling. PLS path models consist of two sub models, namely the measurement model and the structure model (cf. Figure 2).

2.5.1 The measurement model

The measurement model (external model) specifies how many latent variables ξ_j are associated with the manifest variables χ_{jh}. The evaluation of these latent variables is possible through the use of reflective and/or formative measurement models.

In the case of reflective constructs, the values of the observable variables are caused by the latent variable (Hair 2014b). The assumption is made that changes in the unobservable variable cause changes in all observed indicators equally. In addition, the indicators should have the same parent content or at least a common theme (Huber et al. 2007b).

[9] For detailed information see Weiber, Mühlhaus 2010a

In contrast to the reflective model, the essential feature of a formative measurement model is an inversed direction of influence. In the case of formative constructs, the observable variables cause the latent variable (Huber et al. 2007b). Thus, there is no need for the indicators of a formative construct to measure the same content or to have a common theme (Hair 2014b).

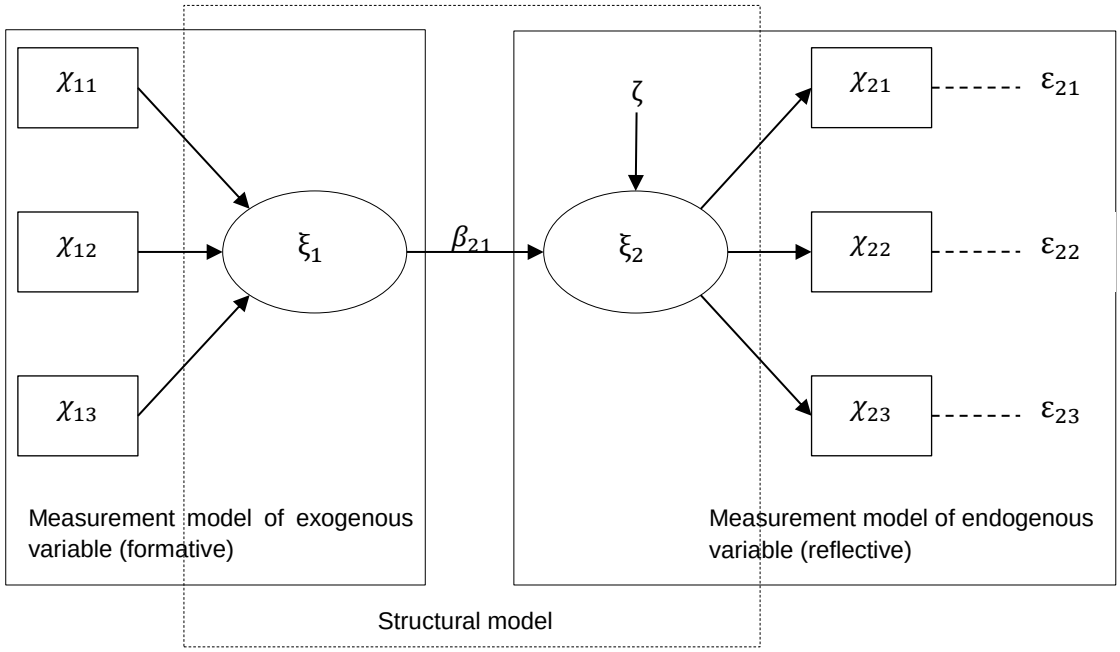

Figure 2: Structural model with two latent variables

Figure 2 is compiled by the author and based on (Ringle 2004)

2.5.2 The structural model

The structural model (inner model) describes the relationship between the latent variables. A latent variable which is not influenced by another latent variable is referred to as exogenous. A latent variable which is influenced by another latent variable is referred as endogenous. A necessary condition to apply SEM is recursiveness, which implies that it is illegitimate to model arrow chains starting from a latent variable either directly or indirectly through other variables to the original latent variable. The strength of the relationships is described by the path coefficients γ, which can assume values between -1 and +1. Values close to -1 and +1 indicate a strong positive or negative relationship respectively between the indicators and constructs, whereas values close to zero indicate a weak or no relationship.

According to Schloderer et al. (2009b) the formulation of the structural model is:

$$\eta = \eta * B + \xi * \Gamma + \zeta$$

where η defines the endogenous (independent) latent variable and $\eta * B$ represents the relationship between the latent endogenous variables. ξ defines the exogenous (independent) variable and $\xi * \Gamma$ refers to the relationship between the endogenous and exogenous variables. ζ is the error term, which describes the unexplained variance.

2.5.3 The PLS estimation algorithm

The PLS estimation algorithm can be described in three stages. In the first stage, the construct values of each latent variable are determined. The estimation is carried out in four steps: (1) Estimation of the inner weights, (2) inside approximation of the values of the latent variable, (3) estimation of the outer weights, (4) outer approximation of the values of the latent variable.

The second stage determines the path coefficients using the construct values gained from stage 1. PLS determines improved values for the dependent variable using different weighting schemes. The determined values serve as initial values for the estimation of the outer weights. Step (2) and (3) are repeated until the weights and construct values remain roughly constant. Thus, the values for the latent variables can be calculated. After the construct values are determined, the loadings between the variables and indicators as well as the loadings of the path coefficients are estimated. In the case of formative constructs, multiple regression coefficients are estimated based on the construct values. Finally, the mean values for the latent and manifest variables are identified.

In the third stage, the mean values and the constant term of the linear regressions is calculated based on the construct values and path coefficients gained from step 1 and 2. The three essential steps of the PLS estimation algorithm according to Weiber and Mühlhaus (2010a) and Huber et al. (2007b) are shown in Figure 3.

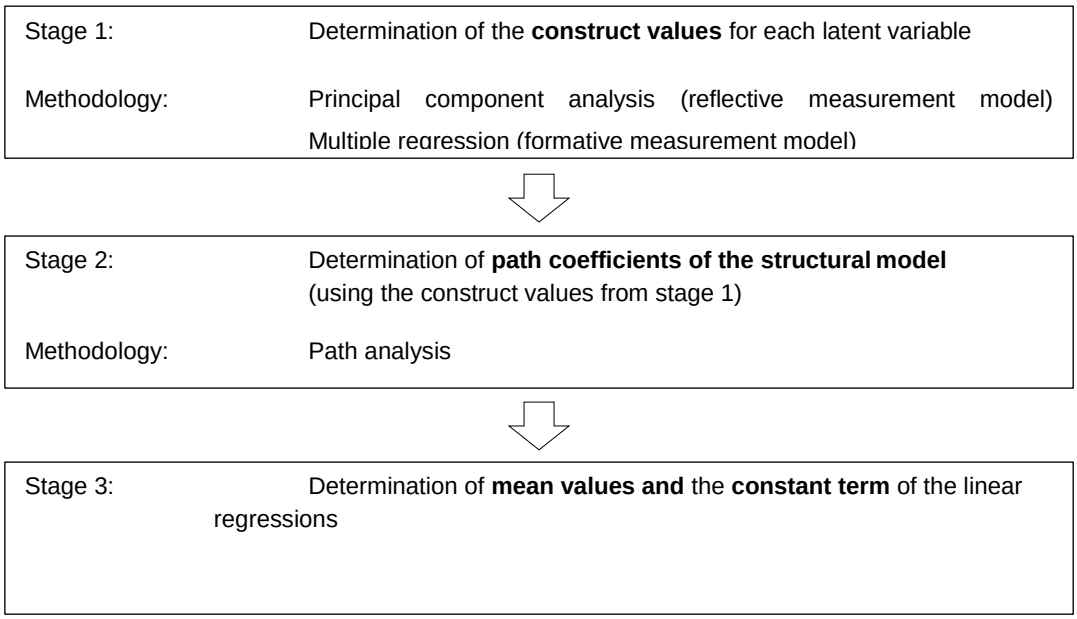

Figure 3: Stages of the PLS estimation algorithm

Figure 3 is compiled by the author

2.6 Adaptive conjoint analysis

Conjoint analysis was used in order to investigate research question (III) "WHICH ATTRIBUTES OF DIRECT WIND ENERGY INVESTMENTS ARE OF PARTICULAR IMPORTANCE TO PRIVATE INDIVIDUALS?". Conjoint analysis is a statistical technique that allows study of consumer preferences among multi-attribute alternatives for a wide variety of products (Green, Srinivasan 1978). The term "conjoint" derives from the fact that participants evaluate an overall product or service based on multiple (conjoint) attributes (Orme 2009c). Traditional expectancy-value models use a compositional approach where each attribute is addressed directly and the overall product is modeled as the sum of the part-worths (utilities) for each of the attribute levels. Those methods involve direct questioning of the respondent about how important each attribute or attribute level is to him/her. In contrast, conjoint analysis asks respondents to make tradeoffs between various product concepts. Thus, the conjoint methodology is characterized by a decompositional approach where data collection is based on a composed level and the part-worths (utilities) of each attribute level are calculated during the statistical estimation of the model. In other words, the purpose of conjoint analysis is to determine the contribution (part-worth) of each attribute level to the dependent variable and to determine the portion contributed by each variable to the overall utility of the object investigated (Moore 1980).

Conjoint analysis has evolved over the years in order to overcome some weaknesses in the traditional method (Backhaus et al. 2016; Orme 2007b). Among the advances are two particular variations of conjoint analysis. Full profile methods require respondents to make simultaneous trade-offs between

all attributes of the various alternatives. In partial profile methods, respondents are first asked to rank the importance of attributes, followed by choice tasks that gradually build up complexity (Sawtooth Software 2007a). The term "adaptive" refers to the fact that a computer-administered interview is individualized for each respondent.

Conjoint analysis has its origin in psychological research (Wittink, Cattin 1989). It was first introduced into marketing research by Green and Rao (Green, Rao 1971) and subsequently further developed by Batsell and Lodish (Batsell, Lodish 1981) and Louviere and Woodworth (Louviere, Woodworth 1983). Owing to the possibility of simulating real life decision making processes, conjoint analysis continues to enjoy increasing use in various disciplines including recreation, transportation, shopping behavior, environmental evaluation (Sara R. Jaeger et al. 2001) and entrepreneurship research (Franke et al. 2009). This methodology has also been used to analyze investment decision-making of entrepreneurs such as informal investors (Landström 1998), management buyout investors (Birley et al. 1999) or venture capitalists (Muzyka et al. 1996a). Conjoint analysis provides two advantages in this specific context (Hampl 2012). First, it avoids the challenges associated with post hoc data collection, which requires respondents to recall and articulate past decisions, which could result in recall bias and/or revisionism (Golden 1992). Second, "*by presenting investors with hypothetical choices among realistic investment objects described by several attributes at the same time, it addresses challenges like social desirability bias and investor's inability to articulate complex decision process*" (Hampl 2012). Thus, conjoint analysis is a well-established and widely used technique in the field of investment decision-making and is relevant for the research topic of this thesis.

2.6.1 Adaptive choice-based conjoint analysis

Adaptive choice-based conjoint analysis (ACBC) is a hybrid method combining the specific characteristics of full- and partial profile methods (Sawtooth Software 2014a). ACBC is a well-established research method to measure customer preferences in various fields (Kaufmann et al. 2013a). ACBC is well suited to investigating investment decisions and has been successfully applied to analysis of investor preferences or financial choices in other studies (Lüthi, Wüstenhagen 2012a).

Most respondents pay attention to only a few attribute levels when making product choices, especially when it comes to complex product concepts as is the case in this thesis (Orme 2009b). ACBC screens a wide variety of product concepts but focuses on a subset of attributes which are of most interest to the respondent (Sawtooth Software 2007a). These concepts are generated to be "near-neighbors" to the chosen concept in the "Build Your Own" Task (BYO) (see below) but still include all levels taken into each respondent's ACBC survey. The generated product-designs are near-orthogonal and have "proven to work exceptionally well in many methodological studies to date"

(Sawtooth Software 2016). According to Sawtooth Software (2016) the steps involved in selecting each of T concepts in the design are as follows:

1. Randomly select an integer (A_i) from A_{min} to A_{max} that specifies how many attributes within C_0 will be modified to create new (near-neighbor) concept C_i.
2. Randomly select A_i elements within C_0 to modify.
3. Randomly select new (non-BYO selected) levels for the attributes chosen in step 2 (all other attributes remain at the BYO-selected levels).
4. Check to ensure that the concept chosen does not violate any prohibited pairs and is not a duplicate of another concept previously selected by this respondent. If it is prohibited or a duplicate, discard the concept and return to step 1.
5. For non-BYO selected levels, examine whether relabeling levels to another non-BYO selected level within the same attribute improves the relative D-efficiency of the design for this respondent. Examine whether swapping non-BYO selected levels between two concepts improves the relative D-efficiency. Any relabeling or swapping is accepted which increases the efficiency while not making the target level count balance worse.

Steps 1-5 are repeated as many times as possible within about one second per respondent. C_0 defines a vector with as many elements as the number of attributes included in the respondent's BYO question and describes which levels were included in the BYO concept. T represents the number of total product concepts generated, A_{min} is the minimum number of attributes based on the BYO concept and A_{max} is the maximum number of attributes from the BYO concept.

Sawtooth Software's SSI WEB was used to design the adaptive choice-based conjoint experiment for this thesis. The computer-administered interview consisted of three sections that build upon each other. The first section is the BYO-section in which the respondents are asked to state their preferred level for each attribute. In the "Screening Section", the software generates a series of hypothetical investments based on the first section. The customized designs are near-orthogonal, are generated by the software "on-the-fly" based on the information provided by the respondent in the first section and follow a controlled, randomized process. Typically, the concepts are presented in groups of three or four and respondents are asked to indicate whether they would consider each one a possibility or not a possibility (Sawtooth Software 2014a). Third is the "Choice Task Section" where the alternatives considered as a possibility are presented and respondents indicate their most favored option. In the subsequent rounds of the tournament, the winning alternatives are measured against each other until the preferred concept is identified (Orme 2014a).

2.6.2 Statistical estimation algorithm

The part-worth values referred to in chapter 3.3 are estimated using a hierarchical Bayes procedure. Historically, scholars using conjoint analysis have primarily employed metric data (rating-based) and used ordinary least squares (OLS) regression models in order to estimate part-worth values (Hampl 2012). The hierarchical Bayes procedure was introduced with the launch of choice-based conjoint designs and has gained a high level of popularity, especially in the field of marketing (Baier 2009). According to Netzer et al. (2008), hierarchical Bayes is a likelihood-based and random-effects method. It is different from OLS estimates in that the hierarchical Bayes procedure consists of two levels. At the upper or population level, it is assumed that individuals' part-worths are described by a multivariate normal distribution. At the lower or individual level, it is assumed that the probability that a respondent will choose a particular alternative is governed by a multinominal logit model (Sawtooth Software 2009a). The two levels allow the algorithm to "borrow" missing information about the individual level from the population level. By doing this, the procedure deals with preference heterogeneity by estimating individual level parameters (Baier 2009).

This approach is especially advantageous in the case of choice-based conjoint approaches, in which less information is gained about each respondent when compared to other methods. In statistical terms, the upper level can be written as

$$\beta_i \sim \text{Normal}(\alpha, D)$$

where β_i is "*a vector of part-worths for the ith individual, α is a vector of means of the distribution of individuals' part-worths, and D is a matrix of variances and covariances of the distribution of part worths across individuals*" (Sawtooth Software 2009a). At the lower level, choices are described by a multinominal logit model. The utility u_k that the individual i refers to the kth alternative is defined as $u_k = x_k' \beta_i$. The probability of the ith individual choosing the kth alternative in a particular task is

$$p_k = \frac{\exp(x_k' \beta_i)}{\sum_j \exp(x_j' \beta_j)}$$

where p is "*the probability of an individual choosing the kth concept in a particular choice task, and x_j is a vector of values describing the jth alternative in that choice task*" (Sawtooth Software 2009a). In order to estimate the parameters β_i, α and D, two different Monte Carlo Markov Chain methods were used. The overall procedure to estimate the parameters was operationalized by a particular technique of Metropolis-Hasting algorithm called Gibbs sampling. The estimation of β_i for each individual was operationalized "*by a more complex iterative process of Metropolis-Hasting algorithm*" (Hampl et al. 2012a), namely using present estimates of α and D (Sawtooth Software

2009a). For a more detailed discussion of the iterative estimation of the parameters see (Sawtooth Software 2009a).

3 Publications

3.1 Which factors influence retail investors' attitudes towards investments in renewable energies?

In order to reach the minimum goal of keeping global warming below 2 °Celsius, huge investments will be required by 2035. Even more investments will be necessary in future if the temperature increase is to be limited to 1.5 °Celsius above pre-industrial levels. Many of these investments will fall within SRI investment strategies, also referred to as sustainability themed investment. These cover various sectors from forestry and water supply to climate change, energy efficiency and renewable energies. Probably the most well-established product in this field is RE investment. In scientific literature there is agreement that individuals' attitudes are good predictors or moderators of ecologically friendly investment behavior and highly influence their intention to make sustainable investments. However, existing studies provide only a scantly developed theoretical basis for understanding investment behavior in RE. Therefore, academics agree that further research is needed to gain a thorough understanding of the predictors of individuals' attitudes towards RE investments. This publication investigates and compares individuals' attitudes towards RE investments and further examines the factors influencing their attitudes.

Based on a cluster analysis, the results show that attitudes towards RE investments are divided into two groups within the German population. On one hand, there are "supporters" who have positive attitudes towards RE investments. On the other hand, there are "skeptics" who view RE investments rather negatively/skeptically. There is no evidence of a third group of people in the German population who are undecided with regard to RE investments.

Based on multiple regression analysis, the results further show that individuals' evaluation of the regulatory framework, confidence in NGOs, social norms, and risk aversion are significant factors influencing their attitudes toward RE investments. No evidence was found that confidence in politicians influences individuals' attitudes in this respect.

Publication:

Gamel, Johannes; Menrad, Klaus; Decker, Thomas (2017): Which factors influence retail investors' attitudes towards investments in renewable energies? In: Sustainable Production and Consumption 12, pp. 90–103. DOI: 10.1016/j.spc.2017.06.001

Status: Published

3.2 Which factors influence individuals' intentions to invest in wind energy?

In order to reach the goal of keeping global warming below 2 °Celsius, an enormous amount of cumulative investments in energy supply are needed. This investment can be provided by the either the public sector or the private sector. As taxation and government expenditure cannot provide all of the necessary investments, it is expected that private individuals will contribute a substantial share of the necessary financial resources. Investment in wind energy is an example of SRI. Globally, SRI has grown significantly in recent years, now contributing 30% of the total managed assets worldwide. Due to the rapid increase of global investments in SRI, it has attracted the attention of both market practitioners and academics from various disciplines. Academics agree on the necessity of gaining a better understanding on individuals' investment behavior with respect to SRI. This publication aims to promote understanding of individuals' intentions to invest in wind energy, which is the type of renewable energy that will require the highest level of global investment by 2035.

The Theory of Planned Behavior was used as the basic theoretical framework for investigating the main factors influencing individuals' investment intentions in wind energy. Two additional constructs, that is consumption profile and investor profile, were integrated into this theoretical framework. The results indicate that the original Theory of Planned Behavior is not the best framework for analyzing individuals' investment intentions in wind energy, a finding which is contrary to some previous studies. However, by including the two additional constructs, the theoretical model becomes more suitable, explaining twice the amount of variance in behavioral intention.

In line with research on investment intentions and/or investment behavior regarding socially responsible investments, the results show that four of the five constructs have a significant influence on individuals' intention to invest in wind energy, regardless of whether the additional two constructs were included in the model or not. Additionally, the results reveal that an individual's experience in investments has the greatest effect on the potential intention to invest.

Publication:

Gamel, Johannes; Menrad, Klaus; Decker, Thomas: Which factors influence individuals' intentions to invest in wind energy? In: The Energy Journal

Status: Submitted

3.3 Is it really all about the return on investment? Exploring private wind energy investors' preferences

Achievement of EU climate targets will require an immense volume of investments in renewable energies, especially in the field of wind energy. Private individuals can play an essential role in raising significant parts of the necessary financial resources. This requires, however, a thorough understanding of investors' preferences. Nevertheless, the investment preferences of private individuals' in renewable energies, and particularly in wind energy, have not been analyzed systematically so far. With the use of an adaptive conjoint experiment, this publication investigates individuals' preferences regarding specific wind energy investments, which are commonly regarded as complying with SRI principles.

The analysis of individuals' utilities reveals that various aspects of wind energy investments are of particular importance. Typical investment criteria (investment sum, investment term, and return on investment) are the most important investment attributes for wind energy investments. The site of a wind turbine, the presence of exit options and opportunities for investor participation, the issuer of the investment, and the beginning of the repayment are perceived as being almost equally important. Analysis of the different attribute levels show that preferences relating to the term of an investment, the return on investment, the exit option, and the beginning of the repayment all follow a distinct order. Thus, the levels relating to the shortest bond, the highest financial gain, the most flexible binding contract, and the earliest repayment gain the highest utility values.

It was further shown that a wind energy production facility owned by citizens or regional companies is clearly preferred over nationwide or international ownership structures. Individuals' preferences for investments in wind energy production increase with the distance to the specific investment object. However, investment objectives situated outside Germany have a strong negative impact on their willingness to invest. The estimation of parameters using covariates shows that investments in wind energy production are less attractive for older people but more attractive for people with greater financial resources. Finally, individuals with a positive environmental attitude accept financial disadvantages for this specific type of SRI.

Publication:

Gamel, Johannes; Menrad, Klaus; Decker, Thomas (2016): Is it really all about the return on investment? Exploring private wind energy investors' preferences. In: Energy Research & Social Science 14, pp. 22–32. DOI: 10.1016/j.erss.2016.01.004.

Status: Published

4 Discussion and conclusion

In this chapter, the methodological approach as well as the results of all three publications are discussed within the context of existing scientific literature. Additionally, conclusions will be drawn based on the findings of the three publications (cf. chapter 3). Finally, the limitations of this thesis are discussed.

4.1 Discussion of the methodological approach

This thesis is based on a combination of a qualitative and a quantitative research approach. In the past, quantitative and qualitative research methods were used separately by researchers. However, increasingly more studies are showing that a combination of qualitative and quantitative research approaches is useful and appropriate for the analysis of various research questions. An increasing number of scientific studies e.g. in the context of energy efficiency (Kostka et al. 2013) or investments in RE (Masini, Menichetti 2013c) emphasize the advantages of using combined methodological approaches.

The application of qualitative approaches is primarily to generate insight into less explored fields of research (Moschner, Anschütz 2010b). As little is known about the factors which influence individuals' attitudes towards RE investments, a qualitative approach was taken in addition to the quantitative data collection, which provided data that could be statistically analyzed using different multivariate methods. The results of the qualitative study were used for several purposes. First, they were used in order to cross-check the hypotheses derived from the existing literature. Second, they were useful for specifying potential factors influencing individuals' attitudes towards RE investments. Third, the results were used to specify the most important characteristics of direct wind energy investments. Finally, the results provided an additional source of insight in terms of operationalizing some of the variables within the conceptual framework.

The qualitative component of the study took the form of expert interviews, a method which offers some advantages over focus groups. Through a conscious selection of interview partners, it was ensured that a heterogeneous group of persons were selected with respect to their work area and place of residence. In addition, experts can assess the field of RE from their professional point of view as well as from their own personal, non-professional point of view. Each interview was conducted individually and as many experts had limited time resources and availability, the period in which the interviews took place extended over several months.

In combination with an extensive literature review, the qualitative study provided the groundwork for the conceptual framework (cf. chapter 2.1). In the second phase, this conceptual framework was empirically tested. Due to the adaptive form of the conjoint experiment, a computer-assisted

questionnaire was necessary and an online-survey was designed for data collection. Generally, online surveys are considered to be more flexible, offering faster data collection and being more cost effective than traditional written surveys and computer assisted personal interviews. Online-surveys also offer a high degree of anonymity and are therefore highly accepted by participants. Moreover, the data quality of online-surveys is high (little erroneous input) because of predefined formats for data input. Through the integration of quota questions, participants can be specifically selected with respect to the representativeness of the target group.

In order to participate in an online-survey, an internet connection is required. Internet access varies significantly between countries and population groups within countries (Kaplowitz et al. 2004a). In Germany, the majority of the population has continuous access to the internet (Statistisches Bundesamt 2015a). In Germany, only people older than 60 years have significantly less access to the internet and use it less than the rest of the population (AGOF 2014a). The target group of this thesis could be sufficiently accessed without serious statistical problems.

The sampling procedure can potentially give rise to statistical issues such as "panel conditioning". This occurs when respondents' answers are influenced by prior (other) interviews, which could affect the results. On the other hand, web-based access panels can be advantageous as respondents have previous experience with such surveys and give more precise and truthful answers (Dillman et al. 2009a).

The combination of quantitative and qualitative research methods was a valuable approach for this thesis. It offered multiple perspectives, made it possible to better understand the complexity of the research questions and to adjust the theoretical framework based on both professional and personal insights from market experts.

The scientific literature identifies three methodological approaches for measuring individuals' preferences (Heidbrink 2012): First, there are compositional models in which respondents have to evaluate each product feature separately and the partial utilities are combined to represent the total utility of a product. Secondly, there are decompositional models in which respondents have to evaluate the whole product and the total utility is separated into partial utilities. Third, there are hybrid models which combine these two models in order to deal with products which have many attributes (Heidbrink 2012).

For this thesis, a hybrid model (adaptive conjoint analysis) was used for measuring preferences. Despite the relatively high number of attributes (nine) resulting from the qualitative study, a decomposition model could be used. In this way, respondents did not have to evaluate each product feature individually and in isolation, which would not correspond to daily, real-life investment decision-making (Stiehler 2015). As the aim of the experiment was to investigate the benefits participants attach to the individual attributes of a wind energy investment, conjoint analysis was

regarded as the most suitable method. Albers et al. (2009) describe the adaptive conjoint analysis as the best variant for measuring preferences with regard to different validity values. Abers et al. (2009) also point out that adaptive conjoint analysis is the prevailing instrument for measuring preferences, particularly for the design of new products. The fictitious investment products in this study serve precisely this purpose. The results are intended to provide market actors with insights into individual preferences with respect to wind energy investments so that new investment products which meet the requirements and expectations of different groups can be designed. Against this background, the adaptive conjoint analysis can be regarded as a suitable method for this thesis.

4.2 Discussion of the results

Based on the research questions mentioned in chapter 1.4, the results of this thesis are now discussed and conclusions for science, practice and future research issues are elaborated.

In publication 3.1 the focus is on the factors influencing individuals' attitudes towards RE investments. The results reveal that social norms, evaluation of the regulatory framework, risk aversion, and confidence in NGOs are significant influencing factors, but no evidence was found that confidence in politicians influence individuals' attitudes.

The first finding is in line with previous studies which show that social factors influence individuals' decision-making (Nolan et al. 2008b) and that people act according to social norms (Schweizer-Ries 2008a). The influencing effect of social norms on attitudes towards RE investments is further supported by the study of Adam and Shauki (Adam, Shauki 2014b), who investigated the investment decision-making process of Malaysians and found evidence of the influence of social norms specifically on attitudes towards investments. Thus, it can be concluded that individuals act according to their social norms in this area.

The second finding is in line with previous studies (Barradale 2010a; Hitchens et al. 2004) which show that assessment of the regulatory framework can either inhibit or promote RE investment behavior. This is further supported by Murovec et al. (Murovec et al. 2012c), who claim that the assessment of the regulatory framework consisting of financial incentives, tax measures and regulation instruments, influences individuals' investment behavior. However, it should be noted that the statements used to conceptualize this variable in the present study are specific to the context of renewable energies, whereas Murovec et al. (2012c) used more general statements relating to the field of energy production without having a clear focus on renewable energies.

Paetzold and Busch (2014a) show that individual risk perception influences individual attitudes towards RE investments. Jothilingam et al. (Jothilingam, Kannan) assessed investor attitudes towards investments and concluded that these attitudes are influenced by the investors' risk perception.

Further studies dealing with sustainable investments indicate that risk aversion and particularly the willingness to take risks has an influence on the intention to invest (Lim et al. 2013b).

The interviews with market professionals indicated the importance of individuals' confidence in politicians, regional energy companies and NGOs, but only the last group was found to have a significant effect on individuals' attitudes towards RE investments based on the quantitative survey. The influence of NGOs is in line with the study of Guay et al. (2004a), which showed that NGOs can influence the investment community and that the overall influence of NGOs on public attitudes is growing. However, the results regarding confidence in politicians and in regional energy companies contradict the statements of the interviewed market professionals. Based on this finding and previous research (Guay et al. 2004a; Torgler, García-Valiñas 2007) it can be concluded that individuals have more trust in NGOs than in politicians, businesses and media and are therefore more likely to be guided by NGOs in the context of their attitudes towards RE investments.

In publication 3.2, the focus is on the main factors influencing individuals' intentions to invest in wind energy. The explanatory power of the TPB performed similarly to a study by Tonglet et al. (2004c), in which the TPB was used to predict individuals' intention to recycle household waste. However, the results of this study suggest that the TPB is not the best framework for analyzing individuals' investment intentions in wind energy. The extended TPB used in this study almost doubled the explanatory power, making the extended TPB consistent with the results of previous studies (Korcaj et al. 2015b; Adam, Shauki 2014b) investigating individuals' investment intentions in RE. The gain in explanatory power is also consistent with the results of Chen's (2015b) study of individuals' intentions to save energy.

Publication 3.2 further revealed that subjective norms have a significant influencing effect on an individual's behavioral intention to invest in wind energy. This finding is in line with the results of comparable studies (Korcaj et al. 2015b; Adam, Shauki 2014b) but the size of the effect is significantly greater than in Chen's study (2015b), suggesting that the subjective norm is a better predictor for direct RE investments (e.g. in wind energy) than for indirect RE investments such as energy-saving behavior.

In contrast to previous studies (Chen 2015b; Thapa Karki, Hubacek 2015a), attitudes towards RE investments had no significant influence on behavioral intention in this study. Individuals' previous investment experience was found to be the best predictor for intention to invest in wind energy. Thus, it can be inferred that general factors (subjective norm, investor experience) may outweigh more specific factors (attitudes towards RE investments) as individuals' investment experience was found to be the best predictor for the behavioral intention, while attitudes towards RE investments had no significant influencing effect in the context of investment intentions in wind energy.

In publication 3.3, the focus is on private individuals' preferences regarding different forms of direct wind energy investments. The analysis of individuals' utilities reveals that various aspects of wind energy investments are of particular importance. Typical investment criteria (investment sum, investment term, and return on investment) are the most important attributes for wind energy investments. The results of this study show that preferences for the attribute levels relating to the term of the investment, the return on the investment, the exit option, and the beginning of the repayments all follow a distinct order. Thus, the levels indicating the shortest bond, the highest financial gain, the most flexible binding contract, and the earliest repayment period gain the highest utility values. These results are in line with the studies of Aguilar and Cai (2010a) as well as Clark-Murphy and Soutar (2004c), who had similar findings in studies investigating investment decisions made by individuals in the USA and Australia respectively. This indicates that private investors in different countries seem to have similar interests concerning the economic outcomes of their RE investments.

Publication 3.3 further shows that the minimum investment amount necessary to enter into a specific wind energy investment is the most important attribute for the survey participants. This finding is in line with previous studies of investment decisions in RE: Ku and Yoo (2010b) (Korea) and Bergmann et al. (2006c) (Scotland) investigated willingness to invest in RE by financing RE projects through an annual surcharge included in the electricity bill. They found that in both countries, the willingness to invest in RE largely depends on a low annual increase in household electricity costs resulting from RE projects. Therefore, the minimum investment amount to enter a specific wind energy investment should be relatively low in order to increase the interest of potential private investors.

Moreover, the results of this study show that sociodemographic (age) and psychographic (environmental attitude) variables as well as the self-assessment of the individual financial situation influence individuals' investment preferences in wind energy. People with more concern for the environment are more likely to invest in wind energy and they even seem willing to accept financial disadvantages for such "environmentally-friendly" projects. This finding is consistent with previous studies investigating investment decisions in RE by Swiss citizens (Walter 2012b) and European individual investors (Nilsson 2008a). With the financial support of more pro-environmental people, wind energy projects can also be realized at non-optimal wind locations, and thus make a major contribution to decentralizing energy supply. Additionally, it was shown that people with more financial resources are more willing to invest in wind energy, which is in line with the findings of Bollinger and Gillingham (2012a) as well as Drury et al. (2012b), who investigated the expansion of photovoltaic energy in California.

4.3 Limitations and future research

The results presented in this thesis are based on different subsamples of the online-survey. Thus, there are limitations to generalization of the results with respect to methodology, geographical location, contextual issues, and other issues. It is emphasized that this thesis contributes to scientific knowledge by developing a theoretical basis for understanding individuals' investment intentions in RE and specifically in wind energy. This is based on three different aspects: First, individuals' attitudes towards RE investments. Second, individuals' behavioral intention to invest in wind energy projects. And third, individuals' preferences for different types of direct wind energy investments. The results of this thesis provide several important implications for future research.

Publication 3.1 investigates individuals' attitudes towards RE investments and publications 3.2 and 3.3 put the focus on a specific type of RE and provide interesting insights into individuals' investment intentions and investment preferences with respect to wind energy. As such, no conclusions can be drawn for other types of RE. Future research should use and adopt the conceptual framework used in this thesis and empirically test it for other renewable energy sources.

There were some limitations regarding the data collection. To recruit respondents, a market research company was subcontracted. This company randomly invited their panel users via email to participate in this study. Since the panel members could decide whether to accept the invitation, self-selection cannot be excluded from the dataset. In addition, further selection processes were made with respect to age and financial knowledge of the participants. As such, the sample cannot be interpreted as having been completely randomly selected.

Germany is taking a leading role in the global expansion of renewable energies. The sample consists exclusively of German citizens, which means that the results and implications of this thesis cannot be extrapolated directly to other countries. Future research should use and adopt the conceptual framework presented in this thesis to allow a detailed analysis of the similarities and differences between individuals in different countries in terms of their attitudes towards RE investments, their intentions to invest in wind energy and their preferences for direct wind energy investments.

Due to the methodology used for data collection, some biases cannot be excluded. A phenomenon which frequently occurs in studies investigating ethically correct behavior is social desirability bias. This bias refers to the tendency of respondents to answer questions in a manner that will be viewed favorably by others. As respondents modify their answers to fit with the expectations of others, the results can be distorted (Lakitsch 2009). In order to counteract this phenomenon, all relevant variables were measured indirectly. However, a complete exclusion of social desirability cannot be guaranteed. Another bias which might occur relates to the fact that the behavioral intention to invest in wind energy was measured directly and therefore this variable is self-reported and not verifiable.

However, Haan and Kuckartz (2013) argue that self-reported behavior and self-reported intentions have proven to be useful indicators in previous studies.

Actual investment decisions could not be studied due to methodological issues, practical hindrances and privacy policy. Thus, the results of this thesis provides insights into individuals' investment intentions for direct wind energy investments, which is assumed to be an immediate antecedent of actual behavior (Ajzen 2002). However, literature argues that behavioral intention cannot fully explain actual behavior (Pascual-Ezama et al. 2013b). Intervening events can attenuate the behavioral intention (Ajzen 1974). As this thesis investigates individuals' intentions to invest in wind energy but not their actual behavior, future research is required to investigate how well behavioral intention is able to predict actual investment behavior in the context of wind energy investments. A confirmation that behavioral intention predicts actual investment behavior in the context of wind energy would be an important future step for the validation of the results of this thesis. This would not be without challenges. In order to measure actual investment behavior, a second study with the same respondents would have to be carried out. The timeframe for data collection would be extremely difficult to plan because the time between the intention to invest in wind energy to the actual investment behavior is not fixed.

The choice experiment included nine attributes of direct wind energy investments. The findings regarding individual preferences for wind energy investments only allow conclusions to be drawn about those attributes. Although the literature review and qualitative expert interviews indicated the relevance of these attributes, unobserved attributes and factors may also have affected the results. Future research could investigate the influence of factors and attributes not included in this thesis e.g. the legal form of the company operating the wind energy project, the number of people financially involved in the project, the amount of wind turbines, restrictions on shareholdings for wind energy projects.

Finally, the conceptual framework presented in this thesis does not take similar previous investments in RE or more specifically in wind energy into account when examining individuals' investment preferences. Therefore, future research should aim to identify individuals' past investments so that their expectations regarding return on investment and the benchmark they use for assessing the expected return on wind energy investments is identified. Further, these insights should be used for analyzing the effects of past investments or past investment experience on actual and future investment intentions.

4.4 Implications for practice

It was shown that social norms, confidence in NGOs, risk aversion and evaluation of the regulatory framework influence individuals' attitudes towards RE investments. In order to support positive

attitudes towards RE investments and increase the propensity for investment in RE products, individuals should be provided with more information about these financial products. Financial institutions (e.g. banks) and providers of wind energy investment products seem to be natural actors for this task, since their consultants are in direct contact with potential individual investors. As individuals were shown to have confidence in NGOs, financial institutions and suppliers of wind energy investments could cooperate with NGOs to verify their investment products with a "certificate" issued by these NGOs. As risk-averse people seem to perceive RE investments as being high risk, a "certificate" issued by an NGO might help to reduce this negative risk perception.

With regard to specific investments in wind energy, people seem to reject investment in wind turbines outside Germany. This finding indicates that international investment horizon might not have been the focus of potential individual investors in Germany, or investors have not regarded it as being an attractive option. In a first step, the financial sector should use these findings and expand its range of investment opportunities for wind energy projects sited in Germany. In a second step, the banking sector could inform customers about the current situation of wind energy investments in foreign markets and offer appropriate investment products. Additionally, the results of this thesis reveal that older people tend to avoid investments with the typical characteristics of wind energy investments. The results indicate that this group tends to prefer investments in locally sited wind farms. Since older people represent an important group of potential investors in RE, the banking sector should put a focus on those people by aligning investment offers specifically to this group (e.g. locally sited wind farms). This applies especially to locally based banks, since a large proportion of older people put their trust in these financial institutions.

Overall, this doctoral thesis has made several important contributions to the current literature on individuals' investment behavior in RE. By shedding light on the attitudes of private individuals with respect to RE, their investment intentions and their investment preferences for a specific type of RE, the findings of this thesis enhance understanding of the factors that should be considered when creating opportunities for individual investment in RE and more specifically in wind energy.

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Appendix 1: Publication 1

Which factors influence retail investors' attitudes towards investments in renewable energies?

Gamel, J.; Menrad, K.; Decker, T.

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Appendix 2: Publication 2

Which factors influence individuals' intentions to invest in wind energy?

Gamel, J.; Menrad, K.; Decker, T.

This paper that is currently under review for publication. The full publication is included in the examiners' copies of this dissertation. In order to avoid any kind of plagiarism or dual publication it is not included in the freely accessible version of this dissertation.

Appendix 3: Publication 3

Is it really all about the return on investment? Exploring private wind energy investors' preferences

Gamel, J.; Menrad, K.; Decker, T.

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