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MASTER THESIS

VALUE AND ACCEPTIBILITY OF WIND ENERGY IN THE NETHERLANDS

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Abstract

This thesis analyses the willingness to accept and willingness to pay for an increase in the supply of wind energy in the Netherlands, as well as the disparity between these values. A national household survey from the LISS panel dating from 2018 is used containing questions on these parameters. Willingness to accept is asked as a one-time monetary compensation for accepting a wind turbine within $500 - 1{,}000$ meters of one's home. Willingness to pay is formulated as an additional monthly tax that lasts for a year. Since these questions do not revolve around the same good, the disparity is investigated in terms of values above ($High$) and below (Low) the median value. The determinants of the parameters are analysed using an ordered logistic regression model, and significant effects of various demographic factors are found in both models. As well as similar existing relationships, a negative effect of $Home\ Ownership$ on willingness to accept is found. A matrix is formed, creating 4 groups according to $High$ and Low WTA and WTP combinations. The distribution of the demographic factors that were included in the regression models are visualized and differences are discussed. A direct comparison between the opponents and supporters group showed merely a significant difference in the share of females and home owners. More research on these parameters in the context of other types of renewable energy might be able to identify more opportunities for policy designers to increase the total production of green energy in the Netherlands.

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Table of Contents

Abstract 1

1 Introduction 3

2 Literature Review 5

2.1 WTA & WTP in the Context of Green Energy 5

2.1.1 Willingness to Accept for Green Energy 5

2.1.2 Willingness to Pay for Green Energy 6

2.2 Willingness to Accept (WTA) & Willingness to Pay (WTP) 8

2.3 Identifying Different Groups using the WTA – WTP Disparity for Green Energy 9

3 Data 11

3.1 Description of the Dataset 11

3.1.1 Questions regarding Windmills 12

3.2 Data Transformations 13

3.3 Descriptive Statistics 15

4 Methodology 18

4.1 WTA & WTP Analysis 18

4.1.1 WTA logistic regression 19

4.1.2 WTP logistic regression 20

4.2 WTA/WTP Matrix 21

5 Results 22

5.1 Willingness to Accept – results 22

5.2 Willingness to Pay – results 24

5.3 WTA & WTP Matrix – results 25

6 Discussion 30

7 Conclusion 34

Appendix A: Survey Questions 36

Appendix B: Distribution of WTA and WTP 41

B.1 WTA 41

B.2 WTP 42

Appendix C: Ordinal logistic regression models 44

C.1 WTA 44

C.1.2 Assumption testing 45

C.2 WTP 46

C.2.2 Assumption testing 47

Reference List 48

1 Introduction

For long, mankind has relied on fossil fuels as major source of energy. The discovery and ability to transition into energy enabled human society to rise to its current levels (Hubbert, 1949). Despite the indisputable importance of this resource, the negative effects the usage has had since have not gone unnoticed. Already in 1990, Barbir et al quantified over 35 different types of environmental damage caused by the usage of fossil fuels and conclude that this damage adds up to $2360 billion per year worldwide (Barbir, Veziroglu, & Plass Jr., 1990). Since then, many other researchers found evidence of the negative effect on the environment and global warming (Haller, John, Bloenchlinger, Marthaler, & Ziegler, 2007) (Hoel & Kverndokk, 1996).

In addition, the supply of fossil fuels is limited. The depletion has been identified to impose a big challenge in the future (Höök & Tang, 2013). Models have been established to predict the rate of depletion. Considering consumption levels, it was found that the reserves of oil, gas and coal could be depleted within 110 years (Abas, Kalair, & Khan, 2015) (Topal & Shafiee, 2009).

Previously described problems call for a solution, one that is sustainable for mankind for long term. These concerns helped shape the renewable energy sector to its current form. Renewable or green energy is defined as energy that has no or minimal negative environmental, economic and societal impact (Dincir, Midilli, & Rosen, 2007). Examples are solar-, water- and wind energy. However, the shift from fossil fuels to the utilization of green energy has been identified as a challenge itself as well (Sadorsky, 2011) (Bergh, van den & Bruinsma, 2008) (Stolten & Scherer, 2013).

Despite the undisputable importance of constructing new renewable energy sources, there have been many protests against these phenomena. Very recently, there were many cases of protests in Germany against the so-called *Energiewende* (Zilles, Hoeft, & Messinger-Zimmer, 2017). Also in the Netherlands there were many protests against the construction of windmills. Currently, there are more than 100 active action groups against the construction of windmills (Windenergie in Nederland, 2020).

Why do people protest against these new sources of green energy, although the importance for the society as a whole is undeniable? With this thesis, my aim is to investigate the Willingness to Accept (WTA) and Willingness to Pay (WTP) for green energy from windmills, the disparity between them, and their determinants. This information can be useful for policy makers to identify where opportunities lay to moving towards the goal of an increase in wind energy supply in the Netherlands.

The data that will be used comes from CentERdata. A total of 905 members of the LISS panel in the Netherlands filled in a survey with questions about hope, social relations, climate and some general questions, of which only the climate and general questions are used for the current analysis. The LISS panel consists of 5,000 household spread across the Netherlands, which are incentivized to fill in an amount of surveys on a monthly basis. The LISS panel thereby delivers reliable data on the Dutch population.

The climate section of the survey included questions about one's WTP for a general increase in the supply of wind energy in the form of an additional monthly tax for one year. The questions thereafter revolve around one's WTA for an increase in local wind supply within 500 – 1,000 metres of one's residence.

The answers to these questions allow us to compute a WTA and WTP for the Dutch population, and analyse the determinants using the demographic variables also available in the dataset. The parameters are categorized and analysed using an ordered logistic regression.

In addition to the separate analysis, I will also research the disparity between these values to see whether implications for policy design can be drawn from this. Since the WTA and WTP questions do not revolve around the same good the disparity is investigated in terms of sub-groups of respondents reporting values above (high) and below (low) the median values on these questions. A two-by-two matrix is formed after which the demographic characteristics of respondents in each sub-group (e.g., low WTA & low WTP) are analysed separately and compared between the four sub-groups.

The relevant background literature, as well as the introduction of the applied concepts and research questions are discussed in the Literature Review in Section 2, followed by a description of the data that is used for analysis, and how the data is transformed before testing in Section 3. Section 4 then sheds light upon the applied methodology to answer the research questions. Next, the results are presented in Section 5, followed by the discussion of the findings in Section 6. Lastly, the conclusion rounds up in Section 7, followed by the Appendix and Reference List.

2 Literature Review

In this section, several papers will be discussed that analysed WTP and WTA values in order to explain what these values and the disparity between them, the mean and what conclusions have been drawn from them. Then, these values are analysed in the context of green energy and windmills, in particular, and research questions of this thesis are introduced.

2.1 WTA & WTP in the Context of Green Energy

A persons Willingness to Accept can be defined as the minimum amount of money one would accept to forgo a good or as a compensation for something negative. The Willingness to Pay defines the maximum price for which a consumer will definitely want a good, and can be considered as a proxy of the utility that the good yields the consumer (Hanemann, 1991).

A typical finding in literature regarding these measures is that one's WTA is usually significantly higher than one's WTP. This holds for a variety of goods, and has been reported in literature for over 30 years to date (Coursey, Hovis, & Schulze, 1987) (Horowitz & McConnel, 2002) (Rotteveel, et al., 2020).

One interesting finding in (Tunçel & Hammit, 2014) was the significantly larger $\frac{WTA}{WTP}$ ratio for environmental goods, compared to other types of goods. In this section, WTA and WTP values in the context of green energy will be further examined independently to shed light upon the potential determinants of this high ratio.

2.1.1 Willingness to Accept for Green Energy

When windmills are built, local residents may receive a sum of money to compensate for the negative external effects (Business Insider, 2014). Wind facilities nearby houses have been found to negatively impact property value (Heintzelman & Tuttle, 2012), even finding a decrease of $8.8 - 15.8\%$ for wind farms located 0.5 miles away. One negative external effect is deteriorated views, which has also been found to negatively affect house prices (Gibbons, 2015) (Jensen, Panduro, & Lundhede, 2014), although to a lesser extent. Furthermore, wind turbines generate noise. A 2009 study in the Netherlands revealed that respondents perceive the noise caused by wind turbines as more annoying than transportation/industrial noise (Pedersen, van den Berg, Bakker, & Bouma, 2009). There are also the effects that the turbines have on surrounding wildlife and nature (Madsen & Boertmann, 2008) (Sánchez-Zapata, et al., 2016).

All these factors influence one's opinion on windmills, and thus the amount of compensation required to accept them sited nearby. People's personal opinion on windmills is found to have a highly significant impact on one's WTA (Groothuis, Groothuis, & Whitehead, 2008), as well as the distance they are built within one's home (Sonnberger & Ruddat, 2017), the height of the turbines (Brennan & van Rensburg, 2016) and the number of turbines (Wolsink, 1989).

Besides perceives side-effects and personal characteristics, Langer et al. (2018) find that also process-related variables and technical and geographical issues determine acceptance of wind energy. Individuals attach value to distributive justice, which means that the costs and benefits of the wind turbines are fairly distributed (Walter, 2014). Financial participation is therefore found to highly affect the acceptability of wind energy, and individuals show great propensity to get financially involved in these projects in order to also reap benefits from it (Upham & Pérez, 2015). Likewise, private compensation is found to be preffered to public compensation by Garcia et al. (2016). Furthermore, (Ek & Persson, 2014) find that acceptability is higher for offshore wind development projects compared to onshore.

In general, there is great public acceptability towards wind energy, and support for increasing the general supply of it. However, wind power development projects often face quite some resistance from local residents (Devlin, 2005), as also has been the case in the Netherlands[12]. There are several cases where wind farm development was discontinued due to local opposition (García, Cherry, Kallbekken, & Torvanger, 2016).

This phenomenon of being opposed to wind projects close to one's vicinity while being pro wind projects elsewhere is called NIMBY, which stands for '*Not-In-My-Back-Yard*' (Petrova, 2013). Even in the nineties it became evident that protestors against wind energy exhibited these preferences (Gipe, 1995) and that this NIMBYism was the main reason people were protesting.

Recall from the Introduction the growing importance of renewable energy, this opposition is a problematic factor in reaching this goal. Therefore it is important to understand the determinants of this non-willingness to cooperate. For this thesis, I will examine which factors impact the WTA in the context of windmills. This knowledge could help policy designers tailor compensations to local residents more efficiently. This yields the following research question:

> **Research Question 1:** *What is the WTA for green energy in the Netherlands, and which factors influence it?*

2.1.2 Willingness to Pay for Green Energy

Different studies concluded that people exhibit a positive WTP for green energy products. At the same time, the price of green energy does negatively affect the WTP (Kotchen & Moore, 2007). The source of green energy seems to matter, as a clear preference is found by Borchers et al (2007). The WTP is found to be the highest for solar power, followed by wind power and farm methane/biomass.

[1] West-Friesland – 27-01-2020 ; Overrijsel 07-07-2020
[2] Gelderland – 16-06-2020 ; Brabant – 22-07-2020

Solar power and wind power have long been found to be the most favoured source of green energy (Farhar, 1999). The preference for a specific source of energy is confirmed in (Sundt & Rehdanz, 2015). Herbes et al summarize the factors influencing consumer's WTP for green electricity based on a review of earlier studies (Herbes, Friege, Baldo, & Mueller, 2015). For Age, a negative relationship is observed in the majority of studies. For example, a survey on UK households found that older individuals have a lower WTP for green energy (Akcura, 2013).

A significant negative relation of age on WTP is also found in Canada (Rowlands, Scott, & Parker, 2003), Germany (Traub & Menges, 2008) and Italy (Bigerna & Polinori, 2014). An insignificant relation is found in the US (Wiser, 2007) and in Chili (Aravena, Hutchinson, & Longo, 2012).

$Gender$ also plays a role, although findings are mixed. A popular finding in the literature is that women exhibit stronger pro-environmental behavior and attitudes than men (Zelezny, Chua, & Aldrich, 2002). More specifically, women were also found to attach higher value to protecting the environment (Milfont & Sibley, 2016). Following this reasoning, one would expect females' WTP for green energy sources to be higher than men. This is confirmed in (Bigerna & Polinori, 2014), and limited evidence of this is found in (Wiser, 2007). However, evidence of the opposite, i.e. a higher WTP for men, is found in (Akcura, 2013), (Kosenius & Ollikainen, 2013) and (Zarnikau, 2003). This discrepancy in gender effects provides an interesting opportunity to further assess the relationship using the Dutch population as subjects.

Based on 21 studies, (Herbes, Friege, Baldo, & Mueller, 2015) find a consensus in the literature that the effect of $Income$ is positive. People with a higher income thus have a higher WTP, logically resulting from the fact that there are more resources to allocate. From a meta-regression analysis on consumers' WTP for green energy, it becomes evident that income is one of the main influencers of WTP (Ma, et al., 2015).

Due to the high correlation between $Income$ and $Education$, a positive relationship of the level of education with an individual's WTP would be expected and this is indeed confirmed by (Rowlands, Scott, & Parker, 2003), (Ek, 2005) & (Ivanova, 2012). This implies that people who have a higher educational attainment, report a higher WTP. This could be the result of a better understanding of climate issues, or partly due to the higher income resulting from higher achieved education. Interestingly, (Ma, et al., 2015) find a significant negative relationship in one of their models, although an insignificant in the other.

Furthermore, an increase in $Household\ Size$ has been found to decrease the WTP in several studies (Bigerna & Polinori, 2014) (Zorić & Hrovatin, 2012) (Traub & Menges, 2008). This effect is likely to be associated with $Income$, since more people need to live on the same income.

Another influential factor is the payment mechanism via which individuals pay for their green energy. The two distinguished methods are $Mandatory$ payments, via taxes/bills, and $Voluntary$ payments, via donations/contributions. One could possibly expect the WTP to be higher via $Voluntary$ payment, given the fact that people are free to decide what amount to spend on green energy or to even allocate funds on that matter at all. However, this expectation is only half correct.

In the UK, it was found that people would indeed prefer a $Voluntary$ scheme when given the choice, but are found to be willing to pay more under a $Mandatory$ scheme (Akcura, 2013). A significantly higher WTP under a $Mandatory$ scheme is also found in (Guo, et al., 2014), (Traub & Menges, 2008) and (Wiser, 2007). One of the possible reasons that are given is the consumers' perception of the effectiveness of payment. Under a $Mandatory$ scheme, no one is able to *free-ride* on payments of others', which leads to a higher total amount that can be invested in green energy. The way of provision, meaning the form of energy supply, also has an impact. Wiser finds that stated WTP under a private provision is higher than under a government provision.

For this thesis, I will investigate the effect of several factors on the WTP for windmills. This knowledge could be useful when trying to identify potential proponents of local wind energy. This yields the following research question:

> **Research Question 2:** *What is the WTP for green energy in the Netherlands, and which factors influence it?*

2.2 Willingness to Accept (WTA) & Willingness to Pay (WTP)

Horowitz and McConnell's meta-analysis reviews 45 earlier studies reporting WTA and WTP values on a wide variety of goods. A limited effect of survey design on the ratio of $\frac{WTA}{WTP}$ was found. Ratios resulting from hypothetical experiments were not found to be significantly lower than ratios resulting from real experiments, thereby debunking the claim that hypothetical experiments would not be suitable to elicit $\frac{WTA}{WTP}$.

Experiments using student samples yield significantly lower ratios than non-student samples. Incentive-compatible experiments were, surprisingly, found to yield significantly higher ratios, contrary to findings by Sayman and Önculer (2005). These findings apply to ordinary goods as well to non-ordinary goods.

Furthermore, the authors find that the further the studied good is from being an ordinary private good, the higher the $\frac{WTA}{WTP}$ ratio will be. (Horowitz & McConnel, 2002). They also found no significant relation between a subject's income and $\frac{WTA}{WTP}$. One year later, the authors research the implied income effect and income elasticities. These estimates were insignificant and deemed implausible (Horowitz & McConnell, 2003).

More recently, Horowitz & McConnell's findings were revised, updated and extended with more recent studies up to 2012, confirming the earlier mentioned results. Tunçel and Hammit however, apply a wider classification of types of goods, and find the $\frac{WTA}{WTP}$-ratio to be significantly larger for *Environmental*, *Health and Safety* and *Other public/Non-market* goods (Tunçel & Hammit, 2014)

Furthermore, Tunçel and Hammit examine the effect of payment method on the $\frac{WTA}{WTP}$ ratio, and find that the disparity between these two values is larger when the payment is direct/salient relative to indirect in the form of bill/tax changes. This effect however, was not significant over all models that were constructed for this study. Framing the WTP to prevent a loss yields a significantly higher ratio than framing WTP as a gain. Having market experience has a significant negative effect on the ratio.

Interestingly, the geometric mean of the ratio among studies published before (Horowitz & McConnel, 2002) is twice as high as the corresponding ratio for studies published after. A variable was constructed to capture this effect of time. This variable, dubbed $Year$ was found to be negative. The negative time trend remains significant after controlling for changes in practices over time (Tunçel & Hammit, 2014).

In this thesis, I will investigate the determinants of the WTA and WTP for green energy in the Dutch population in the context of windmills. In addition, I will explore how these values relate to each other and how their ratio relates to the previous findings for environmental goods presented in (Tunçel & Hammit, 2014). Thereafter, I will distinguish 4 groups based on their WTA and WTP values (See 2.3) and check whether specific associations exist between these groups and demographic variables.

2.3 Identifying Different Groups using the WTA – WTP Disparity for Green Energy

As earlier mentioned, it is quite common for the WTA values to be substantially higher than WTP values for goods like green energy, which leads to a high disparity. However, this need not to be the case. From a policy point-of-view, a large disparity can be potentially problematic in this context when planning to construct more renewable energy sources.

A large disparity resulting from a high WTA and a low WTP would indicate that an individual does not want to pay for green energy, and also does not want it nearby given that they require a high compensation. These people can therefore be classified as opponents. Vice versa, a low WTA and high WTP would imply that this person shows acceptance for nearby wind energy and also would like to contribute to an increase of this cause. These people can be classified as proponents. Differentiating on magnitude, thereby creating $High$ and Low sub-groups of respondents in terms of their WTA and WTP, enables us to distinguish between 4 groups of people in the data and yields the following $2x2$ matrix:

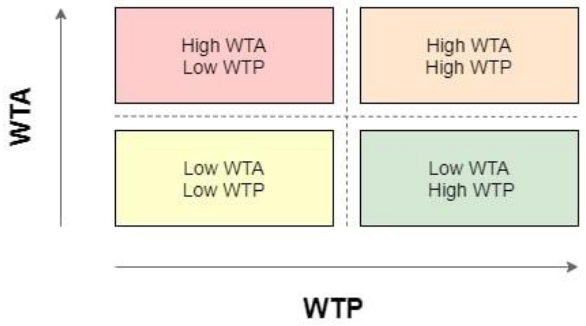

Figure 1: *2x2 matrix distinguishing 4 different groups based on WTA and WTP*

Each respondent will be allocated to a sub-group based on their WTA and WTP values. The cut-off point between $High$ and Low is set at the median value of the variable, as is discussed in detail in Section 4.2. The red marked group in Figure 1 can be seen as the opponents of green energy by windmills, while the green marked group can be seen as the proponents. The orange marked group consists of people who possibly exhibit NIMBY-preferences. They are willing to contribute, but require a high compensation for windmills near their home. The people in the yellow marked group do not seem to have a problem with nearby wind energy, but at the same time are not willing (or able) to financially contribute to this cause.

After allocation, group members can be compared to see whether they exhibit similar characteristics, next to similar preferences. Perhaps it is possible to predict who falls within which group, and policy-makers could design their plans to promote wind energy accordingly. More knowledge on this matter could also provide more insights in chances for policy-makers to steer people towards their intended goal, i.e. switch to a relatively more preffered group. For policy-designers, given their high WTA, the two groups on the top are most problematic since they are not likely to cooperate much with local wind energy plans. The two groups on the right, with high WTP, are perhaps the most interesting, since these people are potential co-operators.

> **Research Question 3:** *What are the demographic characteristics of sub-groups of respondents defined by high/low WTA and WTP?*

3 Data

This section will provide insights on the data that is used for this research. This includes a detailed description of the dataset, and an elaboration on how this data is used to find results. Furthermore, descriptive statistics are given.

3.1 Description of the Dataset

The data is provided by CentERdata, which is a non-profit research institute connected to Tilburg University. CentERdata gathers reliable data on research questions related to people and society. This is done commissioned by the academic society, the government and external market parties (CentERdata, 2020).

The surveys that are carried out are filled in by members of the LISS panel. LISS stands for Long-term Internet Studies for the Social sciences (translated from Dutch). The panel consists of 5000 selected households in the Netherlands. These households are spread over the whole country, and contain people from all layers of society. Panel members fill in one or multiple surveys per month, and are incentivized to do so by receiving a payment to compensate for their time every 3 months (LISS panel, 2020).

For this thesis, the survey “Hoopbarometer 2018” is used which was carried out in November 2018. This study is the second wave of the Hoopbarometer and is part of the project “Hope as motive” by the Erasmus Happiness Economics Research Organization. The survey was sent out to 1,166 randomly selected panel members, of 16 years and older. A total of 905 responses were received, yielding a response rate of 77.6%.

The survey consisted of the subjects *hope*, *social relations* and *climate*. In addition, some questions regarding the questionnaire in general were asked. Information on household demographics is also available in the dataset. The survey consisted of a total of 47 questions with the average response time being just under 15 minutes (893 seconds).

For this thesis, the focus will lay on the questions regarding *climate*. Questions were asked on climate change and to what extent this is perceived as an issue. In the context of renewable energy, the questions were about windmills.

The remainder of the *climate* questions revolved around product/resource usage for environmental reasons. The questions about windmills are mainly interesting for this thesis, and the answers to these specific questions will help to answer the research questions.

3.1.1 Questions regarding Windmills

Respondents were first asked whether they are in favour or against an increase in wind energy supply in the Netherlands in the form of more windmills. Then, respondents had to state highest amount in additional monthly taxes they would definitely be willing to pay for a period of one year to contribute to this cause on a payment scale ranging from €0 to €100 (or 'more', see Figure 2). In the case the respondent gave $€0$ as an answer, they were asked for their motivation in a multiple-choice question; see $q36a$ in Appendix A. If the respondent answered the maximum amount of €100 or more, they were asked to state their actual maximum willingness to pay in an open question, $q36b$.

Next, respondents who answered in between the minimum and the maximum amount were presented the same payment scale again and asked to indicate the lowest amount in additional monthly taxes they would definitely not be willing to pay for a period of one year to contribute to this cause. Finally, respondents were asked what amount between their responses on the payment scales comes closest to their actual willingness to pay additional monthly tax.

Suppose the government wants to pay for these windmills through a tax increase that must be paid by all taxpayers in the Netherlands. This tax increase is for one year and must be paid monthly.

View the amounts below, starting from the left, and choose the highest amount that you would certainly want to pay extra in tax per month for building windmills. Take into account the net monthly income and any savings of your household. If you don't pay tax, imagine what you would pay if you did pay tax.

€0	€5	€10	€15	€20	€25	€30	€35	€40	€50	€75	€100	More
○	○	○	○	○	○	○	○	○	○	○	○	○

Figure 2: *question 35 – minimum WTP*

Next, the context switched from willingness to contribute financially to an increase in wind energy supply in general, to willingness to contribute to an increase in supply by accepting placement of windmills within $500 - 1{,}000$ meters of where they live. Firstly, respondents were asked whether they are the owner of the home they are currently living in. Respondents were then informed about the negative effects the wind turbine near their house could have: noise disturbance, horizon pollution and a depreciation of their house value up to a maximum of 5%.The first question posed to responders was to indicate on a payment scale ranging from €0 to €50,000 (see Figure 3) the highest amount that they would definitely not accept as a compensation for this purpose from the government.

Suppose the government wants to build a windmill near your home, 500 to 1,000 meters away. It is known that windmills can cause noise and that some people do not like the view of a windmill. A windmill near your home can therefore have a negative impact on your living enjoyment. If you own the home, it can also lead to a decrease in the value of your home by up to 5%. The government could reimburse you for these consequences.

View the amounts below, starting from [left], and choose the highest amount that you would certainly not accept as a one-time fee for building a windmill near your home, because you think this fee is too low. Take into account the possible consequences mentioned above.

€0	€5.000	€10.000	€15.000	€20.000	€25.000	€30.000	€40.000	€50.000
○	○	○	○	○	○	○	○	○

Figure 3: *question 41 – minimum WTA*

In case the respondent indicated a WTA of €0, they were asked for their motivation in a multiple choice question. If the maximum amount was answered (€$50{,}000$), the respondent was asked to state their actual minimum WTA in terms of compensation in an open question. Besides that, another multiple choice question was shown where the respondent could indicate that no amount is sufficient to cover for the effects, see $q42a$, $q42b$ and $q42b\_geen$ in Appendix A.

Next, respondents were presented the same payment scale again and asked asked what the lowest amount is they would definitely accept as a compensation. Finally, respondents are asked what amount between their two responses on the payment scale comes closest to their actual willingness to accept as the (one-off) compensation for building windmills within $500 - 1{,}000$ meters of their home in an open question. See Appendix A for a detailed overview of all (relevant) survey questions and how they were structured.

3.2 Data Transformations

To begin with, the dataset is cleansed by removing the questions about *hope* and *social relations*, such that only the *climate* questions remain. Of these questions, only the ones about wind energy are kept, along with the general questions on demographics and questions about environmental attitude.

Next, all respondents that did not fill in all remaining questions of interest were dropped from the sample. A total of 12 respondents were dropped based on this reason. Also, respondents under the age of 18 were excluded for analysis given that it is reasonable to assume that these individuals do not represent the preferences of the adult, tax-paying population in this context. A total of 21 respondents were dropped for this reason.

Furthermore, in the case no information is available on household income, the observation is also deleted since this is one of the main variables of interest. This amounts up to a total of 73 observations, with 799 remaining in the dataset.

Unfortunately, besides true zeroes, there are also some protest zeroes present in the dataset. This does not come as a surprise however, as willingness to accept and willingness to pay questions on environmental subjects are prone to receiving protest answers (Meyerhoff & Liebe, 2010). These are undesirable for analysis and should therefore be removed since these observations deteriorate the integrity of the data as true preferences are not reflected (Rankin & Robinson, 2018).

Meyerhoff and Liebe also note the general absence of reporting how protest answers were defined and how many are removed in the studies that were analysed. Therefore, I will touch upon this topic in more detail. I distinguish the following types of protest answers in WTA context:

- *People who filled in an explanation that could be interpreted as "I do not know/I have no idea"*
- *People who answered* €0 *as their WTA, given the explanation that they do not agree with receiving a compensation in the following multiple choice question* ($q42a$) *or if their explanation clarifies that they would not actually accept* €0
- *People who answered an unreasonably high amount, i.e. the most extreme outliers which corresponds with asking for* $>$ €$250{,}000$

When answering €0, respondents also had the opportunity to indicate that they would have no objection to a windmill near their home or that they would not expect to experience any effects ($q42a$). In this case, the observation is kept as a true zero. A total of 12 respondents required a compensation of $>$ €$100{,}000$, $^1/_3$ of these outliers are deleted which corresponds with asking a compensation of $>$ €250000. The deleted responses ranged from €$350{,}000$ to €$5{,}000{,}000$. These amounts can be considered unreasonable given the potential decrease to house value resulting from a nearby windmill which was presented to be a maximum of 5%.

In WTP context, the following types of protest answers are defined:

- *People who answered they are not willing to pay at all* ($WTP =$ €0) *since they believe the government should pay*
- *People who indicate that they are not willing to pay for other reasons than their valuation of wind energy of €0*
- *People who indicate they are not able to pay*

A distinction is made for the case of $WTP =$ €0, it could point to a protest answer, but not necessarily. This is decided based on the explanation of the respondent's choice for 0 in the open question. An indication that €0 corresponds with the respondent's actual valuation of wind energy is counted as a true zero, whereas otherwise this is counted as a protest zero.

There were few outliers for WTP, the only one that is excluded was also the most extreme one, namely €400, since his reasoning to do so in $q38$ classified this respondent as a protest answer.

Finally, all the open questions where respondents had to explain their choices for choosing €0 were manually searched to see whether the answer can be classified as a protest answer and these were then correspondingly deleted. The full observation was deleted since values for both parameters need to be present for the comparison in *RQ3*, 46 observations are deleted.

A total of 259 protest answers are deleted, leaving the final dataset with a total of 540 respondents. The WTA questions contained the most protest answers, namely 188, which added up to a total of 72.59% of protest answers. A total of 71 protest answers (27.41%) were deleted based on WTP questions.

3.3 Descriptive Statistics

The following demographic variables are described making use of the cleansed dataset ($Model\ I$) and the full dataset ($Model\ II$). As can be seen in Table 1 the descriptive statistics of the demographics vary only slightly after removing incomplete and protest answers.

Variable	Model I					Model II				
	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max
Age	540	52.03	17.80	18	88	905	52.22	18.39	16	91
Gender	540	1.53	0.50	1	2	905	1.54	0.50	1	2
Education	540	4.04	1.49	1	8	905	3.96	1.29	1	9
Income	540	3,310.32	1,763.63	0	11,650	905	3,215.36	1,693.28	0	11650
Household Size	540	2.43	1.26	0	7	905	2.47	1.60	1	8

Table 1: *Descriptive statistics of demographics of the full dataset and filtered dataset*

As can be seen in Table 1, the average age of respondents is quite high. This high average is the result of high prevalence of respondents in the oldest age groups. There are slightly more females present in the dataset then males, and most of the respondents successfully completed a form of higher education. For income, we look at net household income rather than personal income since decisions in this context are typically made based on disposable income (compensation is received per household). Also, 67.22% of respondents own the house they are currently living in themselves. Please see Table 2 below for a detailed overview of demographics:

Variable		Frequency	Percentage
Age	18-24 years old	47	8.70%
	25-34 years old	68	12.59%
	35-44 years old	64	11.85%
	45-54 years old	95	17.59%
	55-64 years old	115	21.30%
	65+ years old	151	27.96%
Gender	Male	255	47.22%
	Female	285	52.78%
Income	≤ €2,000	122	22.59%
	€2,001 – €3,000	142	26.30%
	€3,001 – €4,000	117	21.67%
	€4,001 – €5,000	91	16.85%
	> €5,000	68	12.59%
Education	Low	199	36.65%
	Middle	123	22.78%
	High	218	40.37%
Home Ownership	Yes	363	67.22%
	No	177	32.78%

Table 2: *Display of how respondents are distributed over the dataset*

The distribution of net income in the dataset is very similar to the distribution of general household income in the Netherlands computed by the CBS in 2018 (CBS, 2019). Both histograms are slightly skewed to the right. CBS calculated the average yearly income to be €$29{,}500$, or €$2{,}456.33$ monthly. The lion's share of respondents' households thus earn slightly below the Dutch national average. Education is categorized in low/middle/high which contain people who successfully completed elementary/high school, MBO and HBO/University respectively.

The following tables contain information on the wind energy related questions. As Table 3 interestingly reveals, the level of disagreement increases heavily the closer the windmill is built. A relatively higher share of respondents either agree or strongly agree with a general increase compared to a local increase (i.e., $86.67\% vs. 42.04\%$). This is in line with expectations based on earlier findings regarding NIMBYism mentioned in Section 2.2.2.

Increase in general supply of wind energy ↓	Increase in supply of wind energy within 500 – 1,000 metres ←					Total
	I strongly agree	I agree	I disagree	I strongly disagree	No opinion	
I strongly agree	28	76	32	14	12	162
I agree	4	117	109	28	48	306
I disagree	0	0	7	11	1	19
I strongly disagree	0	0	1	4	0	5
No opinion	0	2	13	7	26	48
Total	32	195	162	64	87	540

***Table 3**: Crosstable displaying the level of agreement when the government plans to increase the general/local supply of wind energy (q34 & q40)*

See Table 4 for descriptive statistics on WTP. Recall that $q35$ denotes the question where the upper bound of the WTP is defined, i.e. *highest amount* definitely willing to pay. Then, $q36c$ denotes the question where the lower bound is defined, i.e. *lowest amount* definitely *not* willing to pay. The actual filled in maximum WTP value is then denoted by $q37$. ''Missing'' values for this variable consisted of respondents who answered €0 or $>$ €100 at $q35$. These ''missing'' values are replaced by actual answers accordingly for calculations, such that $q37$ has 540 observations.

Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
$q35$ *(lower bound)*	540	17.82	25.34	0	250
$q36c$ *(upper bound)*	511	38.86	27.59	10	100
$q37$	540	24.22	22.13	0	250

***Table 4:** Descriptive statistics of WTP questions. See Appendix A for full questions. The number of observations is lower for q36c since only the respondents who answered in between the maximum/minimum amount for q35 were shown this question. The – for this reason – missing values in q37 are complemented with given answers resulting from q35.*

Descriptive statistics on WTA are displayed, in the same way as WTP, in Table 5. Here $q41$ denotes the question where the upper bound of the WTA is defined, i.e. the *highest amount* definitely *not* accepted. Then, $q42c$ denotes the question where the lower bound is defined, i.e. the *lowest amount* definitely accepted. The actual filled in WTA value is denoted by $q43$. Missing values of this variable consisted of respondents who answered €0 or $> €50{,}000$. The missing values were replaced by actual values for further calculations using this variable.

Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
$q41$ *(lower bound)*	540	22,046.57	27,701.34	0	250,000
$q42c$ *(upper bound)*	443	30,225.73	13,837.08	10,000	50,000
$q43$	540	29,244.18	27,880.50	0	250,000

Table 5: *Descriptive statistics of WTA questions. See Appendix A for full questions. The number of observations is lower for q42c since only the respondents who answered in between the maximum/minimum amount for q41 were shown this question. The – for this reason – missing values in $q43$ are complemented with given answers resulting from $q41$.*

What is interesting following from these tables is that for WTP, the mean of $q37$ is closer to the mean of the lower bound ($q36c$) and for WTA, the mean of $q43$ is near the mean of upper bound $q42c$. A histogram presenting the distribution of WTP/WTA over the dataset is presented below.

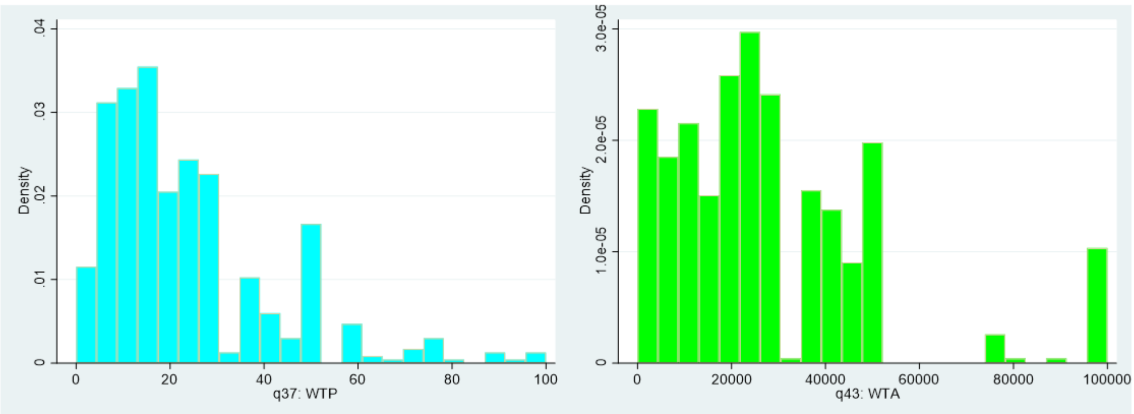

Figure 4: *Histograms displaying the distribution of WTA and WTP values over the dataset. The x-axis ranges from 0 to the maximum answer that is presented in the survey, which are €100 and €100,000. Outliers are excluded from the histogram for a clearer overview. For WTP, the outliers ranged from €200 – €250. For WTA, the outliers ranged from €150,000 – €250,000. See Appendix B for the (complete) corresponding frequency tables.*

Both histograms are skewed to the right. What is interesting to see in the WTP histogram is the spike at €50, such that there is no monotonical decrease. The same applies for the spikes in the WTA histogram.

The right skewness of the WTA histogram implies the presence of a certain degree of acceptance for an increase in local wind energy, as this corresponds with relatively low compensations. The sudden spikes at €50,000/€100,000 could possibly be caused by the general preference of people for round numbers, which naturally also allow easier mental processing (Kettle & Häubl, 2010).

4 Methodology

In this section the methods of analysis are discussed. The section is split up into two parts. The first part explains how the WTA and WTP are examined, and how their determinants are investigated. The second part will then focus on how the matrix (see Figure 1 in Section 2.3) is formed, and how these groups are further analysed to identify opportunities for policy designers.

4.1 WTA & WTP Analysis

As already stated in the Data section, a variable was created containing a WTA and WTP value for each respondent, of which the means are already displayed for the cleansed dataset in Table 4 and Table 5. These values will be compared with values following from the full dataset in order to see whether the average is significantly different after filtering the dataset. A t-test on equal means will be conducted.

As can be clearly seen in Figure 4 both the WTA and WTP do not seem to follow a normal distribution and are skewed. Therefore, a simple OLS regression is not suited to examine effects. The continuous variable for WTA/WTP, which is now denoted by $q43/q37$, will be categorized after which it is possible to analyse using an ordered logit model. An ordered logit is preferred over an unordered logit since the categorization of WTA/WTP reflects a ranking of the scores.

In order to apply an ordered logit model, four assumptions must be satisfied. The dependent variable needs to be categorical, one or multiple independent variables are continuous, categorical or ordinal, there is no multi-collinearity and the data must fulfil the parallel regression assumption. This assumption means that the relationship between each pair of outcome groups needs to be the same. This implies that the coefficient of explanatory variable X is the same for all groups, such that there is only 1 model needed to model the relationship. If this would not be the case, the coefficient of explanatory variable X will be different for category 1, 2, 3 etc. A Brant test (Brant, 1990) will be used to verify whether this assumption holds (UCLA: Statistical Consulting Group) (Williams, 2006) (Williams, 2016).

The assumption tests are conducted for the final models. Models for WTA and WTP are tested separately and the results can be found in Appendix C in the corresponding section.

4.1.1 WTA logistic regression

The pattern of the right histogram in Figure 4 mostly resembles a preference of respondents for round numbers. Therefore these salient values need to be taken into account when choosing cut-off values for the categories. An equal quintile-based division would not result in plausible estimates since this will result in group members who have a substantially different WTA. For example: someone who would not require a compensation at all is different from someone who asks for €$10{,}000$ in essence.

The respondents are categorized into 6 groups. The choice of 6 groups follows from a distinction between $low/middle/high$ values. Such a division however, would generate large differences within groups and the cut-off values would be very arbitrary. Therefore these three groups are each split into two, and the choice for cut-off values is based on a nearly equal distribution among categories. The exact categorization can be found in Table 6 below.

q43: WTA	Size	Percentage
€0	52	9.63%
€1 – €14,999	98	18.15%
€15,000 – €24,999	110	20.37%
€25,000 – €35,000	130	24.07%
€35,001 – €50,000	112	20.74%
€50,001 – max	38	7.04%

Table 6: *Categorizing of the sample population by Willingness to Accept (q43)*

Variable selection is done in 2 steps. Step 1 could be interpreted as the *confirmation* stage, in which variables that are relevant according to literature and available in the dataset are selected. Step 2 can be seen as the *exploration* stage, in which the dataset is searched for additional variables that might influence the independent variable WTA. These additional variables are then added to the model to see whether they improve the model and influence relations in the base model. See Appendix C.1 for a detailed overview of model creation.

The determinants of WTA according to the literature are summarized in Section 2.2.1. Based on this literature review, and the data that is available, the following explanatory variables will be included in the final model (base model): age (in categories), $gender$ (as a dummy for male), $education$ (in categories), $area\ of\ residence$ (as a dummy for urban), $household\ income$ (net per month in €), $income^2$ (to control for varying effects of income per level of income) and $home\ ownership$.

Based on the sign and the significance of the coefficients estimated in the model, it can be concluded whether an increase (decrease) in the factor results in a higher (lower) probability of the highest (lowest) WTA category, ceteris paribus.

4.1.2 WTP logistic regression

For ordered logit estimation, the sample population is divided in 5 groups. The choice of 5 groups follows from a (near equal) division in 3 groups ($low/middle/high$). Then, the $high$ and low groups are each again divided into two separate groups.

The choice for such a division is again based upon the reasoning that dividing in equal quintiles would results in placing people in the same category whose answer is substantially different from respondents who are in the same group. For example, someone who wants to pay nothing is different from wanting to pay a little in essence, the same applies for the other end of the spectrum.

Therefore, the extrema form a separate category. This results in a nearly symmetrical distribution around the $middle$ category, as can be seen in Table 7.

q37: WTP	Size	Percentage
€0	27	5.00%
€1 – €14	153	28.33%
€15 – €25	182	33.70%
€26 – €50	143	26.48%
€51 – max	35	6.48%

Table 7: *Categorizing of the sample population by Willingness to Pay (q37)*

The same method of variable selection is applied as for WTA, described in Section 4.1.1. A detailed overview of model creation can be found in Appendix C.2. The determinants of WTP are summarized in Section 2.2.2. Based on this literature review, and the data that is available, the following explanatory variables will be included in the ordered logistic regression: age (in categories), $gender$ (as a dummy for male), $education$ (in categories), $household\ income$ (net per month in €), $household\ size$ and Also, the quadratic term $income^2$ is added, which is the net household monthly income squared, to control for varying effects of income.

Based on the sign and the significance of the coefficients estimated in the model, it can be concluded whether an increase (decrease) in the factor results in a higher (lower) probability of the highest (lowest) WTP category, ceteris paribus.

4.2 WTA/WTP Matrix

Based on the WTA and WTP categories from Section 4.1.1 and Section 4.1.2, the respondents will be allocated to the corresponding group following from Figure 1. Since the WTA and WTP questions did not revolve around the exact same good, the disparity between these values per se is not as meaningful. Therefore the distinction is made between $high$ and low, and the disparity is investigated in that sense.

For WTA, there are 6 categories, which allows easy division. The $high$ group will consist of the three top categories, and the low group consists of the three bottom categories. Since the median value of $q43$ is equal to $€25{,}000$ this yields the same outcome as choosing the median value as cut-off point for $high$ and low.

The 5 categories for WTP are not as easily divided. Therefore, the distinction is made based on the median value of $q37$, which is also exactly the middle value in category 2 namely $€20$. The $high$ group thus consists of respondents whose WTP is $\geq €21$, et vice versa. The sizes of the four matrix groups are presented in Figure 6 below.

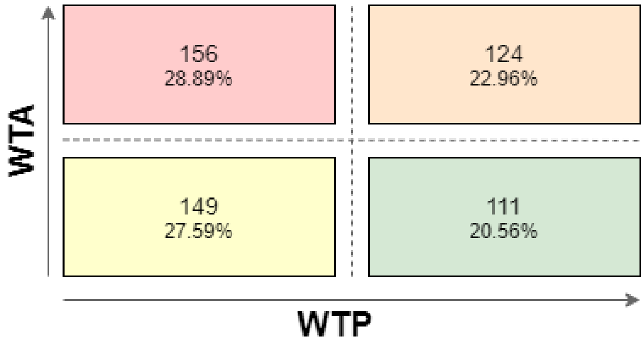

Figure 6: *The sizes of the four matrix group. The size is displayed in terms of frequencies and percentages. The groups have the same implication as in Figure 1.*

Recall that each group has a certain implication for one's view on increasing wind energy. Each group will be analysed separately to inspect which types of people (in terms of various characteristics) are located in each group. The groups will also be compared to each other to examine whether there are substantial differences in characteristics between groups.

This information, combined with the results from the logistic regressions on WTA and WTP will make it possible to identify where opportunities lay for policy designers to move towards the goal of an increase in wind energy supply. This could for example be done by designing plans accordingly, or attempt to make people cooperate, i.e. switch groups.

5 Results

This section, presenting the results of the previously discusses analysis, is split up into three parts. Firstly, the results of the logistic regression on WTA are discussed, followed by the results for WTP. Thereafter, the results of the matrix analysis are displayed.

5.1 Willingness to Accept – results

The mean WTA for the filtered dataset, after removing incomplete- and protest answers, was €29,244. For the full sample, the mean WTA is equal to €32,535. In this sample, respondents who indicated that no amount would be sufficient as a compensation are excluded since no WTA value could be obtained for this observation. The mean is then calculated based on 787 observations. A simple t-test points out that the null hypothesis of equal means can be rejected at a 1%-significance level ($p = 0.0063$). It comes to no surprise that the mean is lower post filtering since protest answers in this context are likely to be high values.

Table 8 summarizes the results of the ordered logistic regression on the WTA categories.

Variable		**ß**	**Robust St. Err.**	**z**	**P> |z|**	**[95% CI]**	
Age	*25 - 34*	0.3027	0.3726	0.81	0.418	-0.4276	1.0330
	35 - 44	0.8006	0.3654	2.19	0.028**	0.0845	1.5167
	45 - 54	0.8441	0.3685	2.29	0.022**	0.1220	1.5663
	55 - 64	0.8803	0.3339	2.64	0.008***	0.2259	1.5356
	65+	0.5699	0.3231	1.76	0.078*	-0.0633	1.2031
Gender	*Male*	-0.3441	0.1576	-2.18	0.029**	-0.6530	-0.0352
Education	*Middle*	0.4903	0.2226	2.20	0.028**	0.0539	0.9267
	High	0.5822	0.1918	3.04	0.002***	0.2063	0.9581
Residence	*Urban*	0.4706	0.1666	2.83	0.005***	0.1441	0.7971
	Income	0.0001	0.0000	2.50	0.012**	0.0000	0.0002
Home Ownership		0.3762	0.1958	1.92	0.055*	-0.0075	0.7600
/cut1		-0.6697033	0.3426916			-1.3414	0.0020
/cut2		0.6978877	0.3457775			0.0201	1.3760
/cut3		1.649702	0.3535979			0.9567	2.3427
/cut4		2.759748	0.3700934			2.0344	3.4851
/cut5		4.472014	0.4162958			3.6561	5.2879

Table 8: *Results from the ordered logistic regression on Willingness to Accept.*

A total of 534 respondents are included in the model, given that there were 6 missing values for $Residence$. The corresponding Wald χ^2-estimator is equal to 48.02 ($p = 0.000$) with degrees of freedom $= 11$. Pseudo-R^2 = 0.0305. As can be found in Appendix C.1, the displayed model satisfies the parallel regressions assumption.

As becomes clear from the results, all factors in the final model have a significant effect on WTA. Individuals who are 35 or older have a higher probability of reporting a higher WTA as compared to individuals that are $18 - 24$ years old, ceteris paribus. This effect is statistically significant at the 5%-level for age groups $35 - 44$ and $45 - 54$, at the 1%-level for $55 - 64$ and at the 10%-level for $65 +$.

Furthermore, $males$ have a lower probability of being in the highest WTA category than $females$, ceteris paribus. This effect is statistically significant at the 5%-level. An effect for $education$ has also been found, as having higher educational attainment than elementary levels increases the probability of being in the highest category. This effect is significant at the 5%-level, and even at the 1%-level for those who completed the highest form of education in the Netherlands.

The $area\ of\ residence$ also seems to significantly influence WTA. Living in an urban area, which means living in an area described as very to somewhat urban, increases the probability of being in the highest category compared to not living in an urban area. This effect is significant at the 1% level. People living in a rural area will presumably experience less negative effects from nearby wind energy compared to people in urban areas, and therefore indicate a lower WTA.

As expected, the effect of $income$ is statistically significant at the 5%-level. The positive sign of the coefficient implies that having a higher household income increases the probability of being in the top WTA category, ceteris paribus.

The square term of income is not included in the final model, since inclusion makes the effect of income insignificant overall as seen in Table C.1 . This insignificance indicates that the marginal effect of income is not dependent on the level of income, ceteris paribus.

The coefficient for home ownership is positive, implying that being the owner of your current home also increases the probability of being in the top WTA category, ceteris paribus. This effect is statistically significant at the 10%-level. People who own their current home, will probably have more insight in the “damage” a nearby windmill will cause them, and therefore indicate a higher WTA.

5.2 Willingness to Pay – results

The mean WTP for the filtered dataset, after removing incomplete- and protest answers, was €24.22. For the full sample, the mean WTP is equal to €19.28. From this sample, a total of 10 observations are excluded since they did not fill in the questions that revolved around this topic, so the mean is calculated based on 895 observations. A simple t-test points out that the mean found in the filtered dataset is significantly different from the mean resulting from the full dataset $(p = 0.000)$. It comes to no surprise that the mean is higher post filtering since protest answers in this context are likely to be low values.

Table 9 summarizes the results of the ordered logistic regression on the WTP categories.

Variable		**ß**	**Robust St. Err.**	**z**	**P> |z|**	**[95% CI]**	
Age	*25 - 34*	-0.7593	0.3790	-2.00	0.045**	-1.5022	-0.0164
	35 - 44	-0.8440	0.3599	-2.35	0.019**	-1.5494	-0.1386
	45 - 54	-0.8595	0.3393	-2.53	0.011**	-1.5246	-0.1945
	55 - 64	-0.7224	0.3204	-2.25	0.024**	-1.3505	-0.0945
	65+	-0.6154	0.3201	-1.92	0.055*	-1.2428	0.0119
Education	*Middle*	-0.0248	0.2158	-0.12	0.908	-0.4478	0.3982
	High	0.2574	0.2019	1.27	0.202	-0.1383	0.6531
	Income	0.0005	0.0001	3.26	0.001***	0.0002	0.0008
	Income^2	-3.33e^{-8}	1.35e^{-8}	-2.47	0.014**	-5.96e^{-8}	-6.87e^{-9}
	Household size	-0.1880	0.0886	-2.12	0.034**	-0.3617	-0.0143
	/cut1	-2.918065	0.4023686			-3.723058	-2.113072
	/cut2	-0.6088208	0.3800236			-1.361203	0.1435609
	/cut3	0.8579523	0.3822389			0.1006127	1.615292
	/cut4	2.860955	0.4025086			2.057343	3.664647

Table 9: *Results from the ordered logistic regression on Willingness to Pay.*

A total of 540 respondents are included in the model, given that there are no missing values for any of the included variables. The corresponding Wald χ^2-estimator is equal to 30.03 $(p = 0.0016)$ with degrees of freedom$= 11$. Pseudo-R^2 = 0.0194. As can be found in Appendix C.2, the model satisfies the parallel regressions assumption.

The effect of age is significant at the 5%-level for all but the highest age category, which effect is significant at the 10%-level, and remains negative for all age categories. This indicates that individuals who are older than 25 have a higher probability of being in the lowest WTP category, ceteris paribus, compared to $18 - 25$ year olds. This is in line with earlier findings regarding age and WTP.

Gender is eventually dropped from the final model, since when included, the parallel regression assumption was not satisfied. The effect was also insignificant at even the 10%-level in both the univariate/multivariate analysis, thus implying that being male has no effect on the probability of being in the highest WTP category compared to being female, ceteris paribus. This is in contrast to earlier findings in literature, where a significant effect for gender was found.

The same applies for education, where the coefficients of $middle$ and $high$ are insignificant at the 10%-level. In the univariate model, the coefficient of $high$ was significant. Including a dummy for higher educated however, does not lead to a significant effect at the 10%-level in the multivariate analysis, likely due to the high correlation between higher education and income. Excluding education from the model does not alter the sign nor the significance of the other coefficients.

The effect of income is positive and highly statistically significant. This indicates that having a higher income, ceteris paribus, increases the probability of being in the top WTP category. The squared income term is also significant at the 5%-level, implying that the effect of income is also dependent on the level of income. The negative sign means that the effect decreases for higher levels of income. The positive effect is in line with earlier findings in literature.

Furthermore, the coefficient for household size is negative, implying that having a larger household size increases the probability of being in the lowest WTP category, ceteris paribus, which is also in line with earlier findings in literature. The effect is significant at the 5%-level.

5.3 WTA & WTP Matrix – results

As described in Section 4.2, each matrix group is analysed separately to examine whether there are substantial differences in distribution among groups. These differences could identify where potential co-operators of wind energy plans can be located, but also where possible opponents are.

This information can be used to implement plans to increase the supply of wind energy in the Netherlands at locations where the degree of cooperation of local residents is relatively high on the one hand, and the degree of resistance from the locals is relatively low in terms of compensation requirements. Therefore especially the difference between group 1 and group 4 is interesting. These groups correspond to the red (group 1) and green (group 4) fields in the matrix in Figure 1 and Figure 6.

In order to visualize potential differences between matrix groups, bar graphs are created displaying the distribution of the demographic variables per matrix group. Since the groups differ in size, relative distributions are displayed, meaning each bar (and the numbers above them) represents a percentage.

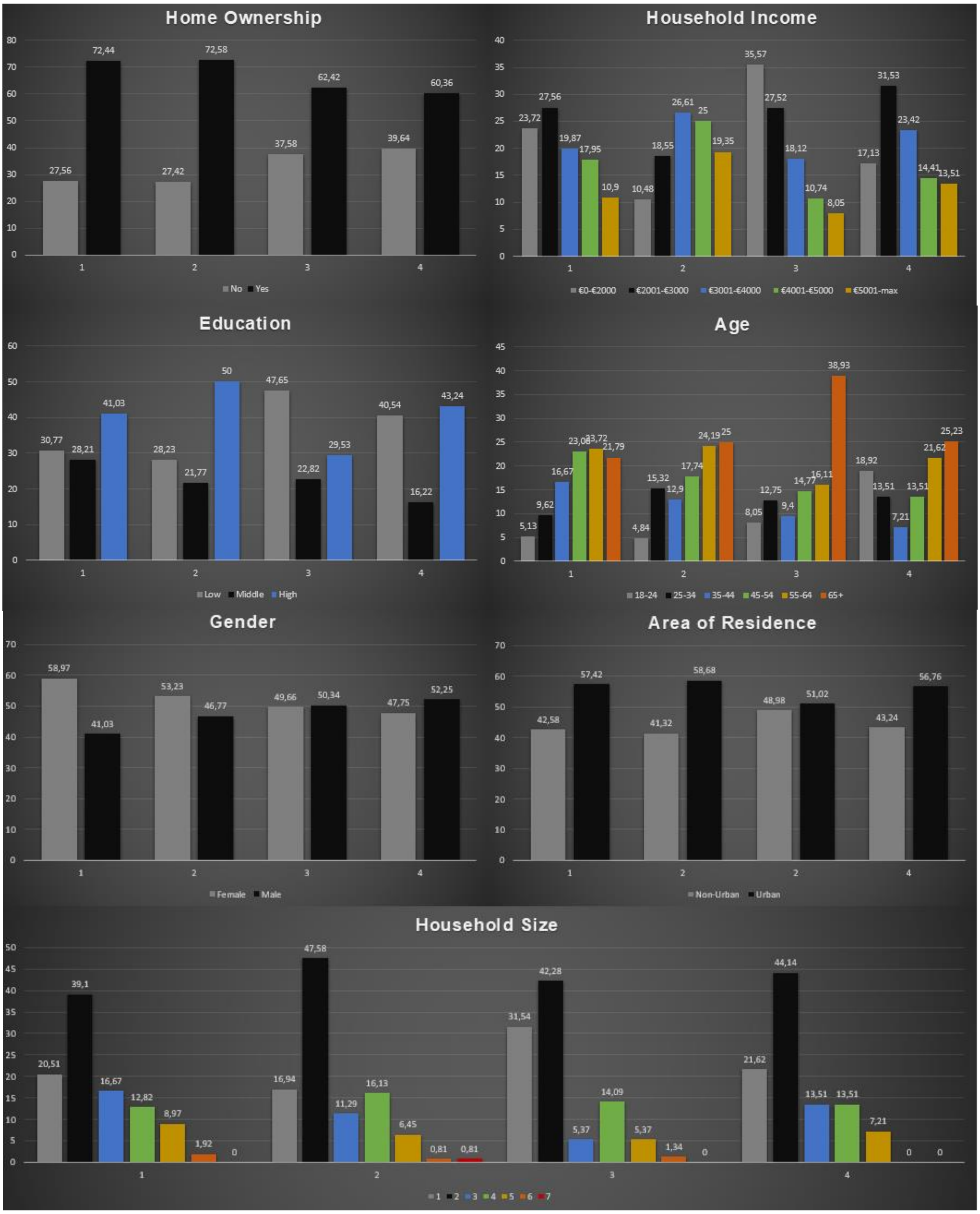

Figure 7: Bar graphs displaying the distribution of various demographic variables across the different matrix groups. The numbers represent percentages. Hence, the relative distribution is displayed. Every variable that is included in either the WTA or the WTP model is included in this analysis.

These bar graphs allow a characterisation of groups with reference to these variables. Group 1 (high WTA, low WTP) includes the highest proportion of home owners, many respondents from lower income groups, higher educated people, slightly more females and 70% of the group members are 45+ years old. More group members live in an urban area relative to a rural area.

Group 2 (high WTA, high WTP) also mostly includes home owners, but the share of middle and high incomes is higher than in group 1. In this group the share of members who have followed a higher form of education is the highest. The group is nearly equally split among men and women. More group members live in an urban area compared to a rural area.

The division of household income is clearly different in group 2 than in group 1, indicating that from respondents who have a high WTA, the one's that also have a high WTP have a higher income.

Group 3 (low WTA, low WTP) shows a clear difference in distribution of household income, were the lower income groups are over-represented. This is in line with the positive coefficients found for $Income$ in both the WTA and the WTP models. The share of lower education is also the highest in this group, which possibly is related to the over-representation of lower income. The lower income can also be the result of the large share of members being 65+ years old, which is the largest of all groups by far. This group displays a near equal split between male – female and urban – non urban area of residence.

Lastly, group 4 (low WTA, high WTP), which can be classified as the possible co-operators, has the largest share of members with a lower household income, despite having a high WTP. Lower and higher educated are equally represented in this group, and form the largest shares. This groups contains the largest share of younger members, where the share of 65+ members is very close to that of group 2. The group contains nearly as much females as males. More group members live in an urban area compared to a rural area.

As can be seen in the graph for $Home\ Ownership$, a clear distinction can be made between groups 1-2 and groups 3-4, which corresponds with high – low WTA. The share of home owners (black bars) is lower for the high WTA groups, which does not come as a surprise since the coefficient found in Section 5.1 was positive and significant. For both groups, the differences intra-group are very small.

In the graph of $Education$, a clear difference between groups 1-2 and groups 3-4 can also be found. Both group 3 and group 4 have a much larger share of lower educated members than group 1 and group 2. Since group 3-4 correspond with low WTA, this finding is in line with the positive coefficient for $Education$ resulting from the WTA model.

Household size follows the same distribution across matrix groups. Except for group 3, where the share of one-person households is larger than for the other groups. It is no surprise that these households are in this specific group, since their disposable income (hence, WTP) is presumably lower and the WTA is lower because these one-person households are possibly not tied to their current home for the long-term just as larger households could be.

Table 10 displays the mean WTA and WTP of each matrix group. We see that intra-groups, in general the differences are small. Except for the larger difference in mean WTA between group 1 and group 2. Although this is partly driven by the presence of the outlier $(250{,}000)$, which accounts for €$1{,}603$ of the total mean. The mean WTA of group 1 adjusted for this outlier is equal to €$46{,}735$, which is still notably higher than the mean of group 2 although no longer statistically significant $(p = 0.1290)$.

Variable	Matrix group	N	Mean	St. Dev.	Minimum	Maximum
	1	156	48,038.42	33,317,24	25,000	250,000
	2	124	43,143.56	23,770.23	25,000	150,000
WTA	3	149	11,155.71	7,784.25	0	24,500
	4	111	11,584.34	7,402.05	0	24,000
	1	156	11.03	5.58	0	20
WTP	2	124	40.56	18.70	21	100
	3	149	11.51	5.94	0	20
	4	111	41.58	29.11	21	250

Table 10: *Descriptive statistics of mean WTA and mean WTP divided per matrix group*

As earlier mentioned, especially the comparison between group 1 and group 4 is interesting. First, a two-sample variance comparison-test is conducted to see whether the variance of various variables differs between these groups. The outcome of this test is then used to determine whether equal/unequal variances are assumed when using a t-test to test for significant differences between groups 1 and group 4. Unequal variance is assumed only for the tests of Age and $Home\ Ownership$, as these were the only variables for which the variance-comparison tests yielded a significant outcome.

Table 11 displays the results of the t-tests on significant differences between group 1 and 4.

Variable	**Group**	**Mean**	**Std. Dev.**	**T**	**p(diff ≠ 0)**
Age (continuous)	1	52.0192	15.4967	-1.3133	0.1906
	4	49.0270	20.1339		
Gender	1	0.4103	0.4935	-1.8194	0.0700*
	4	0.5225	0.5018		
Education (Low – Middle – High)	1	2.1026	0.8438	-0.6946	0.4879
	4	2.0370	0.9191		
Income	1	3,265.76	1,810.962	0.4916	0.6234
	4	3,374.78	1,749.73		
Home Ownership	1	0.7244	0.4483	-2.0519	0.0413**
	4	0.6036	0.4914		
Area of Residence (Urban – Non-urban)	1	0.5742	0.4961	-0.1073	0.9146
	4	0.5676	0.4977		
Household Size	1	2.5641	1.3010	-1.0211	0.3081
	4	2.4054	1.1784		

Table 11: *Outcomes of the two-sample t-tests, whereby the means of the variables in the regression models of matrix group 1 and group 4 are compared. The * indicate significance levels.*

The only significant differences between group 1 and group 4 are observed for $Gender$ and $Home\ Ownership$. The means of $Gender$ are significantly different ($p(group\ 1\ \neq group\ 4)$) at the 10%-level, with corresponding $p(group\ 1 < group\ 4) = 0.0350$. This indicates that the share of males in group 4 is higher, and this is significant at the 5%-level. The difference in mean in home ownership between group 1 and group 4 is significant at the 5%-level, with corresponding $p(group\ 1 > group\ 4) = 0.0207$. This indicates that the share is homeowners is higher in group 1, and this is also significant the 5%-level. A significant difference for Age is found however, when using the categorical variable for age ($p = 0.0881$), with corresponding $p(group\ 1 > group\ 4) = 0.0440$. This indicates that lower age categories are less represented in group 1, and this finding is significant at the 5% significance level.

No further conclusions based on statistical inference about the differences between co-operators (group 4) and opponents (group 1) of wind energy can be made due to the absence of further statistically significant differences between these groups and their members.

6 Discussion

Earlier attempts to increase the supply of wind energy have been faced with resistance by local residents and even with protests. By analysing the WTA and WTP values of the Dutch population, more insight is provided in which factors are of influence here. This knowledge on the determinants could contribute to implement these strategies more efficiently and effectively in the future, to move forwards towards the goal of more clean energy.

The found WTA and WTP values were indeed quite unevenly distributed over the sample. The mean WTA that was found for the Dutch population is equal to $€29{,}244$ and the mean WTP is equal to $€24.22$. The wide variety of answers (and high variance) for each variable separately indeed indicates that there are quite some differences in peoples' view on wind energy. This partly explains the experienced resistance, and calls for a more tailored approach in order to achieve the highest degree of cooperation among the local residents. A compensation of $€29{,}244$ can be considered quite high considering that the actual financial damage comes down to a maximum of 5% of the value of the house. This would correspond to a house price of $€584.884$, which is far above the average house price in the Netherlands.

The results of the logistic regressions can help to identify which factors can be used to find potential co-operators among the Dutch population. All underlying assumptions of the models hold, indicating that the found results are valid for this dataset. Plans to increase the supply of wind energy, i.e. build wind mills, can then be implemented the most efficiently at those specific locations where the degree of cooperation among locals is the highest, and the fewest resistance will be faced. Of course, not all variables are valid for inferring a policy implication since it is not possible to tailor plans accordingly to all the demographic variables that are included in the model.

The logistic regression on WTA revealed that citizens aged 35+ have a significantly higher WTA than their younger compatriots, as well as females compared to males, middle/higher educated compared to lower educated, urban residents compared to non-urban, people who earn a higher income and home owners relative to non-owners. All these effects are of course, ceteris paribus. It would be possible to use the found effects of age/residence/income/home ownership for policy implications.

Not only are the effects of these variables statistically significant, but these are also factors that the policy designers have information about and can differentiate on. For example: plans to increase the supply of wind energy could be implemented most efficiently (in terms of monetary compensations to be paid) in neighbourhoods where younger people live, since the coefficients for Age are positive. To support this claim, a significantly lower representation of younger age categories was found for matrix group 1 as compared to group 4.

The coefficient of $Urban$ indicates that the more urban the location is, the higher the compensation is that local residents require for acceptation. In an urban area, the number of households within a $500 - 1{,}000m$ radius can be assumed to be much higher than in a non-urban area. Besides, the type of neighbourhood may matter. Since the coefficient of $Income$ is positive, the willingness to accept is expected to be lower in neighbourhoods where relatively cheaper houses are located. As in these neighbourhoods, the average household income is expected to be relatively lower.

In addition, the fact whether the current home is owned or not is included in the model, for which no previous assumptions were made based on literature. The positive coefficient of $Home\ Ownership$ indicates that neighbourhoods where the presence of rental properties is higher, have a lower willingness to accept. Hence, it would be more efficient in terms of monetary compensation to implement plans at these locations.

Significant relationships between the WTA in this context and demographic variables are not frequently discussed in earlier literature. These factors are included due to availability in dataset and possibility to translate effect into policy implication, the same line of reasoning was applied for inclusion in the WTP model.

The logistic regression on WTP revealed that citizens aged 25+ have a significantly lower willingness to pay than their younger compatriots, as well as people who earn a lower income (although the effect depends on the level of income, and decreases as income increases) and larger households. All these effects are of course, ceteris paribus. All three variables have a significant effect and are suitable for policy designers to take into account.

The negative coefficients of all age categories indicate that the WTP is the highest among the youngest generation. This finding is in line with earlier findings regarding the WTP for green energy. Nevertheless, this is still interesting since income is usually increasing in age and a significant positive relationship between WTP and income is already found in literature as well as in this dataset. However, the relationship is found to be concave, due to the negative sign of the squared term. This means that the marginal increase in WTP decreases as income increases.

In addition, a significant negative relation is found for household size, also in line with earlier findings. This is presumably related to the amount of resources a family prefers to allocate to various cases. An increase in household size means more of those resources are allocated to family expenses, leaving less disposable income for additional investments like wind energy in this case. In earlier literature, significant effects are also found for gender but interestingly not in this dataset. The ones who are thus willing to pay the most for wind energy in the Netherlands are younger people with small families who earn a high income.

The findings resulting from the matrix formation and analysis yield insights on the respondents who can be classified as opponents and supporters. That is, following from their answers on the questions that were asked in this LISS panel data survey. The groups are formed based on the disparity in their WTA and WTP values in the sense of high and low.

The graph bars clearly show differences in the distribution of the variables of interest per matrix group. For example, a clear difference between high and low WTA groups can be seen in the graph for $Home\ Ownership$, while the inequality between high and low WTP groups stand out in the graph for $Education$. It was possible to draw various connections between these differences and effect signs found in the logistic regressions, indicating that the distinction between groups resembles people's stance in this matter in a truthful way.

When focussing on absolute differences between groups 1 and 4, who are broadly classified as opponents and supporters in this context, only few remain statistically significant. Therefore is it not possible to clearly distinguish between opponents and supporters in the dataset. Only the differences in $Gender$ and $Home\ Ownership$ are significant. These findings indicate that there are significantly more males present in the supporters group, as well as significantly less home owners. It is interesting that there are no significant differences in $Income$ between both groups.

Of course, the validity of the comparison is point for discussion. Although the cut-off values between high and low are arbitrary and based on the specific situation in the Netherlands, the method for choosing the specific values is a controversial issue. For application in another dataset, the values need to be determined based on the data itself to decide who falls in each category.

Altogether, most of the found results relate nicely to earlier findings in the WTA and WTP literature in the context of green energy. Besides replicating earlier results, a significant effect of $Home\ Ownership$ on WTA was found generating a new insight on which factors are of influence in this context.

The found WTP for an increase in the supply of wind energy is quite high. According to the tax authorities, in 2019 there were a total of 9.5 million tax payers in the Netherlands (NU.nl, 2019). An average WTP of €$24,22$ for 12 months will then yield a budget of €2.8 billion in total to allocate to windmill construction. Nevertheless, considering that every local resident needs to be paid approximately €$29,244$ on average, a large chunk of this budget could be claimed for compensation payments.

One of the goals of the Dutch Energieakkoord is to realise a total wind energy production of $6{,}000$ MW in 2020 (Rijksoverheid). The CBS calculated the total output of energy in 2019 at $3{,}527$ MW, so still $2{,}473$ MW away from reaching the previously set goal (CBS, 2020). Considering that one windmill generates a total of $3{,}5$ MW on a yearly basis, in 2020 a total of 707 additional windmills need to be constructed. Merely a one-year additional tax will not prove to be sufficient to cover for the needed investments, as the costs for wind park development can easily dwell up in the millions of euros (windmolenskopen.nl).

However, previously described literature provides insight on which policy changes could be implemented to potentially increase the WTP of (local) residents on the one hand, and also decrease the WTA of local residents on the other hand. For example, the mandatory additional tax can be complemented by the extra possibility for the people who are involved to also get financially involved in the projects.

Various researchers have found that the population shows great propensity to do so, and local resistance might decrease due to more distributional justice of the costs and benefits of the turbines. Via this voluntary investment opportunity, money can be saved on one-off compensations and initial investment costs, such that the total budget can be allocated more effectively. This way, we move further towards the goal of an increase in green energy production in the Netherlands.

One of the advantages of this research is the reliability of the data, but a higher number of respondents (e.g.: non LISS-panel members) would certainly help to identify more differences in the population, especially considering the choice of model. Another drawback is not being able to draw a direct comparison between WTA and WTP values. By altering the way in which questions were presented, it would have been possible to apply a more in-depth approach for both parameters and compare the effects of several characteristics directly as well as finding relationships with variables that are not included in the current model. This more in-depth approach could be beneficial for more detailed policy design.

The results obtained by this thesis are not generalizable, and the interpretation of the results is strictly limited to the situation in the Netherlands only. Both models are found to satisfy all underlying assumptions, thereby being internally valid. Part of this internal validity is due to the cut-off points being set at specific values that are of importance in this dataset. When conducting a similar experiment in another setting, the choice of specific values in the model needs to be re-evaluated.

7 Conclusion

The aim of this thesis was to analyse which factors influence the WTA and WTP for the Dutch population in the context of wind energy, and which conclusions can be drawn from the disparity between these values. National survey data from the LISS panel is used to analyse these parameters.

When a wind turbine is built, local residents typically receive a compensation to cover for the experienced "damage". The average willingness to accept as a one-off compensation for having a wind turbine built within $500 - 1{,}000$ metres of one's home is found to be $€29{,}244$. This is a high request considering the actual financial damage of 5% of housing value. The WTA is then analysed using an ordered logistic regression model, which revealed significant positive relationships with Age (in categories), $Education$, $Urban\, residence$ and $Home\, Ownership$. Males are found to have a significant lower WTA than females in this dataset. In order to raise funds for required investments to increase the supply of wind energy, an additional monthly tax is imposed. The average willingness to pay this one-year additional tax for a general increase of wind energy in the Netherlands is found to be $€24{,}22$ per month.

The ordered logistic regression revealed that the WTP is the highest for the $18 - 24$ group. Also, a positive significant relation with $Income$ is found although the effect decreases as income increases. Furthermore, a significant negative relationship with $Household\, Size$ is found.

Since the WTA and WTP questions did not revolve around the exact same good, the disparity between the two values itself is meaningless. Instead, the disparity is investigated in the sense of $High$ and Low and a matrix is formed containing 4 groups based on these two categories. Each group has its' own stance towards wind energy, the relative distribution of demographics of all groups are compared. Thereafter group 1 (opponents) and group 4 (supporters) are directly compared.

Various asymmetries between groups are found, which varies per demographic factor. Interestingly, also differences between $High\, WTA/WTP$ and $Low\, WTA/WTP$ can be seen from the bar graphs, implying the matrix formation correctly captures underlying differences in group members. When group 1 and group 4 are compared directly, the only differences that remain significant are that the share of females and of home owners is significantly higher in group 1 (opponents).

Existing literature poses some suggestions to extend the presented policy, such that people's WTA decreases and WTP increases. Hereby, more progress can be made to transform the Netherlands's energy sector and fully make the switch to a renewable production state.

To fully explore where the greatest chances lie in the Netherlands, perhaps similar surveys on renewable energy can be sent out on a larger scale than merely the LISS panel members. By adding a demographic factor for province/municipality, locations can be compared to each other to see where support is relatively higher and projects could be implemented more efficiently in terms of support and resistance.

It would also be interesting to examine the willingness to accept and willingness to pay in the context of solar energy, since literature finds that people exhibit clear preferences for type of green energy. This would provide opportunities to investigate to which extent these parameters are different than for wind energy and which factors play a role in this context.

Appendix A: Survey Questions

Since the original survey questions are in Dutch, the questions are translated into English for preview. Only the questions about wind energy that are used for analysis are shown. The survey questions are re-created using Qualtrics software available via the Erasmus University Rotterdam.

q34 One of the possibilities to realize more green energy is to build windmills. Currently, approximately two million households in the Netherlands use green energy from wind turbines.

Suppose the government wants to invest in windmills to allow one million extra households in the Netherlands to use green energy. What is your view on this?

- ○ I strongly agree (1)
- ○ I agree (2)
- ○ I disagree (3)
- ○ I strongly disagree (4)
- ○ No opinion (5)

q35 Suppose the government wants to pay for these windmills through a tax increase that must be paid by all taxpayers in the Netherlands. This tax increase is for **one year** and must be paid **monthly**.

View the amounts below, starting from the **left**, and choose the **highest amount** that you **would certainly** want to pay extra in tax per month for building windmills. Take your net monthly income and any savings of your household into account. If you don't pay tax, imagine what you would pay if you did pay tax.

€0	€5	€10	€15	€20	€25	€30	€40	€50	€75	€100	More
○	○	○	○	○	○	○	○	○	○	○	○

Display This Question:

If q35 = 0

q36a You have indicated that you want to pay € 0 for the construction of the windmills by the government. Can you indicate the main reason?

- ◯ It is not worth more than € 0 to me (1)
- ◯ I cannot pay more than € 0 (2)
- ◯ The government has to pay for this (3)
- ◯ Other (4)

Display This Question:

If q35 = More

q36b You have indicated that you want to pay more than € 100 per month in extra tax for building windmills by the government to allow one million extra households to use green energy. What is the **maximum amount** you would like to pay for this? Take your net monthly income and any savings of your household into account.

____

Display This Question:

If q35 ≠ 0

And q35 ≠ More

q36c Again, take a look at the amounts below, starting from the **right**, and choose the **lowest amount** that you certainly would **not** want to pay extra tax per month for building windmills. Take your net monthly income and any savings of your household into account.

€0	€5	€10	€15	€20	€25	€30	€40	€50	€75	€100	More
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Display This Question:

If q35 ≠ 0

And q35 ≠ More

q37 You have indicated that you want to pay at least [q35] extra tax for building the windmills, but not more than [q36c]. Which **amount between [q35] and [q36c]** comes **closest to the maximum amount** that you would like to pay extra tax per month for building the windmills? Take into account the net monthly income and any savings of your household.

____

q38 Can you explain this choice?

____

q39 Are you the owner of the house you are currently living in?

◯ Yes (1)

◯ No (2)

q40 Windmills can be built at different locations, separately or in groups.

Suppose the government would want to build the windmills near the users of green energy, because then the least energy is lost during the transport to the user. Instead of large wind farms, windmills will be located close to (500 to 1,000 meters away) from residential areas. What is your view on this?

◯ I strongly agree (1)

◯ I agree (2)

◯ I disagree (3)

◯ I strongly disagree (4)

◯ No opinion (5)

---

q41 Suppose the government wants to build a windmill near your home, 500 to 1,000 meters away. It is known that windmills can cause noise and that some people do not like the view of a windmill. A windmill near your home can therefore have a negative impact on your living enjoyment. If you own the home, it can also lead to a decrease in the value of your home by up to 5%. The government could reimburse you for these consequences.

View the amounts below, starting from **[left]**, and choose the **highest amount** that you **would certainly not** accept as a one-time fee for building a windmill near your home, because you think this fee is **too low**. Take into account the possible consequences mentioned above.

€0	€5,000	€10,000	€15,000	€20,000	€25,000	€30,000	€40,000	€50,000
◯	◯	◯	◯	◯	◯	◯	◯	◯

Display This Question:

If q41 = 0

q42a You have indicated that you would accept € 0 as a compensation for building a windmill near your home. Can you indicate your main reason is?

◯ I have no objection to a windmill near my home (1)

◯ I do not expect effects from a windmill 500 to 1,000 meters from my home (2)

◯ I do not agree with the payment of a compensation (3)

◯ Other (4)

Display This Question:

If q41= 50,0000

q42b You have indicated that you do not consider € 50,000 to be sufficient as compensation for the construction of a windmill near your home. What is the **minimum amount** you would accept as compensation? Take the consequences mentioned above into account.

____

Display This Question:

If q41= 50,000

q42b_geen No amount is enough to cover for the effects

◯ No (1)

◯ Yes (2)

◯ empty (3)

Display This Question:

If q41 ≠ 0

And q41 ≠ 50,000

q42c Again, take a look at the amounts below, starting from the **right**, and choose the **lowest amount** that you **would certainly** accept as compensation for placing a windmill near your home. Take the possible consequences mentioned above into account.

- ◯ €0 (1)
- ◯ €5,000 (2)
- ◯ €10,000 (3)
- ◯ €15,000 (4)
- ◯ €20,000 (5)
- ◯ €25,000 (6)
- ◯ €30,000 (7)
- ◯ €40,000 (8)
- ◯ €50,000 (9)

Display This Question:

If q41 ≠ 0

And q41 ≠ 50,000

q43 You have indicated that you would at least accept € [q42c] as compensation for building a windmill near your home, but certainly not € [q41]. Which **amount between € [q41] and € [q42c]** is **closest to the minimum amount** that you would accept as a one-off fee from the government for building a windmill 500-1,000 meters from your home? Take the possible consequences mentioned above into account.

____

q44 Can you explain this choice?

____

Appendix B: Distribution of WTA and WTP

B.1 WTA

WTA-Value	Frequency	Percentage	Cumulative %
€0	52	9.63%	9.63%
€1,000	1	0.19%	9.81%
€5,000	7	1.30%	11.11%
€5,001	1	0.19%	11.30%
€5,100	2	0.37%	11.67%
€5,250	1	0.19%	11.85%
€5,500	2	0.37%	12.22%
€6,000	6	1.11%	13.33%
€7,000	8	1.48%	14.81%
€7,500	13	2.41%	17.22%
€8,000	2	0.37%	17.59%
€8,500	1	0.19%	17.78%
€9,000	4	0.74%	18.52%
€10,000	28	5.19%	23.70%
€11,000	2	0.37%	24.07%
€11,111	1	0.19%	24.26%
€12,000	8	1.48%	25.74%
€12,500	5	0.93%	26.67%
€13,000	2	0.37%	27.04%
€14,000	3	0.56%	27.59%
€14,500	1	0.19%	27.78%
€15,000	22	4.07%	31.85%
€15,001	1	0.19%	32.04%
€16,000	4	0.74%	32.78%
€16,500	1	0.19%	32.96%
€17,000	3	0.56%	33.52%
€17,500	4	0.74%	34.26%
€18,000	11	2.04%	36.30%
€19,000	6	1.11%	37.41%
€20,000	37	6.85%	44.26%
€21,000	2	0.37%	44.63%
€22,000	6	1.11%	45.74%
€22,500	3	0.56%	46.30%
€23,000	4	0.74%	47.04%
€24,000	5	0.93%	47.96%
€24,500	1	0.19%	48.15%
€25,000	44	8.15%	56.30%
€25,001	1	0.19%	56.48%
€26,000	5	0.93%	57.41%
€27,000	5	0.93%	58.33%
€27,500	6	1.11%	59.44%
€28,000	7	1.30%	60.74%
€29,000	7	1.30%	62.04%
€29,500	1	0.19%	62.22%
€29,995	1	0.19%	62.41%
€29,999	1	0.19%	62.59%

€30,000	28	5.19%	67.78%
€31,000	1	0.19%	67.96%
€35,000	23	4.26%	72.22%
€35,900	1	0.19%	72.41%
€36,000	1	0.19%	72.59%
€37,000	2	0.37%	72.96%
€37,500	2	0.37%	73.33%
€38,000	3	0.56%	73.89%
€39,000	4	0.74%	74.63%
€40,000	29	5.37%	80.00%
€40,500	1	0.19%	80.19%
€42,000	2	0.37%	80.56%
€45,000	20	3.70%	84.26%
€46,000	1	0.19%	84.44%
€48,000	1	0.19%	84.63%
€49,000	15	2.78%	87.41%
€49,900	1	0.19%	87.59%
€49,999	1	0.19%	87.78%
€50,000	28	5.19%	92.96%
€75,000	6	1.11%	94.07%
€80,000	1	0.19%	94.26%
€90,000	1	0.19%	94.44%
€100,000	24	4.44%	98.89%
€150,000	3	0.56%	99.44%
€200,000	2	0.37%	99.81%
€250,000	1	0.19%	100.00%

Table B.2: Frequency table of answered WTA-values for a one-off compensation for construction of a windmill within 500 – 1,000 metres. This frequency table corresponds with the histogram on the right of Figure 4. The numbers correspond with the answers for q43 complemented with WTA answers that did not fall within the range of categories for which this question was shown (q42a & q42b). The dashed lines in the right column represent category cut-offs in the logistic regression .

B.2 WTP

WTP-Value	Frequency	Percentage	Cumulative %
0	27	5.00%	5.00%
5	26	4.81%	9.81%
6	16	2.96%	12.78%
7	16	2.96%	15.74%
8	15	2.78%	18.52%
10	50	9.26%	27.78%
11	5	0.93%	28.70%
12	19	3.52%	2.22
13	3	0.56%	32.78
14	3	0.56%	33.33%
15	64	11.85%	45.19%
16	9	1.67%	46.85%
17	7	1.30%	48.15%
18	5	0.93%	49.07%
20	40	7.41%	56.48%
21	3	0.56%	57.04%
22	7	1.30%	58.33%

23	4	0.74%	59.07%
25	43	7.96%	67.04%
26	3	0.56%	67.59%
27	3	0.56%	68.15%
28	7	1.30%	69.44%
29	1	0.19%	69.63%
30	42	7.78%	77.41%
31	2	0.37%	77.78%
32	1	0.19%	77.96%
35	24	4.44%	82.41%
40	12	2.22%	84.63%
41	1	0.19%	84.81%
43	1	0.19%	85.00%
44	1	0.19%	85.19%
45	5	0.93%	86.11%
46	1	0.19%	86.30%
49	1	0.19%	86.48%
50	38	7.04%	93.52%
60	11	2.04%	95.56%
65	2	0.37%	95.93%
66	1	0.19%	96.11%
70	4	0.74%	96.85%
75	7	1.30%	98.15%
80	1	0.19%	98.33%
90	3	0.56%	98.89%
95	1	0.19%	99.07%
99	1	0.19%	99.26%
100	2	0.37%	99.63%
200	1	0.19%	99.81%
250	1	0.19%	100.00%

Table B.2: *Frequency table of answered WTP values for an additional tax for green energy. This frequency table corresponds with the left histogram in Figure 4. The numbers correspond with the answers for $q37$ complemented with WTP answers that did not fall within the range of categories for which this question was shown ($q36a$ & $q36b$). The dashed lines in the right column represent category cut-offs in the logistic regression.*

Appendix C: Ordinal logistic regression models

C.1 WTA

The following table displays the build-up of the applied model, where the variables of interest are regressed independently in an ordinal logistic regression with the WTA categories as dependent variable. Every variable of interest in the final model is added based on theoretic findings.

As can be seen in the table, the significance of the Age coefficients decreases in the final model compared to the basis univariate model, as is also the case for $income^2$ and $Home\ Ownership$. The opposite is the case for $Gender$ and $Residence$, which become significant in the final model after found to be insignificant in the univariate models.

Variable	Model I	Model II	Model III	Model IV	Model V	Model VI	Model VII	Model VIII	Model IX
Age									
25-34	0.7856**							0.2915	0.3027
	(0.3436)							(0.3776)	(0.3726)
35-44	1.3610***							0.7934**	0.8006**
	(0.3383)							(0.3680)	(0.3654)
45-54	1.1954***							0.8324**	0.8441**
	(0.3289)							(0.3731)	(0.3685)
55-64	1.2045***							0.8724***	0.8803***
	(0.3004)							(0.3371)	(0.3334)
65+	0.7035**							0.5632*	0.5699*
	(0.2900)							(0.3257)	(0.3231)
Gender									
Male		-0.2073						-0.3419**	-0.3441**
		(0.1525)						(0.1580)	(0.1576)
Education									
Middle			0.5603***					0.4838**	0.4903**
			(0.2109)					(0.2237)	(0.2227)
High			0.7249***					0.5775***	0.5822***
			(0.1722)					(0.1919)	(0.1918)
Residence									
Urban				0.2145				0.4690***	0.4706***
				(0.1543)				(0.1668)	(0.1666)
Income					0.0002***			0.0002	0.0001**
					(0.0000)			(0.0002)	(0.0000)
Income²						1.33e-8***		-5.03e-9	
						(4.76e-9)		(1.17e-8)	
Home ownership							0.6163***	0.3628*	0.3762*
							(0.1716)	(0.1995)	(0.1958)

Table C.1.1: *Display of all tested models. The top values indicate coefficients, and the asterisks indicate significance levels. The bottom values in parentheses indicate standard errors. Model IX is also displayed in Table 8 in* [*Section 5.1*].

C.1.2 Assumption testing

To check whether there exists multi-collinearity, the correlation between independent variables is examined. A general rule of thumb is that a correlation higher than 0.80 yields worries about multi-collinearity. As becomes clear from the correlation matrix, the highest correlations present are $Age - Home\ Ownership$ (0.3040) and $Income - Education$ (0.2903). A higher correlation between these values does not come unexpected, and the correlation values indicate that the third assumption is satisfied.

Variable	Age	Gender	Education	Urban	Income	Home Ownership
Age	1.0000					
Gender	0.0266	1.0000				
Education	-0.1052	0.1261	1.0000			
Urban	-0.1134	0.0255	-0.0303	1.0000		
Income	-0.1701	0.0600	0.2903	-0.1114	1.0000	
Home Ownership	0.3040	0.0483	0.1858	-0.1908	0.2196	1.0000

Table C.2.2: *Correlation matrix including all the independent variables that are also present in the final model denoted as Model IX in Table C.1.1.*

To test the fourth assumption, the parallel regression assumption, a Brant test is conducted. A significant test statistic provides evidence that this assumption has been violated. Conclusion from this table is thus that all assumptions hold for this model and it is **valid**.

Variable	χ^2	$p > \chi^2$	Degrees of freedom
All	27.57	0.279	24
Age	3.14	0.534	4
Gender	4.26	0.371	4
Education	1.79	0.774	4
Urban	4.74	0.315	4
Income	5.71	0.222	4
Home Ownership	3.61	0.462	4

Table C.3.3: *Brant test of Parallel Regression Assumption. The row for* All *yields a test statistic for the full model, denoted as model IX in Table C.1.1.*

C.2 WTP

The following table displays the build-up of the applied model, where the variables of interest are regressed independently in an ordinal logistic regression with the WTP categories as dependent variable. Every variable of interest in the final model is added based on theoretic finding, except for $Residence$, which is added based on availability and significance in the WTA model. It is removed from the final model due to the insignificance in the univariate as well as in the multivariate model, it's inclusion/removal does not affect signs or significance levels.

As can be seen in the table, the effect of Age becomes significant in the final model, while being found to be insignificant (except for 45 – 54) in the univariate model. The same applies to $Household\ Size$. The opposite is the case for $Education - high$.

Eventually, $Gender$ is dropped from the model since inclusion caused the model to violate the parallel regression assumption. As becomes clear from the table, the removal of $Gender$ does not alter the signs nor the significance of the other independent variables.

Variable	Model I	Model II	Model III	Model IV	Model V	Model VI	Model VII	Model VIII	Model IX	Model X	Model XI
Age											
25-34	-0.3168 (0.3490)								-0.7795** (0.3781)	-0.7526** (0.3777)	-0.7593** (0.3790)
35-44	-0.4989 (0.3358)								-0.8704** (0.3602)	-0.8441** (0.3591)	-0.8440** (0.3599)
45-54	-0.5809* (0.3240)								-0.8240** (0.3400)	-0.8641** (0.3398)	-0.8595** (0.3393)
55-64	-0.3557 (0.2997)								-0.7418** (0.3212)	-0.7257** (0.3206)	-0.7224** (0.3204)
65+	-0.3319 (0.2897)								-0.6304* (0.3268)	-0.6238* (0.3203)	-0.6154* (0.3201)
Gender											
Male		0.1415 (0.1597)							0.1161 (0.1652)	0.1111 (0.1643)	
Education											
Middle			-0.1336 (0.2040)						-0.0601 (0.2206)	-0.0379 (0.2178)	-0.0248 (0.2158)
High			0.3570** (0.1779)						0.283 (0.2056)	0.2391 (0.2032)	0.2574 (0.2019)
Residence											
Urban				0.0916 (0.1553)					0.9634 (0.1636)		
Income					0.0001*** (0.0000)		0.0003*** (0.0001)		0.0005*** *0.0001)	0.0005*** (0.0001)	0.0005*** (0.0001)
Income²						$1.08e^{-8}$*** ($4.11e^{-9}$)	$-2.26e^{-8}$** ($1.15e^{-8}$)		$-3.55e^{-8}$ ($1.32e^{-8}$)	$-3.35e^{-8}$** ($1.33e^{-8}$)	$-3.33e^{-8}$** ($1.35e^{-8}$)
Household size								-0.0232 (0.0634)	-0.2038** (0.0881)	-0.1903** (0.0885)	-0.1880** (0.0886)

Table C.2.1: *Display of all tested models. The top values indicate coefficients, and the asterisks indicate significance levels. The bottom values in parentheses indicate standard errors. Model XI is also displayed in Table 8 in* *Section 5.2**.*

C.2.2 Assumption testing

To test whether the assumptions are satisfied, the same methods are applied as for WTA. The highest correlations that are found between independent variables in the model are $Household\ Size - Income$ (0.4490) and $Income - Education$ (0.2903), as in the WTA model. These values yield no concern for multi-collinearity and the third assumption is satisfied for this model.

Variable	Age	Education	Income	Household Size
Age	1.000			
Education	-0.0789	1.000		
Income	-0.1641	0.2903	1.000	
Household Size	-0.3871	0.1020	0.4490	1.000

Table C.2.2: *Correlation matrix including all the independent variables that are also present in the final model denoted as Model XI in Table C.2.1.*

The next table denotes the output from the Brant test, the insignificance of the test statistic draws the conclusion that the model does not violate parallel regression assumption and is **valid**.

Variable	χ^2	$p > \chi^2$	Degrees of freedom
All	14.21	0.510	15
Age	4.15	0.246	3
Education	1.17	0.760	3
Income	1.61	0.656	3
$Income^2$	1.87	0.599	3
Household Size	1.27	0.735	3

Table C.2.3: *Brant test of Parallel Regression Assumption. The row for* All *yields a test statistic for the full model, denoted as model XI in Table C.2.1.*

The test statistic for Model X (including $Gender$), is equal to 33.13 with corresponding ($p = 0.016$). This led to the decision to drop $Gender$ from the final model since this means the parallel regression assumption is violated. The coefficient of $Gender$ was the only one with a significant individual test statistic ($p = 0.000$).

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