Determinants and development of electricity consumption of German households over time*

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Abstract

This paper investigates the impact of income and electricity price on residential electricity consumption in Germany between 2006 and 2008. In addition, life style variables such as home size, ownership of electric appliances, as well as demographics such as household size, age and education of the household head are considered as determinants of electricity demand. Moreover, the effects of weather conditions and previous electricity consumption on electricity consumption are examined. Both static model and dynamic (partial adjustment) model are used to estimate the residential demand for electricity. The empirical results reveal that electricity consumption of German households increases with household size, home size, age of the household head and income. Higher electricity price and higher educational level seem to have negative impact on consumption. Past period consumption also appears to be an important determinant of the current period electricity consumption. A careful observation of the statistics reveals that consumption has been slowly decreasing since 2005, mainly due to increasing electricity prices.

JEL codes: C13, C23, D12, Q31, Q41, Q48.

Keywords: residential electricity consumption, energy demand, static model, partial adjustment model.

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1. Introduction

The residential sector is one of the major final energy consumers. In Germany, the residential demand for final energy constitutes one third of final energy consumption (32.5% in 2012[2]). Among the energy goods, electricity is the second most consumed good by private households (20.6% of energy consumption in 2012[3]). Electricity is necessary for everyday life; households use electricity in order to perform tasks such as cooking, lighting, washing, heating, cooling and so on. The electricity expenditures are an important share of households income, and especially so for the poor households.

Hence, changes in the energy taxes and energy prices influence the wellbeing of households. The electricity prices were affected by several changes in the supply side of electricity in Germany. Most of the country's nuclear plants were closed in 2011 and the rest of the nuclear plants are going to be phased out by 2022, which was determined in the Nuclear Phase-Out Bill[4] ("Atomausstieg"). Germany is one of the countries with strong preferences for sustainable energy and a pioneer in renewable energy. In the meantime, the production of renewable energy, mainly from wind energy, photovoltaics and biomass, has more than doubled between 2000 and 2012[5]. This rapid growth in renewables can in large part be attributed to the adoption of the Renewable Energy Sources Act (EEG) from 2000, which was updated in 2014[6].

The ambitious project of Energy Transition[7] ("Energiewende"), with aim to promote a change in energy sources from fossil fuels to renewables, is mainly financed by the households. The households are also bearing disproportionate share of the costs of the Environmental Tax Reform (ETR). As part of the ETR, an electricity tax was introduced in 1999 with the aim to limit CO_2 emissions. The households are affected negatively by constantly increasing electricity

[2] See Federal Statistical Office, 2014a.
[3] See Federal Statistical Office, 2014b.
[4] See German Parliament, 2011.
[5] See Eurostat, 2014
[6] See Federal Ministry of Justice and Consumer Protection, 2014.
[7] See Federal Government, 2011.

prices, which are due to all the policy changes necessary to assure that Germany has sustainable and environmentally safe energy in the long run.

To assure that adverse price effects on electricity consumption are minimized, the size of price responses of households should be determined. The purpose of this paper is to investigate to what extent prices and income are affecting electricity consumption of households. The other determinants of electricity demand are also examined. Life style variables such as home size and ownership of home appliances are expected to have a positive effect on consumption. Household size and age is expected to increase demand for electricity. Last but not least, more education is likely to lead to lower consumption levels.

The estimates show that electricity has relatively high own-price elasticity in the static model (-0.567) and a moderate elasticity in the partial adjustment model (-0.396). So, the households' might not be very able to respond to a price change and adjust their electricity consumption in the short run. The income elasticity of electricity demand is ranges between 0.041 and 0.105, indicating that electricity is a necessity good and that households are more responsive to changes in price than to changes in income. Education is found to have negative effect on the demand for electricity while age has positive effect. Residential electricity consumption is increasing with the size of the household but appears to be unaffected by weather conditions.

2. Literature review

The literature on residential electricity demand determinants is extensive. In this review, I focus on studies which use panel or repeated cross sectional data coming from households' surveys. The methodological strategies include both static as well as dynamic models of electricity demand. Zhou and Teng (2013) estimate income and price elasticities of residential electricity demand together with the effects of life style related variables in China. The estimated price elasticity ranges from -0.35 to -0.50 and the income elasticity ranges from 0.14 to 0.33 for the period 2007-2009. They find that dwelling size and holdings of electric appliances are important determinants of electricity demand. Family size and old age have positive effect on consumption.

Alberini et al. (2011) estimate residential demand for electricity and gas in the U.S. between 1997 and 2007. As a methodology, they use both a static energy demand model as well as a dynamic model. They find that own price elasticity of electricity varies between -0.860 and -0.667, while the one for gas between -0.693 and -0.566. It is intriguing that their results indicate great potential for policies involving energy prices. Blazquez et al. (2013) estimate a log-log model for electricity consumption by using the dynamic partial adjustment approach. They investigate how income, price and weather affect electricity demand in Spain for the period 2000-2008. The estimated income elasticity varies between 0.14 and 0.30; and the price elasticity varies between -0.11 and -0.24. They find evidence that weather conditions influence demand for electricity, with higher sensitivity of demand to cold days than to hot.

Labandeira et al. (2012) estimate electricity demand with incomplete or imperfect data. They employ a model of random effects for panel data to predict residential and industrial electricity demand in Spain. They find that electricity demand is inelastic with respect to its own price: an increase in the price will give rise to less than proportional decrease in demand. The authors also find evidence that as income increases, demand becomes more price elastic. Household electricity demand in Spain was also investigated in Romero-Jordan et al. (2014). Using panel data for the years 1998-2009 and employing a partial adjustment model, the authors find that electricity demand is negatively related to electricity prices, gas prices, penetration of electric heating and the presence of older people in the household. They find evidence that electricity demand in previous year, income, electric water heating and number of heating and cooling degree days (HDD and CDD) affect electricity consumption in the current period. They find price elasticity between -0.26 and -0.37, and income elasticity between 0.31 and 0.43.

Boogen et al. (2014) estimate short and long-run price elasticities of residential electricity consumption of Swiss households in 2005 and 2011. They construct appliances index, and use the index and energy services as explanatory variables of electricity demand. They find price elasticity of around -0.6, indicating price inelasticity of residential electricity consumption in Switzerland. Halvorsen and Larsen (2001) use a discrete-continuous approach for estimating household electricity demand in Norway and model long-run effects by investments in new appliances. They find that the long-run price elasticity of electricity is only slightly higher than the short-run.

3. Empirical methodology

3.1. Static model

Logarithmic equation form is mostly used in studies which deal with individual demand equations. Since the coefficients from such specification can directly be interpreted as elasticities, this particular specification is usually preferred to the one which utilizes the levels of the variables. Here, a variation of the static energy demand model (see Zhou and Fang (2013) Labamdeira et al. (2012), Alberini et al. (2011), etc.) was used, to estimate the following demand function:

$$(1)\quad \ln(E) = \alpha_0 + \alpha_1 * \ln(P^e) + \alpha_2 * hhsize + \alpha_3 * \ln(Y) + \alpha_4 * \ln(m\_sq) + \alpha_5 * age2 + \alpha_6 * age3 + \alpha_7 * educ2 + \alpha_8 * educ3 + \alpha_9 * \ln(HDD) + \beta_{2007} * D_{2007} + \beta_{2008} * D_{2008} + \gamma_2 * land2 + \cdots + \gamma_{16} * land16 + \varepsilon$$

where $\ln(E)$ represents the logarithm of household's yearly electricity consumption; $\ln(P^e)$ represents the logarithm of price of electricity; $hhsize$ represents household's size (number of adults and children); $\ln(m\_sq)$ stands for the logarithm of home size (in meters squared); $\ln(Y)$ stands for the logarithm of yearly disposable income (after income taxes) of the household; $age2$ is a dummy and has value of 1 for the households head with age above 30 and below 50 and zero otherwise; while $age3$ takes value of 1 for the households whose head is above 50 years old; the reference group is households with young head: 18-29 years old. $educ2$ takes value of 1 for household, whose head has finished high school or other specialized school. $educ3$ is a dummy with value of 1 if the head has higher education (university degree) and zero otherwise; the reference group is the households with head without completed high school; $\ln(HDD)$ stands for logarithm of the number of heating degree days (18^{o} C is used as the threshold); D_{2007} and D_{2008} are year dummies equal to 1 if the year in year i ($i = 2007, 2008$) and zero otherwise; $land2 - land16$ are dummies indicating in which of the 16 German states (Bundesländer) the household lives; the reference state is $land1$: Schleswig-Holstein; ε is the disturbance term.

3.2. Dynamic partial adjustment model

The partial adjustment model is especially useful for analyzing cases when the electricity demand diverges from its long-run equilibrium consumption. This can often happen in the short-term, when the stock of electric appliances cannot be easily adjusted. For estimating the dynamic model, the approaches of Alberini et al. (2011) and Blazquez et al. (2013) were combined:

$$(2) \quad \ln(E_{it}) = \alpha_0 + \alpha_1 * \ln(E_{i,t-1}) + \alpha_2 * \ln(P_{it}^e) + \alpha_3 * hhsize_{it} + \alpha_4 * ln(Y_{it}) + \alpha_5 * \ln(m\_sq_{it}) + \alpha_6 * age2_{it} + \alpha_7 * age3_{it} + \alpha_8 * educ2_{it} + \alpha_9 * educ3_{it} + \alpha_{10} * \ln(HDD_{it}) + \beta_{t+1} * D_{i,t+1} + \beta_{t+2} * D_{i,t+2} + \gamma_2 * land2_{it} + \cdots + \gamma_{16} * land16_{it} + \varepsilon_{it}$$

where $\ln(E_{it})$ represents the logarithm of previous period electricity consumption of household i and the other variables are already defined under (1).

4. Data

The data used in this paper comes from the German Residential Energy Consumption Survey (GRECS) for the years 2006 to 2008. The dataset represents mixed panel/multi-year cross sections for around 3,000 households per annum. The GRECS is a rich dataset in the sense that it contains data on energy consumption, income, demographics, life style and other socio economic characteristics of the German households. A panel database with time-consistent information was generated from the most recent GRECS data waves. Generating such a pooled database was a challenging task as variables have been added and removed and notation of variables has changed.

Another difficulty was that the income variable is provided as categorical variables. Complex income imputation methods were used in order to obtain income as continuous variable. From the Income and Expenditure Survey (EVS) wave of 2008, the household type specific income distribution for Germany was estimated. Then, by using a bootstrap procedure, the household income in the GRECS data was imputed from the fitted income distribution. For details concerning the income imputation methodology please refer to Grösche and Schröder (2014).

The postal codes of the place of residence are provided in GRECS and were used to identify the state (Bundesland), in which the household is located. Then, symmetric trimming was used to exclude any possible outliers from the data. The lowest and highest percentile of the distribution of electricity consumption are excluded from the analysis. The final sample size is 5,805 households in three years: 2,041 in 2006, 2,097 in 2007 and 1,667 in 2008. *Table 1* summarizes the descriptive statistics of the variables used for analyses.

The average German household consumed 3,618 kWh of electricity in the period 2006-2008. The average electricity price in the same period was 0.212 euros/kWh. The income variable represents disposable income of the household i.e. income after income taxes. The mean annual income of the average household is around 35,000 euros. The average German household consists of more than 2 members and lives in home, whose average size is 110 meters squared. The number of average heating degree days in the period was 3,384 in Germany. We can see that 42% of households have a head in the age group 30-49, while 53% of households have a head in the age group above 50. Concerning education, 48% of households have a head with completed high school education, while only 34% with completed higher education.

Table 1. Descriptive statistics

	Obs	Mean	Std. Dev.	Min	Max
Electricity consumption	5805	3618.926	1.669	720.235	9172.129
Electricity price	5805	0.212	0.039	0.097	0.672
HH size	5805	2.454	1.119	1	5

Income	5805	34849.761	18682.482	3328.019	129240.003
Home size	5805	110.985	4.583	12	666
HDD	5805	3384	3.254	2216	4799
Age2	5805	0.423	0.494	0	1
Age3	5805	0.532	0.499	0	1
Educ2	5805	0.483	0 .499	0	1
Educ3	5805	0.337	0.473	0	1

Note. Database is GRECS 2006-2008.

For analyzing the development of electricity consumption and its costs over time, earlier waves of the GRECS data were examined: namely the 2003 and the 2005 waves. *Table 2* shows the mean values of consumption, expenditures and price of residential electricity in Germany for the period 2003-2008. The average consumption of electricity per household was highest in 2003 - 4,294 kWh and has been decreasing until 2008 - 3,531 kWh. The reduction in quantity is mainly due to electricity price increase, which amounted to 26.2% between 2003 and 2008. Part of the reduction maybe can be also attributed to using more energy efficient electric appliances but this effect is not expected to be too large. As the price rose, the costs of electricity consumption have also increased in the period from 832 euros to 943 euros yearly.

Table 2. Development of electricity consumption over time

	Obs	Cons(kWh)	Cost (euros)	Price (euros/kWh)
2003	6005	4293.774	831.787	0.172
2005	3343	4125.439	880.600	0.187
2006	2041	3736.765	886.521	0.195
2007	2097	3663.371	870.716	0.206
2008	1667	3531.364	942.533	0.217

Note. Database is GRECS 2003-2008.

Electricity is a neccessity good for all households as it essential for everyday life: lighting, cooking, heating, washing, etc. Increase in the price of electricity can thus affect certain groups of households more than others, and especially the poorest households. In order to see wheter consumption and expenditures on electricity differ between the poor and the rich households, it is investigated how they evolve among each of the ten income deciles. The poorest German household consume 2,200 kWh, the middle income households 3,720 kWh while the richest consume 4,930 kWh annually. The costs of electricty consumption also increase with income: the households in the first income decile pay 495 euros and the households in the 10th income decile pay 968 euros yearly. But as percentage of income, the costs are disproportionally higher for the poorer in comparison to the richer. While the poorest give 7.3% of their disposable income on electricity, this proportion is only 1.4% for the riches households.

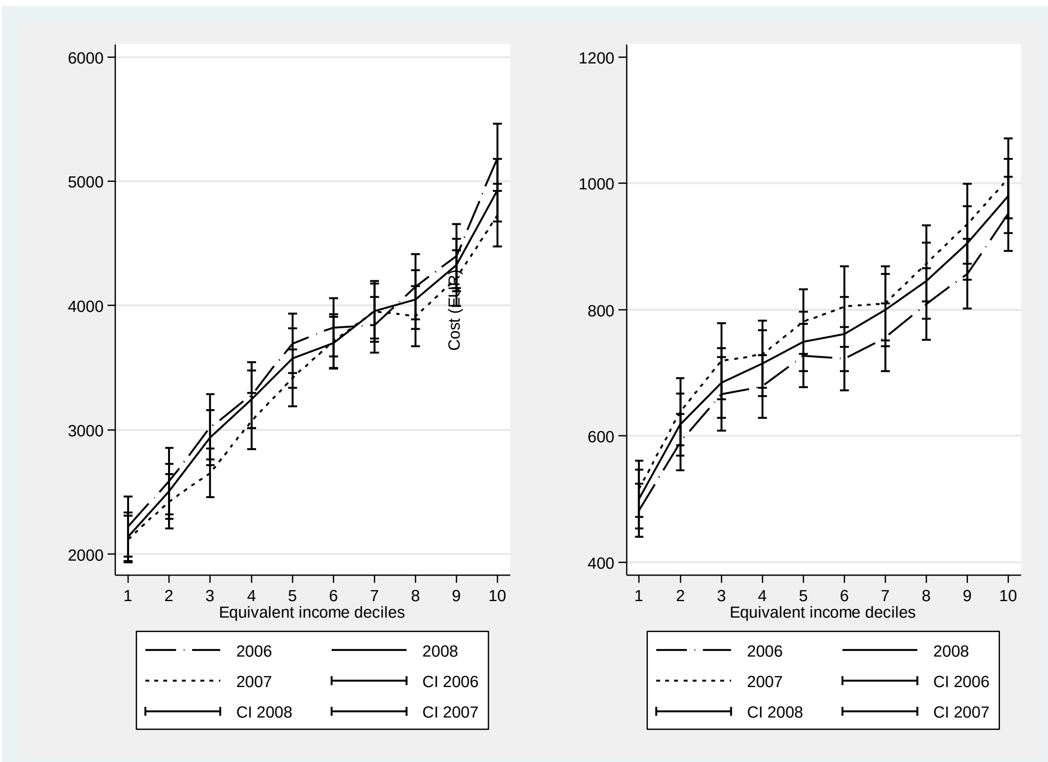

Figure 1. Consumption and costs across income deciles

Table 3 includes the correlation coefficients among the dependent variables. Price of electricity has moderate correlation with household size, income and home size. The price has weak correlations with the age and education variables. Income has moderate correlation with household size, home size and education while it has weak correlation with age. Because of the weak to moderate correlations between price and income and the demographic variables, it is not expected that the inclusion of demographic variables will lead to serious multiple collinearities. The electricity consumption has positive correlation with income, household size and home size and negative correlations with its own price and education. The collinearities give a preview of the expected empirical results concerning residential demand for electricity in Germany.

Table 3. Correlation matrix of right hand side variables

	Ln(p)	Hhsize	Ln(y)	Ln(m_sq)	Ln(hdd)	Age2	Age3	Educ2	Educ3
Ln(p)	1.000								
Hhsize	-0.233*	1.000							
Ln(y)	-0.204*	0.380*	1.000						
Ln(m_sq)	-0.310*	0.485*	0.504*	1.000					
Ln(hdd)	0.016	0.089*	-0.050*	0.056*	1.000				
Age2	0.038*	0.309*	0.053*	-0.020	0.040*	1.000			
Age3	-0.081*	-0.285*	-0.007	0.104*	-0.034*	-0.913*	1.000		
Educ2	-0.004	0.051*	-0.103*	-0.030*	-0.010	0.132*	-0.162*	1.000	
Educ3	0.030*	-0.023*	0.268*	0.054*	-0.026*	-0.026*	0.032*	-0.690*	1.000

*Note. *significant at 10%.*

5. Estimation results

5.1. Results from the static model

The demand for electricity is estimated by the ordinary least squares (OLS) model and the results are presented in *Table 4.* Specification 1 (S1) and Specification 2 (S2) include year dummies but do not include state dummies. The difference between those two specifications is that S2 includes also demographic and life style variables, namely home size and household size, age and education level of the household head, and number of heating degree days. S3 and S4 include controls for the German state in which the household is living. Since a double log model was used, the coefficients on price and income can be directly interpreted as elasticities. In S1, the price elasticity is negative and estimated to be -0.652. For 1% increase in the price of electricity, quantity demanded of electricity will decrease by 0.652%, while holding everything else constant. The income elasticity under S1 shows that if the household income increases by 1% quantity demanded will increase by 0.401%.

Once the other explanatory variables are included in the model, such as in S2, the price and income elasticities both decrease in absolute terms. Home size has positive effect on electricity demand as bigger flats or houses need more energy for lighting, heating or cooling. Families which live in 10% bigger homes will tend to spend 4.7% more electricity in comparison to families which live in smaller homes. Adding one more person to the household will increase electricity consumption by 14.2%. This shows that household size has a scale effect on electricity demand. Households with older head tend to have higher consumption. If the head of the household is 29-49 years old, this household will consume 10.4% more electricity than if the head of the household is 18-28 years old; if the head of the household is above 50 years old, then consumption is 21% higher. Households which have a leader with completed high school education will spend 6.2% less electricity while those with higher education will spend 12.6% less electricitity than households with head who has not completed high school. It is surprising that the number of heating degree days has a negative effect on electricity consumption in the second specification.

The third specification (S3) is comparable to S1 in terms of sign and magnitude of estimated coefficients. Controlling for state where the household is located leads to slightly lower income and price elasticity and slightly higher constant. The state dummies include information on climate, religion, culture as well as other unobservable characteristics which are likely to be state specific. The goodness-of-fit as measured by the R^2 improves by 1.8% in comparison to S1, where no state dummies were included. S4 is found as the superior specification because year dummies and state dummies as well as demographic and life style variables are included; the R^2 is at its highest and all estimates are statistically significant (with the exception of HDD). The sign and magnitude of all coefficient estimates are highly comparable to the estimates under S2, except of the coefficient in front of HDD. This coefficient is now positive, which is the expected sign (as the number of heating degree days increases, demand for electricity is likely to increase) but on the other hand it is statistically insignificant. The insignificance might be due to the inclusion of state or Bundesland dummies, which are likely to include information on climate and temperature, as these should be similar within one state. Since the data for 2006-2008 does not contain information about the ownership of electric home appliances, it was impossible to investigate the impact of appliances such as computer, refrigerator or air conditioner on residential electricity consumption.

The obtained price and income elasticities estimates from this study are comparable to the existing literature. Halvorsen and Larsen (2001) find income elasticity of 0.06-0.13 and price elasticity between -0.442 and -0.433. My estimates are also similar to those of Zhou and Teng (2013) and Boogen et al. (2014). Labaneira e al. (2012) find higher income elasticity but lower price elasticity than this study.

Table 4. Determinants of residential electricity demand in the static model

	S1	S2	S3	S4
Ln(p)	-0.652***	-0.558***	-0.647***	-0.567***
Hhsize	0.401***	0.105***	0.379***	0.105***
Ln(y)		0.470***		0.472***
Ln(m_sq)		0.142***		0.141***
Age2		0.104**		0.108***
Age3		0.213***		0.216***
Educ2		-0.062**		-0.060***
Educ3		-0.126***		-0.128***
Ln(hdd)		-0.004*		0.056
Constant	3.900***	3.974***	4.097***	3.670***
Year dummies	yes	yes	yes	yes
State dummies	no	no	yes	yes
R^2	0.324	0.550	0.341	0.555

*Note. *significant at 10%; ** significant at 5%;***significant at 1%.*

5.2. Results from the partial adjustment model

The four specifications for the dynamic model are estimated with generalized least squares (GLS) method. Random effects model was used because the diagnostic tests revealed that fixed effects model was inappropriate. All four specifications have the previous period electricity consumption as an explanatory variable (see *Table 5*). S1 and S2 do not contain dummies for the states while S3 and S4 do. Similarly to the static model, S2 and S4 include additional demographic and life style variables as determinants of electricity demand. The estimates under S1 reveal that if previous period electricity consumption was 1% higher, the current period consumption will be 0.759% higher. The own price elasticity of electricity is -0.381, which is almost twice lower than the elasticity obtained in the static model. The second specification reveals that increasing the home size by 1% will make consumption rise by 0.165% and adding one more household member will make consumption 5% higher. It is interesting that age, high school education, and HDD do not impact electricity demand. But this might be consequence of including past period consumption, which already takes into account the effect of the demographic variables. Previous period electricity consumption is found to have moderate correlation with price, income household size and home size, while it has weak correlations with age and education (for details see *Table 1* in the Appendix). Only if the household head has a completed higher education, demand is likely to be 4.1% lower than if the household head has no higher education. The inclusion of the state dummies in the model (such as in S3 and S4) does not significantly alter the results. Only the income elasticity drops to 0.041 in the model with demographics. The R^2 is highest under the fourth specification (0.868). The estimates from the partial adjustment model compare favorably to previous studies. Bernard et al. (2011) also find lagged consumption to affect current electricity consumption (by 0.616%). Blazquez et al. (2013) estimates are also comparable; their OLS estimate is 0.779. Only Alberini et al. (2011) find lower effect of lagged electricity consumption on demand: in the range between 0.096 and 0.123.

Table 5. Estimates from the partial adjustment model

	S1	S2	S3	S4
Ln(e_{t-1})	0.759***	0.704***	0.756***	0.701***
Ln(p)	-0.381***	-0.389***	-0.387***	-0.396***
Hhsize	0.074***	0.039***	0.073***	0.041***
Ln(y)		0.165***		0.165***

Ln(m_sq)		0.052***		0.051***
Age2		0.001		0.002
Age3		-0.013		-0.011
Educ2		-0.016		-0.018
Educ3		-0.041***		-0.047***
Ln(hdd)		-0.073		-0.035
Constant	0.767***	0.742***	0.808***	0.709***
Year dummies	yes	yes	yes	yes
State dummies	no	no	yes	yes
R^2	0.860	0.866	0.862	0.868

6. Consistency checks

To see how robust the coefficient estimates are, an estimation of the fourth specification (S4) of the static model was done for each income decile individually. As it can be seen in *Table 6*, the price elasticity varies from -0.348 to -0.856 and these values are comparable to the estimates from the four different specifications. The income elasticity is positive and takes values between 0.009 and 0.823, which is again a reasonable range. The effect of age on consumption is again found to be positive, while the effect of education on consumption is negative. The effect of heating degree days on residential electricity consumption is ambiguous, but in most cases statistically insignificant. As an alternative robustness check, an estimation of S4of the static model was done for each German state separately. The results of those estimations are in *Table A2* in the *Appendix*. The general message is again that the ranges of the estimated coefficients fall within reasonable limits. The price elasticity variation is large: while it is -0.282 for households living in Sachsen, it is -1.174 households living in Sachsen-Anhalt. The income elasticity ranges from 0.088 to 0.176.

Table 6. Coefficient estimates for the income deciles-static model

Income deciles	1	2	3	4	5	6	7	8	9	10

Ln(p)	-0.348	-0.760	-0.853	-0.433	-0.303	-0.391	-0.664	-0.856	-0.613	-0.619
Hhsize	0.009	0.062	0.784	0.144	0.335	0.494	0.008	0.737	0.823	0.104
Ln(y)	0.396	0.625	0.404	0.586	0.457	0.428	0.371	0.404	0.239	0.530
Ln(m_sq)	0.117	0.140	0.216	0.148	0.185	0.157	0.160	0.124	0.111	0.126
Age2	0.190	-0.006	0.366	0.084	0.348	0.144	0.043	-0.009	0.291	0.176
Age3	0.118	-0.055	0.439	0.151	0.505	-0.005	0.246	0.174	0.459	0.299
Educ2	-0.066	-0.167	-0.009	-0.098	0.019	-0.002	-0.093	0.051	-0.093	-0.184
Educ3	-0.185	-0.132	-0.123	-0.163	0.010	-0.161	-0.233	-0.038	-0.117	-0.197
Ln(hdd)	0.003	-0.008	0.002	-0.001	-0.001	0.001	0.001	-0.002	0.001	0.001
Constant	3.798	4.270	1.824	3.717	5.640	2.993	4.924	6.901	2.695	3.325

Note. Database is GRECS 2006-2008. In the estimations, it was controlled for state and year dummies and life style and demographic variables.

7. Conclusion

Estimating the residential demand for electricity is an important part of policy design of any country. In the face of increasing costs of electricity, mainly borne by households, it is important to investigate the determinants and development of electricity consumption of German households in the past years.

In the static electricity demand model, the price elasticity of electricity is relatively high; for one percent price increase, quantity demanded will drop by 0.567 to 0.647 percent. The income elasticity spans between 0.105 and 0.379, which means that changes in income will not have as large influence on electricity consumption as changes in prices. Electricity is a necessity good for all German households. If the household head has completed high school or higher education, the demand for electricity will tend to be lower. If the household head belongs to the age groups 29-49 or above 50 years old, electricity consumption of the household is found to be higher. Climate is not found to have an effect on consumption; however the consumption is found to differ across the German states, which can serve as a proxy for temperature and other unobserved state specific characteristics.

The dynamic partial adjustment model takes into account that households are not able adjust their electric appliances stock and consumption in the short-run. In this model, the own price elasticity of electricity is in the range from -0.381 to -0.396. The income elasticity varies between 0.039 and 0.074. Past period electricity consumption is an important determinant of electricity demand in Germany. Results indicate that if past period consumption was 1% higher, the current period consumption will be 0.759% higher, holding everything else constant. Increasing the home size by 1% will make consumption rise by 0.165% and adding one more household member will make consumption 5% higher. Age, high school education, and weather conditions do not influence electricity demand. Only the German households, whose head has higher education, will have lower consumption of electricity.

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Appendix

Table A1. Correlation matrix with $Ln(E_{t-1})$-dynamic model

	lnet_1	lnp	hhsize	lny	lnm_sq	age2	age3	educ2	educ3
$Ln(e_{t-1})$	1								
Ln(p)	-0.356*	1							
Hhsize	0.483*	-0.100*	1						
Ln(y)	0.413*	-0.147*	0.392*	1					
Ln(m_sq)	0.597*	-0.152*	0.507*	0.510*	1				
Age2	-0.015*	0.037*	0.303*	0.067*	-0.018	1			
Age3	0.080*	-0.057*	-0.281*	-0.020	0.090	-0.914	1		
Educ2	-0.021	0.013	0.041*	-0.111*	-0.041*	0.141*	-0.173*	1	
Educ3	-0.026	-0.015	-0.019*	0.267*	0.049*	-0.034*	0.043*	-0.689*	1

Table A2. Estimates for the separate German states-static model

States 1-8	Schleswig-Holstein	Hamburg	Nieder-sachsen	Bremen	Nordrhein-Westfallen	Hessen	Rheinland-Pfalz	Baden-Wuttenberg
Ln(p)	-0,783	-1,174	-0,570	-0,489	-0,480	-0,813	-1,105	-0,655
Hhsize	0,105	0,139	0,132	1,016	0,176	0,145	0,143	0,088
Ln(y)	0,564	0,521	0,445	0,152	0,400	0,438	0,519	0,406
Ln(m_sq)	0,166	0,133	0,201	-0,421	0,104	0,165	0,098	0,156
Age2	0,087	0,214	0,037	0,364	0,109	0,151	0,183	0,050
Age3	0,322	0,358	0,229	0,000	0,252	0,317	0,176	0,198
Educ2	-0,173	0,047	-0,132	-0,498	-0,027	0,012	-0,011	-0,038
Educ3	-0,092	0,052	-0,103	0,375	-0,125	-0,148	-0,028	-0,120
Ln(hdd)	0,206	-1,982	-0,091	1,369	-0,194	-0,020	0,401	0,393
Constant	2,711	1,647	5,571	1,119	5,325	3,146	0,836	0,786
States 9-16	Bayern	Saarland	Berlin	Branden-burg	Meckenburg-Vorprommen	Sachsen	Sachsen-Anhalt	Thuringen
Ln(p)	-0,635	-0,948	-0,498	-0,882	-0,759	-0,282	-1,132	-0,885
Hhsize	0,113	0,236	0,157	0,105	0,108	0,261	0,123	0,118
Ln(y)	0,405	0,892	0,568	0,675	0,470	0,768	0,506	0,408
Ln(m_sq)	0,182	0,014	0,091	0,067	0,008	0,106	0,151	0,200
Age2	-0,105	0,070	0,040	-0,058	0,380	0,311	-0,053	-0,153
Age3	0,021	0,000	0,000	-0,036	0,251	0,293	-0,039	-0,028
Educ2	-0,083	-0,215	-0,057	-0,019	-0,211	-0,208	-0,087	0,099
Educ3	-0,098	-0,092	-0,243	-0,017	-0,160	-0,311	-0,202	-0,039
Ln(hdd)	0,485	0,202	-0,092	-0,648	0,686	-0,738	2,292	1,240
Constant	0,111	1,227	3,994	5,765	-1,115	6,818	1,406	6,139

Note. Database is GRECS 2006-2008. In the estimations, it was controlled for state and year dummies and life style and demographic variables.