**Appendix A: The discrete choice experiment (DCE) (may appear exclusively online)**

*[The following section shows the DCE as it was presented to the participants. The instructions and choice sets have been translated from German.]*

Introduction:

Please imagine that you can switch your electricity tariff today. Your new electricity provider offers you two different tariffs, which both have a contract term of 12 months. The electricity consumption is based on the average German household: 3,500 kilowatt hours per year. However, this is not the quantity that needs to be taken. If you opt for one of the two tariffs, your new provider will arrange the termination of the existing contract with your current supplier to complete the switch.

*In order to enable a better understanding, there was a brief explanation of how the tariff components may vary:*

1. **Green energy source**

For the offered tariffs, the share of green electricity may consist of different renewable energy sources. Available renewable energy sources may include solar energy, wind power, biogas or a mix of several renewable energy sources.

1. **Share of green energy**

The share of green energy is expressed as both a percentage value and as a concrete figure, i.e. how many kilowatt hours are replaced by renewable energy. The share of green energy can vary, and therefore, it may be above or below your current tariff’s share of green energy. The remaining share of the tariff that is not derived from renewable energy sources is covered by conventional, non-regenerative power sources (coal, nuclear power, natural gas and other fossil fuels).

1. **Switching bonus**

The switching bonus represents a payment to you as new customer. It will be included in your tariff rate. The bonus payment can vary.

1. **Price guarantee**

The price guarantee refers to a period in months over which the electricity provider can assure the price will not change after you switch. The price guarantee applies to all price components, with the exception of taxes, government charges and levies. After the expiration of the price guarantee, changes may occur which could result in a financial burden or a reduction in the costs. The duration of the price guarantee can vary.

1. **Tariff price**

To increase transparency, the tariff price is displayed as a monthly rate. In addition, you will be given the amount of the annual electricity bill, and the price per kilowatt hour. The switching bonus is already included in the tariff price as well as the basic charge. The tariff price refers to the German average household’s electricity consumption and amounts to 3,500 kilowatt hours per year.

--------------*[page break]--------------*

*Subsequently, questions were posed to check whether the participants read and understood the introduction*:

Before we start presenting different decision situations to you, we would like to make sure that you know which core data the decision situations relate to. Please answer the following two questions:

**What annual electricity consumption do we use to calculate the tariffs in the decision situations?**

 1,050 kWh

 2,000 kWh

 3,500 kWh

 Your individual electricity consumption

**How long is the contract term of the tariffs?**

\_\_\_\_\_\_\_\_\_\_\_\_\_ Months.

*[If the answers to the questions were correct, the instructions follow. Otherwise, the introduction and the questions were presented again. If the questions were incorrectly answered twice, the experiment was blocked for the participant.]*

--------------*[page break]--------------*

*[The following twelve choice sets were presented to the participants in a random order to avoid an order effect.]*

*Each choice set was introduced with the following paragraph. In order to keep the appendix concise, this paragraph is only shown for the first choice set.*

Instructions for the DCE:

In the following, you will be asked twelve times whether you would like to switch your current electricity tariff. In each of the twelve decision situations, two different tariff alternatives are offered which refer to an **annual electricity consumption of 3,500 kilowatt hours**. Please consider each decision situation independently of the others. We are interested in your personal opinion. Therefore, there are no “wrong” answers. In order to make the choice easier, please imagine that the assumed consumption of 3,500 kilowatt hours will later be adjusted to the annual electricity consumption you stated in the beginning.

**Please note** that the declared tariff costs are the amount that your household has to pay if the chosen alternative is to be implemented. Previous studies on the willingness to pay for switching the electricity tariff have shown that participants seem to be over-estimating how much they really are willing to pay. Therefore, if you decide to switch the tariff, consider carefully how the costs will affect your budget, to make sure that you would select the chosen tariff in reality as well. That is why, it is particularly important that you deal with the tariff alternatives in each of the 12 decision situations. **Just imagine that according to your answers, an electricity tariff would be tailor-made for you**. Within the experiment, you will always be given the possibility to choose a new tariff alternative, as well as have the option to keep your existing tariff with the alternative 'no switch'.

***[Choice set 1]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | Wind | Biogas |  |
| **Share of green energy** | 40 %= 1,400 kWh | 80 %= 2,800 kWh |  |
| **Switching bonus**  | €120  | €30  |  |
| **Price guarantee** | 6 months | 6 months |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 70 €/month770 €/year22.0 Cent/kWh | 80 €/month880 €/year25.1 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 2]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | Biogas | Solar |  |
| **Share of green energy** | 100 %= 3,500 kWh | 40 %= 1,400 kWh |  |
| **Switching bonus**  | €120  | €120  |  |
| **Price guarantee** | 12 months | none |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 85 €/month935 €/year26.7 Cent/kWh | 75 €/month825 €/year23.5 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 3]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | Wind | Wind |  |
| **Share of green energy** | 100 %= 3,500 kWh | 40 %= 1,400 kWh |  |
| **Switching bonus**  | €60  | €60  |  |
| **Price guarantee** | none | 12 months |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 75 €/month825 €/year23.5 Cent/kWh | 85 €/month935 €/year26.7 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 4]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | Wind | RE-Mix (45% Wind, 25% Biomass (15% Biogas) 20% Solar, 10% Waterpower) |  |
| **Share of green energy** | 60 %= 2,100 kWh | 80 %= 2,800 kWh |  |
| **Switching bonus**  | €90  | €120  |  |
| **Price guarantee** | none | 6 months |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 80 €/month880 €/year25.1 Cent/kWh | 70 €/month770 €/year22.0 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 5]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | RE-Mix (45% Wind, 25% Biomass (15% Biogas) 20% Solar,10% Waterpower) | Solar |  |
| **Share of green energy** | 40 %= 1,400 kWh | 100 %= 3,500 kWh |  |
| **Switching bonus**  | €60  | €60  |  |
| **Price guarantee** | none | 12 months |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 80 €/month880 €/year25.1 Cent/kWh | 75 €/month825 €/year23.5 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 6]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | Biogas | RE-Mix (45% Wind, 25% Biomass (15% Biogas) 20% Solar, 10% Waterpower) |  |
| **Share of green energy** | 40 %= 1,400 kWh | 100 %= 3,500 kWh |  |
| **Switching bonus**  | €60  | €90  |  |
| **Price guarantee** | 12 months | none |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 75 €/month825 €/year23.5 Cent/kWh | 80 €/month880 €/year25.1 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 7]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | Biogas | RE-Mix (45% Wind, 25% Biomass (15% Biogas) 20% Solar, 10% Waterpower) |  |
| **Share of green energy** | 80 %= 2,800 kWh | 40 %= 1,400 kWh |  |
| **Switching bonus**  | €30  | €30  |  |
| **Price guarantee** | none | 12 months |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 85 €/month935 €/year26.7 Cent/kWh | 80 €/month880 €/year25.1 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 8]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | Solar | Wind |  |
| **Share of green energy** | 80 %= 2,800 kWh | 60 %= 2,100 kWh |  |
| **Switching bonus**  | €30  | €90  |  |
| **Price guarantee** | 6 months | 6 months |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 75 €/month825 €/year23.5 Cent/kWh | 85 €/month935 €/year26.7 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 9]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | RE-Mix (45% Wind, 25% Biomass (15% Biogas) 20% Solar,10% Waterpower) | Biogas |  |
| **Share of green energy** | 80 %= 2,800 kWh | 60 %= 2,100 kWh |  |
| **Switching bonus**  | €30  | €120  |  |
| **Price guarantee** | 6 months | 6 months |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 70 €/month770 €/year22.0 Cent/kWh  | 85 €/month935 €/year26.7 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 10]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | RE-Mix (45% Wind, 25% Biomass (15% Biogas) 20% Solar,10% Waterpower) | Wind |  |
| **Share of green energy** | 60 %= 2,100 kWh | 80 %= 2,800 kWh |  |
| **Switching bonus**  | €120  | €30  |  |
| **Price guarantee** | 12 months | none |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 70 €/month770 €/year22.0 Cent/kWh | 75 €/month825 €/year23.5 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 11]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | Solar | Wind |  |
| **Share of green energy** | 60 %= 2,100 kWh | 100 %= 3,500 kWh |  |
| **Switching bonus**  | €90  | €60  |  |
| **Price guarantee** | 6 months | 12 months |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 80 €/month880 €/year25.1 Cent/kWh | 70 €/month770 €/year22.0 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

***[Choice set 12]***

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tariff A** | **Tariff B** | **No Switch** |
| **Green energy source** | Solar | Biogas |  |
| **Share of green energy** | 100 %= 3,500 kWh | 60 %= 2,100 kWh |  |
| **Switching bonus**  | €90  | €90  |  |
| **Price guarantee** | 12 months | none |  |
| **Tariff price for 3,500 kWh** (incl. switching bonus and fees) | 85 €/month935 €/year26.7 Cent/kWh | 70 €/month770 €/year22.0 Cent/kWh |  |
| **Which alternative do you choose?** |  |  |  |

**Appendix B: Development of the willingness to pay (WTP) in WTP space**

The starting point of the econometric analysis was the *random utility theory* [84], which says that for each individual *n* and each good or action alternative *i* which is available in a decision situation, an indirect utility function *Uin* can be established:

$$U\_{in}=β\_{kn}'x\_{ik}+ε\_{in}$$

This indirect utility function *Uin* can be described by *k* utilizing attributes. Unobservable individual preferences are considered by the unexplained component$ ε\_{in}$. As a utility maximizer, individual *n* chooses alternative *i* instead of *j* from a given set of alternatives $C\_{n}$ if:

$$U\_{i}>U\_{j} ∀ j ϵ C\_{n}, i\ne j$$

Train (2009) argued that various models can be used to analyze DCE. They differ in the fact that different assumptions for the distribution of the undefined component$ ε\_{in}$ can be drawn. In this investigation, a generalized multinomial logit model was chosen.

In discrete choice models, the utility of alternative *j* perceived by respondent *n* in choice situation *t* is denoted by $U\_{ntj}$. Moreover, $U\_{ntj}$ is divided into two components, with a deterministic component $V\_{ntj}$ and an unobserved component $ε\_{ntj}$, so that

|  |  |  |
| --- | --- | --- |
|  | $$U\_{ntj}=V\_{ntj}+ε\_{ntj}$$ | (1) |

Focusing on the estimation of the willingness to pay (WTP), the deterministic component can be divided by a price component, $p\_{ntj}$, and non-price attributes, $x\_{ntj}$:

|  |  |  |
| --- | --- | --- |
|  | $$U\_{ntj}=-α\_{n}p\_{ntj}+β\_{n}^{´}x\_{ntj}+ε\_{ntj}$$ | (2) |

where $α\_{n}$ and $β\_{n}$ vary randomly for all electricity customers and $ε\_{ntj}$ is an independent and identically distributed (IID) random component. In order to account for the variance of $ε\_{ntj}$ being different for different electricity customers, $k\_{n}$ is introduced as a scale parameter for electricity customer *n*. Therefore, the utility in equation (2) is divided by $k\_{n}$ without affecting behavior (Train, 2004):

|  |  |  |
| --- | --- | --- |
|  | $$U\_{ntj}=-(α\_{n}/k\_{n})p\_{ntj}+(β\_{n}/k\_{n})^{´}x\_{ntj}+ε\_{ntj}$$ | (3) |

Defining the utility coefficient as $λ\_{n}= (α\_{n}/k\_{n})$ and $c\_{n}=(β\_{n}/k\_{n})$, utility can be written as:

|  |  |  |
| --- | --- | --- |
|  | $$U\_{ntj}=-λ\_{n}p\_{ntj}+c\_{n}^{´}x\_{ntj}+ε\_{ntj}$$ | (4) |

which is referred to as the model in preference space. The WTP for an attribute is the ratio of the attribute’s coefficient to the price coefficient calculated ex post estimation: $w\_{n}=c\_{n}/λ\_{n}$. Based on this definition, utility can be rewritten as

|  |  |  |
| --- | --- | --- |
|  | $$U\_{ntj}=-λ\_{n}p\_{ntj}+(c\_{n}^{´}w\_{ntj})´+ε\_{ntj}$$ | (5) |

which is referred to as utility in WTP space, where $w\_{n}$ is calculated directly in the estimation process.

Appendix C

Table C.1 – Descriptive statistics of the sample

|  |  |  |  |
| --- | --- | --- | --- |
| **Characteristics** | **Sample n=371** | **Germany** | **Source** |
| Female (%) | 57.4 | 51.5 | Destatis, 2016: 26 |
| Ø Age (years)  | 43.9 | 44.3 | BiB-Demographie, 2017\*) |
| Married (%) | 30.5 | 42.3  | Destatis, 2016: 51 |
| Household without child/ren (%) | 77.6 | 72.0 | Destatis, 2016: 52\*)  |
| Ø living space (square meters) | 98.8 | 92.1 | Destatis, 2016, PM:316/16 |
| Ø annual electricity consumption (kWh) | 2,750 | 3,247 | Destatis, 2017: Energieverbrauch |
| Ø annual electricity costs (Euro) | 750 | 1,008\*\*) | BDEW, 2015 |
| Household with pure green energy tariff (%) | 35.3 | 19.1 | Federal Network Agency, 2016 |
| No switch within the past 5 years (%) | 38.8 | - |  |
| **Persons living in the same household**  | **%** | **%** | Destatis, 2016: 50 |
| 1 | 37.7 | 41.3 |  |
| 2 | 36.9 | 34.2 |  |
| 3 or more | 25.4 | 24.4 |  |
| **Age (years)** | **%** | **%** | Destatis, 2017,Code: 12411-0005\*) |
| 18-24 | 12 | 7.7 |  |
| 25-29 | 9 | 6.6 |  |
| 30-39 | 18 | 12.3 |  |
| 40-49 | 22 | 14.0 |  |
| 50-64 | 33 | 22.1 |  |
| > 64 | 6 | 21.1 |  |
| **Region**  | **%** | **%** | Destatis, 2016: 27 |
| North | 16.4 | 16 |  |
| East | 20.2 | 20 |  |
| South | 42.9 | 41 |  |
| West | 20.5 | 23 |  |
| **Monthly household’s net income (Euro)** | **%** | **%** | Destatis, 2017, Code:12211-0105\*) |
| < 1,300 | 25.3 | 23.0 |  |
| 1,300-1,999 | 24.5 | 22.6 |  |
| 2,000-2,599 | 16.2 | 14.9 |  |
| 2,600-3,199 | 8.1 | 10.9 |  |
| 3,200-4,499 | 14.3 | 14.4 |  |
| > 4,500 | 11.6 | 11.4 |  |

**Table C.1 (*continued*)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Characteristics** | **Sample n=371** | **Germany** | **Source** |
| **Town size (number of residents)** | **%** | **%** | Destatis, 2017, Code: 12211-0103\*) |
| < 5.000 | 16.2 | 13.1 |  |
| 5.000-19.999 | 19.9 | 24.8 |  |
| 20.000-99.999 | 22.1 | 27.3 |  |
| 100.000-499.999 | 20.8 | 16.1 |  |
| > = 500.000 | 21.0 | 18.7 |  |
| **Consumer attitudes** | **% agreement** |  |  |
| Food or fuel: RES only from plants not used for food or feed production | 50.4 |  |  |
| EEG levy: likely instrument | 26.4 |  |  |
| Increase the demand for green electricity tariffs by cancelling the EEG levy for those who decide to switch to pure green energy tariffs. | 62.5 |  |  |
| Green Party identification | 12.4 |  |  |
| Environment is important when buying groceries | 52.0 |  |  |
| Never switched before | 31.3 |  |  |
| Wish to outsource switching process | 16.4 |  |  |

Source: Author`s elaboration and calculations; translated from German into English

\*) Own calculations based on the German census for 2015

\*\*) Annual electricity costs arising for a consumption of 3,500 kWh

**Appendix D: STATA code for the estimated generalized multinomial logit model in WTP space (may appear exclusively online)**

*[In the following, the STATA code used for the calculation of the generalized multinomial logit**model in WTP space is presented. For reaching convergence in the final model, it is crucial to use starting values. Otherwise it is not ensured that a global maximum instead of a local maximum is achieved [78]. Thus, we followed the estimation procedure suggested by Gu et al. [78]. Therefore, starting values for the final model were generated first using a generalized multinomial logit model without correlations followed by a generalized multinomial logit model including correlations. Finally, these estimation results were used to estimate the generalized multinomial logit in WTP space. To integrate non-varying (across alternatives), individual-specific variables into the model, it is necessary to generate interaction terms with the alternative-specific-constant (ASC) or the attributes. For more information regarding the aforementioned STATA-command 'gmnl', readers are referred to the STATA help-file. The syntax below presents the final generalized multinomial logit model in WTP space with correlations and included interaction terms.]*

matrix start = b[1,1..35]

constraint 1 = [Mean]tariff price = -1

gmnl

choice

energy source: solar

energy source: wind

energy source: RE mix

tariff price

ASC x region: east

ASC x region: south

ASC x region: west

ASC x town size

ASC x age of respondent

Price guarantee x age of respondent

ASC x children

Switching bonus x income

ASC x EEG levy: likely instrument

ASC x Green Party identification

Share of green energy x Green Party identification

ASC x food or fuel

ASC x environment is important when buying groceries

ASC x wish to outsource switching process,

rand( asc

share of green energy

price guarantee

switching bonus)

group(csetfort) id(nr) nrep(1000) correlation from(start, copy) constraint(1) gamma(0)