Quality Uncertainty and the Market for Renewable Energy: Evidence from German Consumers

Jens Rommel and Julian Sagebiel and Jakob R. Müller

Leibniz Centre for Agricultural Landscape Research, Institute for Ecological Economy Research, Universität Erfurt

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Jens Rommel, Leibniz Centre for Agricultural Landscape Research, Eberswalder Straße 84, 15374 Müncheberg, Germany, Phone: +49 (0)33432 82-483, jens.rommel@zalf.de

Julian Sagebiel, Humboldt-Universität zu Berlin and Institute for Ecological Economy Research, Unter den Linden 6, 10099 Berlin, Germany, Phone: +49 (0)30 2093-6575, julian.sagebiel@hu-berlin.de

Jakob R. Müller, Universität Erfurt, Faculty of Law, Social Sciences and Economics, Nordhaeuser Strasse 63, 99089 Erfurt, Germany, Phone: +49 (0)361 737-4510, jakob_robert.mueller@uni-erfurt.de

Abstract

Consumers can choose from a wide range of electricity supply contracts, including green power options. Electricity produced from renewable energy involves information asymmetries. With a sample of more than 2,000 German electricity consumers, we tested the proposition of a "lemon market" for renewable energy in a discrete choice experiment. Specifically, we found that, compared to investor-owned firms, additional willingness-to-pay (WTP) for renewable energy is approximately double when offered by cooperatives or municipally-owned electricity utilities. Consumers who are experienced with switching suppliers have an additional WTP of one Eurocent per kilowatt hour for cooperatives and two Eurocents for public enterprises. The results demonstrate that organizational transformation in dynamically-changing electricity markets is not only driven by political initiatives but also by consumers' choices on the market. Public policy may reduce information asymmetries by promoting government labeling of green energy products.

Keywords: Cooperatives; Discrete Choice Experiment; Germany

1. Introduction

Over the past two decades, European retail markets for electricity have changed fundamentally, and market deregulation has occurred in most countries. Currently, electric utilities owned by municipalities compete for customers with investor-owned firms and newly formed consumer-owned cooperatives. In the fulfillment of international agreements, European countries also strive for greening their energy systems, and various policy instruments have been established to ensure a reduction in carbon emissions from electricity generation (Lehmann et al., 2012). For instance, Germany – Europe's largest economy – has decided to phase out the utilization of nuclear power and increase its share of renewable energy sources in electricity generation to at least 40 percent by the year 2025 (Renewable Energy Act, 2014).

At the municipal level, political referenda initiated by citizens have called for the reorganization of local energy supply. In Hamburg, Germany's second largest city, a majority has been achieved in a political referendum in favor of a deprivatization of the local electricity grid and generation capacities. In Berlin, a similar initiative has reached a majority of 83 percent, but the necessary quorum of 25 percent was missed by 0.9 percent. In both cases, citizens proposed a remunicipalisation by the city or a cooperative model based on the joint investment of citizens in a democratically controlled and consumer-owned enterprise.

In addition to the role that citizens play in the political process, they have also started to choose the type of supplier they want on the market. Since 1998, German electricity consumers can freely choose from a wide range of electricity suppliers and tariffs, including green power options. Besides price, a supplier's general service, or the share of renewable energy, various characteristics of suppliers have been identified as important attributes of electricity contracts in discrete choice experiments (Amador et al., 2013; Murakami et al., 2015). Firm size, location, or commitments to price transparency affect consumers' willingness-to-pay (WTP) for electricity (Kaenzig et al., 2013; Sagebiel et al., 2014). However, these studies have overlooked the fact that supplier characteristics may interact with other properties of supply contracts (cf. Müller and Sagebiel, 2015). Moreover, the perspective of the citizen-consumer choosing a supplier on the market is an important complement to the perspective of the citizen-voter articulating his or her preferences at the voting booth (Yildiz et al., 2015). In this paper, we use data from a discrete choice experiment with German electricity consumers to test if WTP for renewable energy differs by supplier governance.

2. Theoretical Framework and Context

Consumers can observe and experience numerous attributes of contracts with their electric utility. Some attributes are independent of the contract and known to the consumer ex-ante (e.g., the expected frequency of power cuts). Others can be experienced by the consumer ex-post (e.g., response time after a complaint is placed). A third group can neither be observed ex-ante nor experienced ex-post. For instance, consumers cannot easily obtain information on the electricity generation process. This is important because, today, different standards regarding electricity generation from renewable energy exist, and firms have adopted a wide range of generation options. While some companies ensure instantaneous generation from renewable sources at all times, other companies base their green power tariffs on Tradable Renewable Certificates which give rise to relabeling and fraud (cf. Sagebiel et al., 2014). It is difficult for consumers to observe the electricity generation process and assess its environmental impact, thus creating a potential “lemon market” (Akerlof, 1970) for renewable energy.

In Akerlof’s (1970) model, there are buyers and sellers of goods. Information is asymmetric, and sellers know the true quality of the good they sell. Buyers have information only on the distribution of quality in the market as a whole. A high quality seller would typically ask for a price higher than a buyer would be willing to pay, thus giving rise to adverse selection (i.e., low quality sellers are dragged into the market, and high quality sellers are pushed out). Market failure and even a complete breakdown of the market can be the result. Akerlof concludes that several economic institutions are created to counteract information asymmetries. For instance, labeling or licensing may exist primarily for reasons of quality monitoring. This idea is the basis for Spence’s (1973) signaling model in which the selling party can reveal the quality of a good by engaging in a costly signal whose price negatively correlates with quality. Investment in the signal will pay off only for sellers of good quality. Consequently, prices can be differentiated by quality on the basis of the signal. Although labels and certification schemes exist for renewable energy in Germany, one study found that less than three percent of consumers know them well (Mattes, 2012, p. 6). Even more importantly, less than one quarter of respondents who are actually using a renewable-energy-only tariff are aware of labels and certificates (ibid.)

Apart from signaling and labeling, the cost of obtaining information on a company differs by firm type. Because obtaining and processing information is a costly process in itself, consumers may assess quality on the basis of these generic firm types as “quasi-labels.” Vis-à-vis locally producing firms (e.g., utilities run by the municipality or consumer-owned businesses like cooperatives), it might be easier to obtain information regarding the electricity generation process (Bonus, 1986; Vetter & Karantininis, 2002). Specifically, they might believe that because information from municipality-owned utilities and cooperatives is accessible at low cost, these firms may be more trustworthy and less likely to engage in dishonest behavior when reporting quality (cf. Castaldo, 2007). Thus, the organizational form of the distribution company might help to reduce information asymmetries.

3. Material and Methods

3.1 Empirical Strategy

We modeled consumer utility from electricity consumption on the basis of alternative supply contracts that differ in their attributes. Utility U_{int} of respondent n in choice situation t between alternatives i is derived from characteristics $\boldsymbol{A}_{int}$, where the effect on utility of each element in $\boldsymbol{A}_{int}$ is described by parameter vector $\boldsymbol{\beta}$. We applied a random utility approach so that utility U_{int} is comprised of a deterministic part V_{int} and a stochastic part ε_{int}. The ε_{int} are identical and independent (iid) extreme value type I distributed with the cumulative distribution function $F(\varepsilon_{int}) = \exp(-\exp(\varepsilon_{int}))$. In order to capture unobserved heterogeneity in preferences, we applied a mixed logit model with random parameters where utility parameters from $\boldsymbol{\beta}$ are assumed to be normally distributed with density $f(\boldsymbol{\beta})$ (Hensher and Greene, 2003) so that

$$U_{int} = V_{int} + \varepsilon_{int} = \boldsymbol{\beta}\boldsymbol{A}_{int} + \varepsilon_{int}$$

The panel data random parameters (mixed) logit choice probability is given by

$$\Pr\ \{jnt\} = \int_{-\infty}^{\infty} \prod_{t=1}^{T} \frac{\exp(V_{jnt})}{\sum_{i=1}^{I}(\exp(V_{int})} f(\boldsymbol{\beta}) d\boldsymbol{\beta}.$$

Parameters $\boldsymbol{\beta}$ can be estimated by using the maximum simulated likelihood method (Train, 2008).

Other models capturing preference heterogeneity are readily available. For instance, the latent class logit model assumes that preferences fall into a finite number of discrete classes. From a theoretical viewpoint, the distribution of preferences could take various forms (Hensher & Greene, 2003), and consequently, model choice is based on statistical considerations and the analyst's judgement (Glenk et al., 2012; Sagebiel, 2011). Here, we opted for the simpler mixed logit model.

Our discrete choice experiment contained labeled alternatives for three different types of suppliers. Respondents could choose between a cooperative, an investor-owned firm, and a municipally-owned enterprise. In addition, contracts differed in their price per kilowatt hour, ranging from 23 to 30 Eurocents and the share of renewable energy (either 0%, 33%, 67%, or 100% share of renewable energy). In the modeling approach, we used alternative-specific parameters for the share of renewable energy and a generic parameter for the price attribute. Each supplier is identified with an alternative-specific constant (ASC) where we used the constant for an investor-owned firm as the reference. The utility function for each alternative i is

$$V_i = \beta_i ASC_i + \beta_{Ren\_i} Ren_i + \beta_c Cost_i$$

where i represents the supplier type, Ren_i is the share of renewable energy from a supplier of type i, the βs are parameters measuring the impact on utility, and $Cost_i$ is the price per kilowatt hour charged by supplier i.

3.2 Experimental Design and Data

An introductory text explained both attributes to respondents prior to the discrete choice experiment. We used a d-efficient design, optimized for a multinomial logit model with priors taken from a previous study (Sagebiel et al., 2014), created with the software package NGene (ChoiceMetrics, 2012) which resulted in 24 choice sets divided into three blocks. Thus, each respondent faced eight choice sets. We randomized the order of presentation of choice sets to avoid fatigue and learning effects (Savage and Waldman, 2008). Table 1 shows a sample choice set.

[INSERT Table 1 APPROX HERE]

The survey was conducted online from March 10, 2014 to March 24, 2014 with 2,174 German consumers who were older than 18 years and took or would take part in the decision on the electricity supply company of their household. In collaboration with the marketing research institute *forsa.omninet*, respondents were randomly selected from a panel of 10,000 German households that are representative of Germany with respect to age, income, gender, education, and region (cf. Forsa, 2015). The response rate was 46%. The questionnaire included socio-demographic and attitudinal questions as well as questions concerning energy use. The mean time for completion was approximately 20 minutes. Table 2 presents summary statistics for some important socio-demographic variables of respondents.

[INSERT Table 2 APPROX HERE]

Respondents were on average 52 years old, and roughly half of the respondents were male. The mean monthly income on a ten-point scale was 5.6 (equivalent to 2,000 to 3,000 Euros), and respondents lived in households with two members on average. More than half of the respondents were married. We used a seven-point ordinal scale that included the most common degrees in Germany for asking about education. Less than two percent of respondents did not have any degree, and approximately 16 percent had a college or university degree. Roughly half of the respondents had previous experience with changing the electricity supply company.

4. Results

Table 3 presents estimation results and WTP values for two different specifications of the mixed logit model. Model 2 is an extension of Model 1 that controls for socio-demographic heterogeneity by introducing interaction terms with the type of supplier (a dummy variable for female respondents; a dummy variable for respondents who have switched to another supplier in the past; age in years). For easier interpretation of coefficients, we used deviations from the mean instead of absolute values for the socio-demographic interaction terms.

[INSERT Table 3 APPROX HERE]

Both models have a high explanatory power as indicated by the large χ^2 values. Parameter estimates are similar in both models. Small differences result from the slightly different samples due to missing observations for some of the socio-demographic variables (cf. Table

2). Positive signs for the type of supplier (Municipally-owned, Cooperative) show that consumers prefer electricity supplied by cooperatives or municipally-owned utilities compared to the baseline of an investor-owned firm. As expected, the coefficient of Price is negative and statistically significantly different from zero, indicating that respondents, *ceteris paribus*, prefer lower prices. Large, positive, and statistically significant coefficients for the interaction variables of supplier type with renewables indicate that renewables in the energy mix are preferred. Differences in these coefficients indicate that the slope of the increase differs by supplier type. Significant standard deviations of the random parameters show that preferences are heterogeneous, although socio-demographic variables already capture some heterogeneity in specification (2).

Specifically, WTP for electricity from cooperatives and municipally-owned utilities increases with age, being female, and having experience with a change in supplier. In a dynamically changing market, customers continuously learn. Notably, in the model that includes observed heterogeneity, customers who are experienced with switching their supplier exhibit a larger WTP of almost one Eurocent per kilowatt hour for cooperatives and almost two Eurocents per kilowatt hour for public enterprises. Based on model specification (1), Table 4 displays consumers' additional WTP by type of supplier and share of renewable energy in the power mix.

[INSERT Table 4 APPROX HERE]

It can be easily seen that consumers prefer electricity provided by municipally-owned suppliers the most followed by cooperatives. The increase in WTP for renewable energy is steep for municipally-owned suppliers and cooperatives. It is lower – roughly half – for investor-owned firms.

5. Discussion

Between 2011 and 2013, the price of a kWh of retail level electricity was between 25 and 29 Eurocents in Germany, including all taxes (Eurostat, 2014). In our estimates, between non-renewable energy from an investor-owned firm and renewable energy from a municipality-owned utility, one can observe a difference of approximately seven Eurocents, which is roughly equal to one quarter of total price. The difference between a cooperative and an investor-owned firm is less than one Eurocent for non-renewable energy; these figures increase to a difference of approximately two and a half Eurocents for tariffs that are entirely based on renewable energy. Thus, trust vis-à-vis public enterprises and vertical integration via consumer cooperatives are important determinants of WTP for renewable energy.

In a study of German electricity consumers, a lack of trust for 16.1 percent of the respondents has been identified as the main reason for not purchasing renewable energy (Rommel & Meyerhoff, 2009, p. 79). This lack of trust could be addressed by promoting certification and labeling schemes. However, currently only a few consumers – less than three percent – are aware of labels and certificates in Germany (Mattes, 2012, p. 6). Moreover, the variety of labels makes it difficult for consumers to learn about the differences, and ultimately, there is the meta-problem of quality uncertainty and fraud regarding labeling and certification (Banerjee & Solomon, 2003).

In Akerlof's (1970) model, the idea of quality uncertainty is illustrated by the market for used cars, a good which is different from electricity in many aspects. Unlike in the case of quality uncertainty regarding renewable energy, buyers of used cars will learn about the good they are considering for purchase. Although this does not necessarily have implications on market functioning ex-ante, it can be important when there are repeated transactions because sellers may be able to develop reputations or they may be able to offer guarantees. For credence goods which are consumed on a permanent basis, this is more difficult as uncertainty cannot be reduced with experience.

Our results have shown that there is substantial heterogeneity in preferences regarding the type of supplier. In particular, women, older respondents, and respondents who have experience with switching suppliers exhibit higher WTP values for utilities that are not investor-owned. In a study on the marketing efforts of German electricity utilities, Herbes and Ramme (2014) show that firms could improve in communicating environmental benefits to consumers on their websites. Our findings suggest that municipally-owned utilities and cooperatives should also take some effort in communicating their firm type, especially to the elderly and female demographic segments of the market. Marketing channels that are more likely to reach these groups might be preferred. The same applies to people who have changed their supplier in the past.

6. Conclusions

Germany and other European countries seek to green their energy systems. Citizens can articulate their preferences regarding the energy system in at least two ways. On the ballot, they can use their voice to push for political change. In the market, they can opt for the type of supplier they prefer. In this paper, we have focused on the latter aspect. We have shown that consumers are often willing to voluntarily adopt renewable energy tariffs, even if the price is higher. Preferences for supplier type are reflected in a higher WTP for electricity from public enterprises and cooperatives. Furthermore, there is a large interaction effect between the share of electricity from renewables and supplier type.

Information asymmetries make it difficult for consumers to assess the quality of green energy supply. In such “lemon markets,” vertical integration and trust play an important role. We found that consumers are willing to pay premiums of approximately four Eurocents for renewable energy from cooperatives or municipally-owned firms in comparison to only two Eurocents from investor-owned firms.

Currently, the renewable energy market offers opportunities mainly for cooperatives and public enterprises. Experienced customers are especially willing to pay more. Investor-owned firms may counter information asymmetries by ensuring quality and engaging in (credible) labeling schemes to increase transparency for consumers. Alternatively, some firms may completely abandon generation from exhaustible resources, leading to a polarization in the generation portfolio of investor-owned firms. Consumers can then more easily judge the type of energy they buy. Lower revenues for green power options increase investor-owned firms' incentives to cheat. If such cases become publicly known and they are attributed to the specific type of firm, consumers' WTP may be further lowered. A downward spiral, and ultimately a collapse of the "lemon market" as predicted by Akerlof's (1970) seminal model, may be the result. Our findings also imply that the successful deprivatization of energy suppliers through political initiatives has the potential to increase consumer welfare, particularly when the share of renewables is large. If consumer information websites and consumer protection organizations were to provide more detailed information on the energy mix and the origin of renewables offered by utilities, information asymmetries could be reduced in the future.

Public policy may play a role in setting a clear standard of what constitutes electricity from renewable resources and in promoting respective certification and labeling. Labeling by the government may be preferred over private labels because long-term commitment and credibility are crucial for programs to work effectively (Banerjee & Solomon, 2003). The positive experience with the European label for organic food, which is now mandatory in all members states (Regulation European Commission No. 834/2007), may serve as an example for policy-makers. As Janssen and Hamm (2012) indicate in a study of six European countries, consumers have difficulties understanding and valuing the many different labels available for organic food. However, if compared to private alternatives, national government's labels and the European Union label of organic food products are relatively well-known. Furthermore, trust, credibility, and consumers' perceptions of the strictness of standards and their monitoring reaches high levels for these labels. As of now, Germany and other European countries do not have governmental labeling schemes for renewable energy. Thus, there is an opportunity to develop a transparent label at the European level, preventing a variety of national labels to emerge (cf. Truffer et al., 2001). Whether or not consumers would accept such a label remains to be seen. In particular, it is an interesting question if a label would have the potential to increase trust in a way that it would substantially reduce differences in WTP for renewables produced by the three types of suppliers investigated in this paper.

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Table 1: Example of a Choice Set

	Cooperative	**Municipally-owned**	**Private**
Share of Renewable Energy	67%	33%	100%
Price	0.29 Euro per kilowatt hour	0.27 Euro per kilowatt hour	0.23 Euro per kilowatt hour
I choose	□	□	□

Table 2: Summary Statistics of Selected Respondent Characteristics

Variable	Description	Obs.	Mean	SD	Min	Max
AGE	Age in years	2174	52.78	14.11	19	86
CHANGED	= 1 if respondent has changed supplier in the past	2169	0.51	.50	0	1
FEMALE	= 1 if female	2174	.45	.49	0	1
INCOME	Categories for net household monthly income (1 = less than 500 Euros, 10 = more than 4,500 Euros)	1887	5.60	2.23	1	10
HHSIZE	Number of persons living in the household	2156	2.19	1.08	1	7
EDUCATION	Highest degree (1 = no degree, 7 = university degree)	2117	3.68	1.87	1	7
MARRIED	= 1 if married	2130	.56	.49	0	1

Table 3: Model Results and WTP Values

	(1) Attributes only		(2) Socio-demographic Interactions	
	Coefficients	WTP	Coefficients	WTP
Mean				
Municipally-owned	1.152***	1.819***	1.182***	1.867***
	(0.0590)	(0.0898)	(0.0602)	(0.0921)
Cooperative	0.347***	0.548***	0.403***	0.636***
	(0.0572)	(0.0899)	(0.0582)	(0.0914)
Price	-0.633***		-0.633***	
	(0.0106)		(0.0106)	
Cooperative x Renewable	0.954***	1.506***	0.957***	1.512***
	(0.0358)	(0.0532)	(0.0356)	(0.0529)
Municipally - owned x Renewable	1.066***	1.682***	1.073***	1.695***
	(0.0400)	(0.0584)	(0.0398)	(0.0579)
Investor-owned x Renewable	0.487***	0.769***	0.510***	0.806***
	(0.0373)	(0.0585)	(0.0368)	(0.0579)
Cooperative x Female			0.243**	0.384**
			(0.0984)	(0.155)
Municipally - owned x			0.534***	0.844***

Female			
		(0.0982)	(0.155)
Cooperative x Changed		0.543^{***}	0.858^{***}
		(0.0974)	(0.154)
Municipally - owned x Changed		1.166^{***}	1.841^{***}
		(0.0976)	(0.154)
Cooperative x Age		0.00781^{**}	0.0123^{**}
		(0.00339)	(0.00536)
Municipally - owned x Age		0.0244^{***}	0.0385^{***}
		(0.00342)	(0.00540)
Standard Deviations of Random Parameters			
Cooperative x Renewable	1.148^{***}	1.132^{***}	
	(0.0394)	(0.0396)	
Municipally - owned x Renewable	1.291^{***}	1.265^{***}	
	(0.0441)	(0.0437)	
Investor-owned x Renewable	1.224^{***}	1.179^{***}	
	(0.0412)	(0.0404)	

N	52176	52056
AIC	22429.5	22129.6
BIC	22509.2	22262.5
χ^2	3677.6	3446.8
Log Lik. (NULL)	-13044.6	-12773.2
Log Lik.	-11205.7	-11049.8

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Additional WTP in Eurocents per kilowatt hour by share of renewables and supplier type

Share of Renewable energy is					
		0%	33%	67%	100%
Firm is	investor-owned	0 (Baseline)	0.769*** (0.0585)	1.538*** (0.117)	2.306*** (0.176)
	municipally-owned	1.819*** (0.0898)	3.501*** (0.0907)	5.184*** (0.123)	6.866*** (0.171)
	a cooperative	0.548*** (0.0899)	2.054*** (0.089)	3.560*** (0.116)	5.066*** (0.157)

Source: own calculations based on delta method; standard errors in parentheses