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Estimating a Consumer Demand System of Energy, Mobility and Leisure

A Microdata Approach for Germany

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Abstract

This paper investigates empirically the consumer demand of environmentally relevant goods for Germany, as well as their relationship to the demand for leisure. Higher prices for energy goods like gas, electricity or fuel oil due to higher indirect taxation amongst others may have serious welfare and distributional effects for households. Also, there is very little evidence of the labor market implications of environmental taxation, as there is e.g. no quantification of labor supply effects, respectively leisure demand effects for Germany. Using a demand system to estimate the price, cross-price and income effects of the goods mobility, electricity, heating and leisure from microdata, there will also be accounted for the extensive demand for leisure, which is the not negligible labor market participation. Additionally, the extensive and intensive leisure demand is combined to total leisure demand elasticities, which can then be used for welfare and behavior analyses.

Keywords: Consumer demand system, almost ideal demand system, environmental taxation, demand for leisure.
JEL Classification: D12, H31, Q48, R48

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1 Introduction

Due to the increasing taxation of energy and fuel goods and their high prices, allocational and distributional issues regarding the private households become more important. Especially for Germany, despite the raising relevance of environmental taxation since the late 1990's and the massive challenges for the energy market due to the energy transition (*Energiewende*), only few studies exist that analyze the demand of energy goods and none of them incorporates the cross-price relationships to leisure demand yet, which has been emphasized as highly relevant for welfare analysis in studies for the United States (see West and Williams, 2004a,b, 2005, 2007).

The regressivity of the indirect taxes, which means a shrinking tax burden relative to an income-based economic welfare measure, like the disposable income, is a well known suggestion of empirical distributional studies. This result is seen as problematic because it increases inequality in an economy. It could enforce poverty and reduce the popularity of such taxes. With demand system estimation, it is possible to simulate welfare effects that take into account behavioral effects, own-price effects and cross-price effects between goods. The substitution between the taxed commodities and leisure demand is suggested to be especially important for welfare analysis and optimal taxation.

In this paper, as modeled in the framework of West and Williams, an Almost Ideal Demand System (AIDS, see Deaton and Muellbauer, 1980a) is estimated to get own-price and cross-price effects of the consumer goods "Mobility", "Electricity", "Heating" and other non-durable goods, as well as of "Leisure". This approach allows calculating the compensated and uncompensated elasticities, which can then be used to simulate behavioral responses and welfare effects of price shifts. The demand system is estimated with pooled German micro data from three survey years of the EVS (Income and Consumption Survey for Germany, *Einkommens- und Verbrauchsstichprobe*).

The structural approach applied in this paper allows for leisure responses at the *intensive* as well as at the *extensive* margin, where reactions at the *extensive* margin refer to changes in labor market participation (or at the macro level in the number of working persons), while changes at the *intensive* margin refer to changes in the average number of hours worked for the working population (see e.g. Blundell, Bozio, and Laroque, 2011). The estimates of the Almost Ideal Demand System referring to leisure demand or accordingly to labor supply are interpreted as elasticities at the *intensive* margin, while the *extensive* labor market participation elasticities are estimated in a preceding discrete choice model, which is then linked to the demand system and used for selectivity correction. The elasticities of both margins are combined to get elasticities of total leisure demand, which are then used in the simulation and welfare analysis.

This approach is an extension compared to the West and Williams framework, where selection issues are also addressed but the distinction between *extensive* and *intensive* leisure demand is not handled explicitly. Relevant cross-price effects are found e.g. between mobility and leisure, which suggest a substitutional relationship between these two goods.

In the next section, the AIDS framework and its theoretical properties, especially with respect to "Leisure", are presented. The discrete choice model and the estimation issues are discussed later in Section 3.3.

2 A Demand System Involving Leisure

For the purpose of modeling the demand for mobility and energy goods along with their relationships to leisure, the approach mainly follows the framework of West and Williams (see West and Williams, 2004a,b, 2005, 2007). The own-price and cross-price effects of the consumer goods "Mobility", "Electricity", "Heating" and other non-durable goods, as well as of "Leisure" are estimated together in an Almost Ideal Demand System (AIDS, see Deaton and Muellbauer, 1980a). The AIDS specification is based on price-independent generalized logarithmic (PIGLOG) preferences and is, therefore, linear in the logarithm of the budget.

Let $Q_{i,j}$ denote the demand of household i for good j in quantities and $s_{i,j} = Q_{i,j} \cdot p_{i,j}/y_i$ the respective budget share. Then, demand for consumption good j is represented by the following system of J equations:

$$s_{i,j} = \alpha_{0j} + \beta_j \ln(y_i/P_i^*) + \sum_k \gamma_{jk} \ln(p_{i,k}) \tag{1}$$

for households $i = 1, ..., N$ and goods $j, k = 1, ..., J$. y_i is household i's budget, which includes all expenditures spent on the consumer goods and leisure, $p_{i,k}$ is the price of good k for household i, and α_{0j} is a good-specific constant. β_j denotes the parameter of the budget effect of demand and γ_{jk} a parameter of the effect of relative price changes. Due to the exclusion of savings and durables in the household budget y_i, the assumption of "Two-stage budgeting" has to be made, which relegates the decision whether to consume, to shift consumption to the future or to invest in durable goods to a preceding step.[1]

$\ln(P_i^*)$ is the translog price index, which can be approximated by a linear price index, e.g. by the log-linear Laspeyres index ($\ln(P_i^*) = \sum_j s_{i,j} \ln(p_{i,j})$), resulting in the linearized AIDS. However, this index can be seen as endogenous because it depends on the household's shares. Therefore, the individual shares are replaced by the sample means. Additionally, the prices are

[1] See Deaton and Muellbauer (1980b) for details on the concept of "Two-stage budgeting".

normalized to have homogenous units because the log-linear Laspeyres index is not invariant to changes in the measurement unit for $p_{i,j}$ (e.g. from index number to monetary measure, see Moschini, 1995). This yields $\ln(P_i^*) = \sum_j \bar{s}_j \ln(p_{i,j}/\bar{p}_j)$. At this point without further restrictions, the system could still be estimated consistently by seemingly unrelated regressions (SUR) or because all equations contain the same explanatory variables, equation by equation by OLS.

The parameters in the structural model can be used to calculate the elasticities. Omitting household indices for simplicity, the income elasticity corresponds to:

$$\eta_j \equiv \frac{\partial Q_j}{\partial y}\frac{y}{Q_j} = 1 + \frac{\beta_j}{s_j} . \tag{2}$$

The uncompensated price elasticity for the demand level of good j w.r.t. price of good k (where k is any good except leisure) is:

$$\varepsilon_{jk}^u \equiv \frac{\partial Q_j}{\partial p_k}\frac{p_k}{Q_j} = \frac{\gamma_{jk}}{s_j} - \delta_{jk} - \frac{\beta_j s_k}{s_j} \tag{3}$$

where δ_{jk} is the Kronecker delta, i.e. $\delta_{jk} = 1$ if $j = k$ and $\delta_{jk} = 0$ if $j \neq k$. By the Slutsky equation, the compensated price elasticity follows as:

$$\varepsilon_{jk}^c \equiv \varepsilon_{jk}^u + s_k\eta_j = \frac{\gamma_{jk}}{s_j} - \delta_{jk} + s_k \tag{4}$$

A fully consistent demand system has to fulfill the following *cross*-equations constraints on the parameters: $\sum_j \alpha_{0j} = 1$, $\sum_j \beta_j = 0$, and $\sum_j \gamma_{jk} = 0$. These restrictions together imply adding-up of the budget shares to one for each household: $\sum_j s_{i,j} = 1 \; \forall \, i = 1, ..., N$.[2] It follows that only $J - 1$ equations can be estimated. The coefficients of the last equation are given by the adding-up conditions. While adding-up is fulfilled by definition of the model, other properties of a consistent demand function that make the model consistent with demand theory can be imposed or tested for the AIDS: compensated own price elasticities shall be non-positive ($\varepsilon_{jj}^c \leq 0 \; \forall \, j$), the Slutsky-matrix is symmetric if the cross-price effects are equal, $\gamma_{jk} = \gamma_{kj}$, and compensated demand is homogeneous of degree zero in prices if the *within*-equation constraints, $\sum_k \gamma_{jk} = 0 \; \forall \, j$, hold (see Deaton and Muellbauer, 1980b).

Here, the traditional model, which involves only expenditures on consumer goods, is extended to the demand for leisure. In the general notation, the expenditures on leisure are given by $(t - h_i) \cdot w_i$, where t is the time-endowment of the agents in the household, which is the same

[2] Adding-up of the predicted shares cannot be tested, though, given adding-up of observed shares is fulfilled by construction (see Deaton and Muellbauer, 1980a, p. 316).

for all agents, h_i is the working-time and w_i is the net wage per hour. The budget y_i then consists of the expenditures on all included consumer goods and on leisure. Following West and Williams (2004a), the model will be estimated separately for one-adult households and two-adult households. In case of one adult per household, there is obviously only one demand for leisure. In case of two adults, there are two demand decisions for leisure per household, which are treated as two separate goods. Therefore, the demand for male leisure and for female leisure appear in the demand system. The uncompensated elasticities with respect to changes in the net wage (either female or male in the two-adult case) are slightly different from the regular price elasticities (see West and Williams, 2004a):

$$\varepsilon^u_{jk} \equiv \frac{\partial Q_j}{\partial w}\frac{w}{Q_j} = \frac{\gamma_{jk}}{s_j} - \delta_{jk} + \frac{\beta_j}{s_j}\left(s_{Lk} - s_k\right) + s_{Lk} \tag{5}$$

for $k = m, f$ (male or female), where $s_{Lk} = t \cdot w_k / y_i$, which is the share of expenditures that is financed from personal wage income. For example, in the case of a one-adult household with zero non-labor income s_L should be 1 and in the two-adult case, where both adults face the same wage, then $s_{Lm} = s_{Lf} = 0.5$.

Further issues concerning the derivation of the net wage per hour and the practical application of leisure demand in the estimation are discussed in the next section.

While many studies of demand systems assume weak separability between the commodity demand and leisure (see e.g. Blundell, Parshades, and Weber, 1993), which is rejected in several papers (see e.g. Blundell and Walker, 1982), this assumption is relaxed here. However, as the present system involves only non-durable goods and leisure time, the assumptions of intertemporal separability and separability between the demand of non-durables and durables have to be made. This does not imply no substitution effect over time or a cross-price elasticity of zero between durables and non-durables, but it assumes a constant intertemporal rate of substitution.[3] Therefore, all price changes affect the savings with the same elasticity because the intertemporal consumption decision is separated and relegated to a preceding step, which is linked to the intra-period model via "Two-stage budgeting". The great advantage of this assumption is that neither price nor wage information from other periods or on durable goods are required to estimate the model. This assumption is also crucial, but necessary to avoid an overloaded framework which is not possible to identify with the existing available data. The data issues are discussed in the next section.

[3]The relationship between the non-durable goods and the durables can be split off into an intertemporal part, which is covered by the intertemporal rate of substitution and a within-period cross-price effect, which refers to a current utility stream from the durable good and would have to be estimated in the intra-period model. But this effect could also be assumed to be equal to the composite good of non-durables effect if no particular durable good is considered.

3 Data and Empirical Strategy

In the following section, some special issues concerning the application of the demand system estimation will be considered. Firstly, the data and the construction of the commodity prices are presented, then further data manipulation regarding the expenditures for leisure is described and finally, the estimation strategy and specification are discussed.

3.1 Lewbel Prices

The demand system will be estimated on three pooled repeated cross-sections from household consumption survey data for Germany, which are the survey waves 1998, 2003 and 2008 of the EVS (Income and Consumption Survey for Germany, *Einkommens- und Verbrauchsstichprobe*). The EVS is an administrative data set provided every five years with a sample of about 40,000 households that contains rich information of income and expenditures. The households are observed quarterly, which yields in combination with the three years of time variation 12 points in time in the pooled data set. The price variation for the consumer goods over time is therefore quite small. To expand the possibilities of demand system estimation with this data set, the cross-sectional characteristic and the detailed consumption information have to be exploited. Under additional assumptions, household-specific prices can be constructed (see Lewbel, 1989) and used in the demand system estimation, in order to exploit price variation between households within a time period. The idea is to use the consumption structure in an aggregated commodity group (e.g. "Mobility") by holding the expenditure shares of the commodities in this group constant and constructing household-specific commodity group prices (as already denoted in Eq. (1)). This is done by weighting the prices of the commodities within a commodity group with the expenditure shares within the group. The underlying assumption has to be *Cobb-Douglas* preferences within the commodity group (because of the constant shares). The aggregate price for commodity group j is calculated by:

$$p_{i,j} = \sum_{g}^{Gj} s_{i,gj} \cdot p_g, \quad \forall\, g = 1, ..., Gj \tag{6}$$

where p_g is the Consumer Price Index for commodity g and $s_{i,gj}$ is the budget share of commodity g in commodity group j for household i. These prices are calculated for the commodity groups "Mobility", "Heating" and the other non-durable goods. "Electricity" consists only of one commodity, so all the price variation comes from time, here.

3.2 Data Issues and the Constructing of the Commodity "Leisure"

In the data set, the EVS, consumption expenditures are only reported at the household level, while income information is available for every household member. Including "Leisure" in the demand system requires information on the gross wage income, the marginal income tax and on the worked hours of the relevant persons. Given the information on the gross wage income, it is possible to derive the net wage income using an income-tax simulation module. In Ochmann (2014), a simulation model for the EVS survey years 1998 and 2003 was applied, which exploits all tax relevant information in the data set to simulate a marginal tax rate for every household member. In the study at hand, this income tax simulation module for the EVS is revised and extended to the income taxation law of 2008 to simulate the marginal tax rates plus the solidarity surcharge and the additional marginal burden on labor due to the social security contributions (SSC) for all used EVS survey years.[4]

The second necessary variable for modeling the demand for leisure is the information on the hours worked. In the 2003 and 2008 surveys, the EVS contains information on every household member covering the interval between 10 and 60 hours per week, as well as the information "9 or less hours" and zero hours.[5] Unfortunately, the EVS 1998 contains only ordinal data on the occupational status. There exist five categories, which are "no occupation", "marginally occupied", "part-time occupation", "full-time occupation" and "occupied with no further information". This ordinal variable is used to impute the actually hours worked into the EVS 1998 using information of an external data set, the microcensus 1998 (*Mikrozensus 1998*). The microcensus is a representative and administrative data set, which is maintained by the German Federal Statistical Office (*Statistisches Bundesamt*) and involves 1% of the German households every year (about 390,000). For the purpose of imputation, the scientific use-file is used, which is a 70% subsample of the original microcensus. In the microcensus, the ordinal occupational status, as well as the socio-demographic characterictics can be defined very similarly to the EVS. On the individual level, about 500,000 persons are observed, which allows for a detailed mean imputation. The mean imputation of the hours worked is done separately for each occupational category (marginal, part-time, full-time) by age group, gender, household composition, three educational achievement categories and by East and West Germany. For those combinations of characteristics that have less than 20 observations in the microcensus, the differentiation into educational achievement and East versus West Germany is omitted. Missing information on the occupational status in the EVS 1998 and on the hours worked in all

[4] See Appendix A.1 for histograms that show the distributions of simulated marginal tax rate plus SSC burden (also called "marginal total burden" in the following) for the three survey years.

[5] The EVS survey year 2003 covers the continuous interval zero to 99 hours, but this is transformed in the more restrictive version to harmonize with the 2008 EVS.

survey years is imputed firstly by logical imputation (e.g. if social status is "unemployed" and occupational status is "unknown" then hours worked are set to zero) and then also by within sample mean imputation. Additionally, to increase the variance of the imputed variable on a similar level to the observed ones, a normally distributed error term is drawn with the original variance and added to the imputed mean. This added variance smoothes the distribution of the hours worked compared to the observed distributions, but should not bias the estimated coefficient in a linear model.[6]

Finally, all information is available to construct the net wage per hour, which is $w_i = inc_i(1 - r_i)/h_i$, where inc_i is the gross wage income and r_i is the marginal tax rate including social security contributions.[7]

3.3 Estimation

Several issues for the estimation of Eq. (1) are addressed in this subsection. The structure of the underlying model will be discussed, where the focus is especially on the treatment of potential selectivity bias. Then, endogeneity problems concerning the variables of interest are considered.

As previously noted, following West and Williams (2004a), the model will be estimated for one-adult households and two-adult households separately. This allows for responses to both wages in a two-adult household to be estimated, consequently yielding two different estimation samples and specifications. Preceding the presented AIDS model, which reflects substitution effects at the intensive margin, the extensive labor supply elasticity is estimated in discrete choice models. The approach finally consists of three stages: Firstly, a Heckman model (see Heckman, 1979, "Heckit") is estimated to obtain selectivity-corrected net wages, secondly, an extensive labor supply model, that includes wages and prices is estimated by probit (singles) or bivariate probit model (couples) and thirdly, wages and selectivity terms from the first and second stage are included in the AIDS to estimated intensive elasticities. This stepwise approach is now discussed in detail.

A problem in the demand estimation for leisure arises, since a relevant share of individuals in the samples does not work. The wages of these households are not observed. Estimating the system with the persons who work and with the observed wages would induce biased parameter estimates. At the first stage, to get selectivity-corrected net wages, a Heckman model is run separately for one-adult and two-adult households (for the two-adult households, the model is run on individual level for males and females separately). Explanatory variables include age,

[6] See Appendix A.2 for a comparison of the histograms between imputed and observed hours worked.

[7] As a robustness analysis, the model was estimated with the observed survey years only, which yielded very similar wage effects.

age squared, education, marital status, federal state, agglomeration level of the residence and time dummies. As exclusion restrictions appear the number of children in the household and cubic and quartic polynoms of age for the singles, and the spouse's socio-demographics and gross wage for the two-adult case.[8] Then, selectivity corrected net wages are derived from the estimated Heckit models by calculating the conditional predictions.[9] The selectivity-corrected wages are used to calculate the expenditures on leisure and enter the model as price for leisure in logs.

At the second stage of the model, the wages and the prices of the commodities are included in a probit, a so called "structural" probit compared to the reduced form probit in the Heckman model from stage one.[10] The commodity prices are weighted by the inverse of the average budget share (without leisure) to control for the magnitude of the relative price change. In the one-adult case, the work participation equation takes the form:

$$\begin{aligned} P_i^* &= \alpha + z_i'\beta + \sum_k \beta_k \ln(p_{i,k}) \cdot (1/\overline{s}_{i,k}) + \beta_w \widehat{\ln(w_i)} + \gamma \, nlinc_i + u_i \\ P_i &= \begin{cases} 1 \; if \; P_i^* > 0 \\ 0 \; otherwise \end{cases} \end{aligned} \tag{7}$$

where $\widehat{\ln(w_i)}$ is the selectivity corrected conditional prediction from the Heckit model in stage one and $nlinc_i$ is non-labor income. The parameters β_k and β_w can then be used to calculate the extensive price and wage elasticities of labor supply and γ measures the income effect.[11] The index k runs over all commodity prices (without leisure because the wage stands separately in Eq. (7)). In the two-adult case, the probit turns into a bivariate discrete choice model, which allows for correlation between the error terms in the participation equations of the man and the woman. It takes the form:

[8] The results of these models can be considered in Appendix B.1. As an additional exclusion restriction, the ratio of consumed alcohol and tobacco to expenditures on food is included, which should control for harmful behavior concerning labor force productivity. The coefficient is significantly negative in all estimated Probit equations, except for the female participation equation in the structural probit for couples.

[9] The formula for the conditional level prediction out of the Heckit model is given by $E(w_i|x, w_i > 0) = exp(x_2'\beta_2 + \sigma_2^2/2) \left\{1 - \Phi(-x_1'\beta_1)\right\}^{-1} \left\{1 - \Phi(-x_1'\beta_1 - \sigma_{12}^2)\right\}$, where 1 refers to the selection equation and 2 to the log wage equation (see Cameron and Trivedi (2010), p. 563).

[10] This approach is often applied in the literature (without commodity prices), see e.g. Mroz (1987) for a review and Bishop, Heim, and Mihaly (2009) for an application.

[11] Note that homogeneity in wages and prices should also hold for the extensive labor supply, but is not imposed here because this is only a partial model and not so robust against theoretical restrictions (because of the neglected opposing equation). For couples, symmetry in the cross-wage effects can not be rejected at least at the 1% level and is imposed.

$$
\begin{aligned}
P^*_{im} &= \alpha_m + z'_{im}\beta + \sum_k \beta_{km} \ln(p_{i,k}) \cdot (1/\overline{s}_{i,k}) + \beta_{wmm} \ln(\widehat{w_{im}}) + \beta_{wmf} \ln(\widehat{w_{if}}) \\
&\quad + \gamma_m \, nlinc_{im} + u_{im} \\
P^*_{if} &= \alpha_f + z'_{if}\beta + \sum_k \beta_{kf} \ln(p_{i,k}) \cdot (1/\overline{s}_{i,k}) + \beta_{wff} \ln(\widehat{w_{if}}) + \beta_{wfm} \ln(\widehat{w_{im}}) \\
&\quad + \gamma_f \, nlinc_{if} + u_{if}
\end{aligned}
\tag{8}
$$

$$
\begin{aligned}
u_{im}, u_{if} &\sim \Phi_2(0, 0, 1, 1, \rho) \\
P_{im} &= \begin{cases} 1 \; if \; P^*_{im} > 0 \\ 0 \; otherwise \end{cases} \\
P_{if} &= \begin{cases} 1 \; if \; P^*_{if} > 0 \\ 0 \; otherwise \end{cases}
\end{aligned}
$$

where Φ_2 denotes the bivariate normal distribution and ρ is the parameter of correlation between the two equations. The variables in x_{im} do not exactly equal the ones in x_f because the interactions between age and education are only included for the particular person and the spouse's age and education information are included without interaction terms in the equations.[12]

While the extensive elasticities are interesting on their own, the results from stage one and two are included in stage three, the estimation of the demand system. In the AIDS model, which corresponds to the intensive elasticities, estimating the system by OLS (or standard SUR) and including only the working households in the estimation would produce inconsistent estimates anyway. The decision of persons whether to participate in the labor market or not is neglected and if it is correlated with the prices and the wage, then estimated parameters are inconsistent. The classical Heckman estimator (Heckman, 1979) applies here. But in a system of equations, the Heckman solution is not straightforward and the literature on this problem is rare. Heien and Wessells (1990) propose to include Heckman-style correction terms in all equations and estimate the system on all observations. Shonkwiler and Yen (1999) find that this procedure is biased and propose their own estimator, which provides consistent estimation of censored systems of equations. However, this estimator does not fulfill the adding-up condition, which has to be implemented by hand. The Shonkwiler and Yen (1999) estimator multiplies

[12] The estimation of the probit in the one-adult case contains all persons that are younger than the age of 65 and not self-employed. In the two-adult case, all observations with a male younger than the age of 65 or a female younger than the age of 63 are included.

all regressors with the probability of being censored in the particular equation, includes the density term as an additional regressor and estimates the system on all observations. West and Williams (2004a) apply a modified approach by correcting only the wages with the probability of being censored and estimating the system on non-censored observations, where they suggest that this is consistent with the Heckman estimator for one equation. The study at hand is geared by the specification of Shonkwiler and Yen (1999) and West and Williams (2004a). In the one-adult case, only the working population is included in the estimation of the demand system. In the two-adult case, households, where both spouses do not work are excluded from the estimation sample. The wages included as prices for leisure are corrected in the one-adult case as follows:

$$\begin{aligned} E\left[\ln(w_i)\right] &= E\left[z_i'\beta + u_i > 0\right] \cdot E\left[\ln(w_i) \,|\, P_i = 1\right] \equiv E\left[\ln(p_{i,leisure})\right] \\ with \quad E\left[z_i'\beta + u_i > 0\right] &= \Phi(z_i'\beta) \end{aligned} \tag{9}$$

where $E\left[\ln(w_i) \,|\, P_i = 1\right]$ is the conditional prediction from the Heckit model in stage one. $\Phi(z_i'\beta)$ is the probability also from the reduced form model in stage one because the predicted wage is already included in stage two.[13] As additional regressor, which comes from stage two, the density term $\lambda_i = \phi(z_i'\beta)$ enters all equations in the system.

The two-adult case is more complex. Let z_{im} describe the explanatory variables from the male participation equation in Eq. (8) and z_{if} from the female one. The correction term in the Heckman case for two correlated selection mechanism would be (according to e.g. Ham, 1982):

$$\begin{aligned} \lambda_{im} &= \phi(z_{im}'\beta) \cdot \frac{\Phi\left(\frac{z_{if}'\beta - \rho\, z_{im}'\beta}{(1-\rho^2)^{0.5}}\right)}{E\left[z_{im}'\beta + u_{im} > 0,\, z_{if},\, \rho\right]} \\ \lambda_{if} &= \phi(z_{if}'\beta) \cdot \frac{\Phi\left(\frac{z_{im}'\beta - \rho\, z_{if}'\beta}{(1-\rho^2)^{0.5}}\right)}{E\left[z_{if}'\beta + u_{if} > 0,\, z_{im},\, \rho\right]} \end{aligned} \tag{10}$$

As in Eq. (9), the expectational term in the denominator of Eq. (10) is again replaced by the predictions from the reduced form model in stage one (i.e. $\Phi(z_{im}'\beta)$ for males and $\Phi(z_{if}'\beta)$ for females), which are then multiplied to the conditional wage predictions from stage one, analogously to the Shonkwiler and Yen (1999) transformation for the single selection equation case. The new terms added as additional regressors to the demand system equations are then:

[13] The only difference in vector z_i between the selection equation in the Heckman model and the stage two model is that the prices (and of course the wage) are left out in the Heckit.

$$\begin{aligned}\tilde{\lambda}_{im} &\equiv \phi(z'_{im}\beta) \cdot \Phi\left(\frac{z'_{if}\beta - \rho\, z'_{im}\beta}{(1-\rho^2)^{0.5}}\right) \\ \tilde{\lambda}_{if} &\equiv \phi(z'_{if}\beta) \cdot \Phi\left(\frac{z'_{im}\beta - \rho\, z'_{if}\beta}{(1-\rho^2)^{0.5}}\right)\end{aligned} \tag{11}$$

The next issue addressed is related to the former concerns of "zero consumption" of the commodities. There are of course households, that do not spend amounts on every good included in the demand system. By constructing broad commodity groups like "Mobility", one can minimize the problem. But "zero consumption" households can produce inconsistent estimates, or at least inefficient estimates if the censoring is kind of random. If the censoring is not random, but the share of censored households is small, then the bias in the estimates should also be small. In the demand system at hand, considering only the consumer goods (omitting leisure from the budget for a moment), only households with a share of at least 1% in the categories "Mobility" and "Electricity" are included in the estimation to guarantee enough variation in the shares. In the category "Heating", there are more "zero consumption" cases than in the other ones, but these households are kept in order to avoid losing too many observations. Similar to the introduced procedure with the non-working households, a selection equation is estimated, which explains whether heat expenditures are observed or not. The equation includes in addition to the regressors, which enter all equations (see below), information on social status, expenditures on housing, owner or renter status, the log prices of the commodities, and the consumption budget (without leisure). But the assumption is that every household consumes "Heating" and the selection is only due to seasonal censoring of the expenditures. So, the only relevant results from this selection equation is the predicted probability to consume "Heating" and the density term, which is included in all equations. The selectivity corrected new price for "Heating" is then the probability times the log of the regular price, analogous to the procedure for wages.

In the one-adult sample, the number of observations is thus reduced from 38,128 to 31,885 due to dropping the zero "Mobility" and "Electricity" cases, which make up about 16% of the total sample. The censoring within one equation, which is 10% for "Mobility" and 7% for "Electricity" (see Section 4 for detailed descriptives), may cause a systematic bias in the estimation if the dropped censored households differ from the uncensored ones. However, correcting for selectivity in the equations is not undertaken due to the rather small number of cases. In the two-adult sample, the sample is reduced from 77,910 to 72,869 (-6%). The censoring rates are even smaller here for "Mobility" (2%) and "Electricity" (4%).

Obviously, there is a constructed endogeneity problem because net wages depend on labor supply decisions. The marginal tax rate depends mechanically on the functional form of the

progressive tax system in Germany. In West and Williams (2004a), the simulated marginal tax rate, as well as measurement errors in the hours worked and the gross income, which appear together with the marginal tax rate on both sides of the equation, are suggested to be sources of endogeneity. However, except for the endogeneity due to the progressive income tax, the problem is resolved by the fact that the wage is a prediction from the Heckit model for all included persons in the regression. In the literature, the endogeneity of the progressive income tax is overcome by instrumental variable technique, where the marginal tax rate is instrumented by a "synthetic" tax rate, which is simulated with a lagged income term (see e.g. Auten and Carroll, 1999). This approach cannot be applied here because no panel data including rich information on consumption is available for Germany. There is also no additional cross-sectional instrument like the mean net wage by profession or branch in the data.

Another endogeneity problem is the dependency of the budget on the allocation of the consumed goods and leisure. In a demand system without leisure, the endogeneity problem is not so serious because the consumer total budget does not depend much on the structure of the consumed non-durables. But in the present study, if leisure is included, then the budget that is allocated for consumption depends on the leisure-work decision and the endogeneity problem becomes more serious. An instrument for the term $\ln(y_i/P_i^*)$ is derived by building an aggregate that includes non-labor income and public as well as private transfer income.[14] These income components are assumed to be exogenous in the model, whereas this assumption can be seen as critical for the public transfers because reducing work may increase these transfers (and the other way around). Despite that fact, the instrument is assumed to be less correlated with the labor/leisure decision, especially at the intensive margin, and therefore a good instrument.

This finally results in a Three-Stage-Least-Squares (3SLS) model with the budget being regressed on the instrument, the additional exogenous variables and year dummies at the first stage. The estimated system of model Eq. (1) comprises the following equations:

$$\begin{aligned} s_{i,j} &= \alpha_{0j} + x_i'\beta + \beta_j \ln(y_i/P_i^*) + \sum_k \gamma_{jk} \ln(p_{i,k}) + \sigma_{1j}\lambda_{i,leisure} + \sigma_{2j}\lambda_{i,heating} + \epsilon_{i,j} \\ \ln(y_i/P_i^*) &= x_i'\beta + \gamma_1 \, nlinc_i + t'\gamma + \nu_i \end{aligned} \tag{12}$$

where $nlinc_i$ is non-labor income and transfers, t is a vector of year dummies, $\lambda_{i,leisure}$ is the density term for leisure, $\lambda_{i,heating}$ is the density term for heating, $\epsilon_{i,i}$ and ν_i are error terms and x_i' contains the control variables age, age squared, education, social status, federal state dummies,

[14] Many observations have a value different from zero in the instrumental variable due to its broad definition. In the one-adult sample, less than 15% of the households have a zero and in the two-adult sample, less than 5% have a zero.

agglomeration level of the residence, quarterly dummies, the living space in square meters and the number of children in the household.[15] In the two-adult sample, all individual information appears for both spouses, as well as the two density terms for leisure appear instead of the one for the single households. The price for leisure equals the one from Eq. (9) and the price for heating is also the selectivity corrected one. The system is estimated by Three-stage least squares (3SLS) to control for cross-equation error term correlation and to set the cross-equation restrictions of homogeneity and symmetry listed in Section 2. It includes in the single-adult case, only observations of those who are working but are not self-employed and younger than 65 years old, additional to the conditioning on households that have positive expenditures in the mentioned consumer good groups. In the case of couples, the sample is conditioned on all observations with a male younger than the age of 65 or a female younger than the age of 63, and that at least one spouse is working.

3.4 Combining the Extensive and Intensive Elasticities of Leisure

The results from stage two of the model are the extensive elasticities, which refer to labor market participation and the results of stage three are intensive elasticities, which show adjustments of the hours spent on leisure for those who work. These two concepts can be linked to the total elasticity of leisure demand. Following McDonald and Moffitt (1980), the total response of leisure demand with respect to e.g. a change in the net wage can be decomposed into:

$$\frac{\partial E\left[Q_L\right]}{\partial w} = \Phi(z_i'\beta) \cdot \frac{\partial E\left[Q_L^*\right]}{\partial w} + E\left[Q_L^*\right] \cdot \frac{\partial \Phi(z_i'\beta)}{\partial w} \tag{13}$$

where Q_L is the demand for leisure and Q_L^* is the demand for leisure conditional on labor market participation (the intensive demand). Simple mathematical rearranging yields:

$$\begin{aligned} \frac{\partial E\left[Q_L\right]}{\partial w} \cdot w &= \Phi(z_i'\beta) E\left[Q_L^*\right] \cdot \frac{\partial E\left[Q_L^*\right]}{\partial w} \cdot \frac{w}{E\left[Q_L^*\right]} + \Phi(z_i'\beta) E\left[Q_L^*\right] \cdot \frac{\partial \Phi(z_i'\beta)}{\partial w} \cdot \frac{w}{\Phi(z_i'\beta)} \\ \frac{\partial E\left[Q_L\right]}{\partial w} \cdot \frac{w}{E\left[Q_L\right]} &= \frac{\Phi(z_i'\beta)}{\Phi(z_i'\beta) + (1 - \Phi(z_i'\beta)) \cdot k} \cdot (\epsilon^i + \epsilon^e) \end{aligned} \tag{14}$$

where ϵ^i is the intensive leisure elasticity and ϵ^e is the extensive elasticity. The correction term $k = T/E\left[Q_L^*\right]$ appears, where T is the time endowment. Note that the total elasticity of leisure is not equal to the formula for labor because $E\left[Q_L\right] = \Phi(z_i'\beta) E\left[Q_L^*\right] + (1 - \Phi(z_i'\beta)) \cdot T$, where

[15] The living space in square meters was not included in a previous version of the paper (Beznoska, 2013), which appeared in higher income effects on heating.

the latter term drops off in the case of labor supply. The labor supply formula is just $\epsilon^i + \epsilon^e$.[16] The reason is the high level of leisure demand for the unemployed, which makes the total leisure demand more inelastic given the same marginal effect.

4 Descriptive Evidence

The focus on energy goods and mobility in the demand system results from the increasing importance of these goods compared to total expenditures. Increasing prices and taxes led to higher expenditure shares of energy goods and also of mobility which are mainly driven by the oil and gasoline prices. The demand system includes the group "Mobility", which consists most importantly of expenditures for fuels (gasoline and diesel) and additionally of expenditures on public transport (local and long-distance travels). The consumer good "Electricity" explains itself by containing all reported expenditures on electricity. And the commodity group "Heating" includes expenditures on natural gas, heating oil, coal, as well as the cost for central heating, which may use one of many different kinds of energy sources, including district heating.

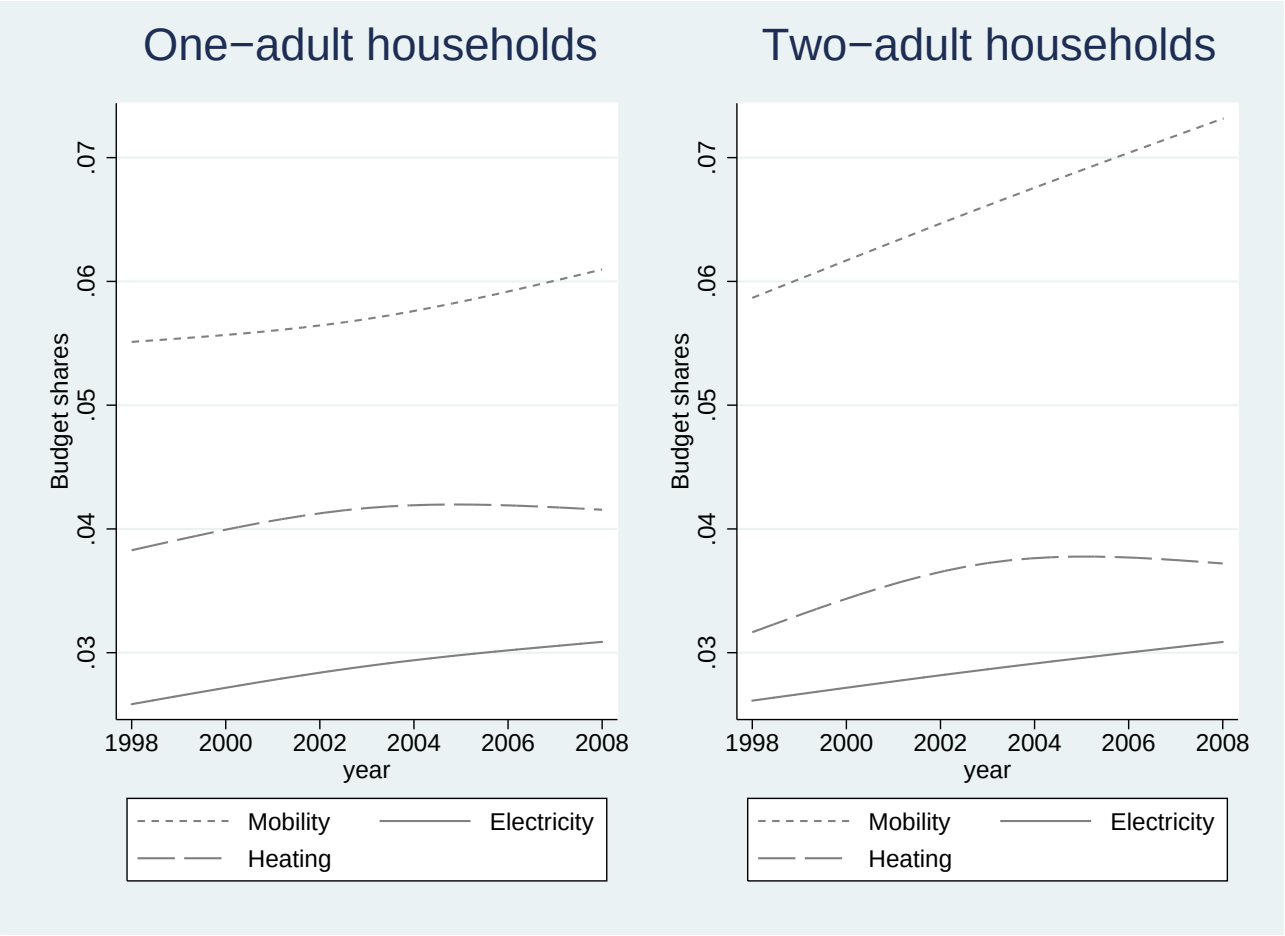
Expenditures for electric heating can be included either as "Electricity" or "Heating", depending on how they are reported by the household. The last consumer good group contains all expenditures that are classed as *non-durable*. This includes consumer goods like housing, food, drinks, tobacco, articles of daily use, health expenditures, spending for leisure activities etc., where housing forms the biggest position within the group. Housing expenditures in the data can be actually paid rents without heating and electricity costs or imputed rents for owner-occupied houses and flats. The imputed rents are calculated by the German Federal Statistical Office (*Statistisches Bundesamt*) and already implemented in the EVS data sets.

In Figure 1, the development of the shares for energy goods and mobility in the examined time span can be considered. The shares are defined as expenditures on the respective consumer good group divided by total expenditures on non-durable goods (leisure time is excluded). The left part of the figure shows the shares for one-adult households as median spline plots, which connect the medians at the three observed points in time 1998, 2003 and 2008. In the right part, the same is shown for the two-adult household sample.

The graphs show a clear tendency of increasing expenditure shares for energy goods with the exception of stagnating shares of heating expenditures between 2003 and 2008. For both, the one-adult and two-adult households, the median share of electricity expenditures follows a positive linear trend that ends over 3% in 2008. Heating expenditures are slightly over 4% in

[16] Note that the intensive labor supply elasticity is not always the same as the intensive leisure demand elasticity, only in the special case if the number of hours worked is equal to the one of leisure time. See Section 5 for details and the difference between the two elasticities in this study.

Figure 1: Development of the Expenditure Shares over Time



Notes: Median spline plots in the subsamples calculated using the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*). The budget shares are defined as expenditures in the respective consumer good group divided by total expenditures on non-durable goods.

one-adult households and about 3.7% in two-adult households.

Differences between the household types exist for mobility consumption. Although, the positive time trend can be seen in both plots, the median share for two-adult households lies over 7% in 2008 but only around 6% for the singles.

Table 1 gives a comprehensive picture of the descriptive evidence for one-adult households. In the upper part, the statistics for the consumer goods are presented, which means that expenditures on leisure are left out. So, the sum of consumer good shares is one. On average, the total budget on non-durables is about 1,100 euro per month and the shares are 7% for mobility, 3% for electricity, 5% for heating and 85% for other non-durables. As mentioned in Section 3.3, some observations are excluded because of zero or small consumption in respective categories. From the total one-adult sample of 38,128 households, only 31,885 remain due to missing information about mobility or electricity consumption. The upper right part of the table shows the descriptives for the conditional sample, in which the mobility share is risen by one percentage point due to the censoring.

The lower part of Table 1 shows the statistics if leisure time is introduced to the model. Firstly, the statistics on leisure/labor specific information are presented. The descriptives for the whole sample on the right are compared to subsamples in the left part of the table, first the sample of working households (21,449 observations) and below the estimation sample, which consists of all individuals younger than the age of 65 who are working and have mobility and electricity expenditure shares of each with at least 1% (calculated without leisure consumption). The estimation sample comprises 17,362 observations.

For the whole sample the average working time is 19.5 hours per week and 34.2 hours for the working population.[17] The average gross and net wages, as well as the unconditional Heckman wage predictions are listed in the lines below (all in euro per hour).[18] And the marginal tax rates and the marginal burden rates, which include the marginal tax rate and the marginal burden on social security contributions, follow under it.[19] In the demand system, the share of leisure expenditures amounts to about 47% of the new total budget in the whole sample and the share is 46% in the estimation sample. The share of leisure expenditures increases slightly between 1998 and 2008 because of the reduced hours worked over the time span (not in the table).

Table 2 presents the same statistics for the two-adult households. The average consumption budget is about 1,900 euro per month and the average consumption structure does not differ

[17] See Appendix A.2 for a comparison of the distributions of hours worked by survey year and household type.

[18] Note that the net wages are wages after tax and social security contributions, which may differ from other net wage definitions in the literature, where it is defined as wage after tax.

[19] See as well Appendix A.1 for histograms that show the simulated marginal burden rates in the three survey years.

Table 1: Descriptive Statistics on One-Adult Households

Without leisure	**Whole sample**			**Conditional sample obs. 31,885**	
	mean	**st. dev.**	**obs. >0**	**mean**	**st. dev.**
Consumption budget	1107.22	523.35	**38,128**	1118.27	523.35
Expenditures					
Mobility	77.80	83.39	34,219	84.62	79.16
Electricity	34.79	27.55	35,633	36.82	27.67
Heating	50.93	69.07	29,515	52.35	68.75
Other non-durables	943.69	471.01	38,128	944.48	419.52
Shares					
Mobility	0.07	0.06	34,219	0.08	0.06
Electricity	0.03	0.02	35,633	0.03	0.02
Heating	0.05	0.05	29,515	0.05	0.05
Other non-durables	0.85	0.07	38,128	0.84	0.07

Including leisure	**Whole sample obs. 38,128**		**Working individuals obs. 21,449**	
Labor/Leisure				
Hours worked	19.50	18.71	34.18	10.95
Gross wage	8.81	10.23	15.50	9.08
Net wage	4.65	5.36	8.16	4.71
Net wage (Heckman)	8.36	2.33	9.14	2.04
Marginal tax rate	0.18	0.16	0.28	0.13
Marginal total burden	0.26	0.23	0.42	0.16
	Whole sample obs. 38,128		**Estimation sample obs. 17,362**	
Shares				
Mobility	0.04	0.03	0.05	0.03
Electricity	0.02	0.01	0.02	0.01
Heating	0.02	0.03	0.02	0.02
Leisure	0.47	0.14	0.46	0.11
Other non-durables	0.45	0.12	0.45	0.10

Notes: The consumption budget and expenditures are in euro per month. The hours worked are hours per week and the wages are in euro per hour.

Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Table 2: Descriptive Statistics on Two-Adult Households

Without leisure	**Whole sample**			**Conditional sample obs. 72,869**	
	mean	**st. dev.**	**obs. >0**	**mean**	**st. dev.**
Consumption budget	1898.68	757.57	**77,910**	1884.31	757.57
Expenditures					
Mobility	140.05	118.90	76,256	141.13	111.52
Electricity	58.44	39.42	74,495	60.50	38.96
Heating	79.38	102.93	60,055	79.63	101.82
Other non-durables	1620.80	686.80	77,910	1603.06	635.29
Shares					
Mobility	0.07	0.05	76,256	0.08	0.05
Electricity	0.03	0.02	74,495	0.03	0.02
Heating	0.04	0.05	60,055	0.04	0.05
Other non-durables	0.85	0.07	77,910	0.85	0.07
Including leisure	**Whole sample obs. 77,910**			**Working individuals male obs. 49,587 / female obs. 43,571**	
Labor/Leisure					
Hours worked male	24.81	20.02		38.99	8.77
Hours worked female	15.16	16.21		27.11	12.07
Gross wage male	11.94	12.50		18.76	10.83
Gross wage female	7.38	9.34		13.19	8.91
Net wage male	6.81	7.35		10.70	6.58
Net wage female	3.88	4.98		6.93	4.81
Net wage (Heckit) male	10.66	3.73		11.74	3.41
Net wage (Heckit) female	6.75	2.13		7.64	1.58
Marginal tax rate male	0.21	0.15		0.29	0.10
Marginal tax rate female	0.17	0.16		0.25	0.13
Marg. total burden male	0.28	0.21		0.41	0.13
Marg. total burden female	0.25	0.23		0.39	0.19
	Whole sample obs. 77,910			**Estimation sample obs. 53,078**	
Shares					
Mobility	0.04	0.03		0.04	0.02
Electricity	0.02	0.01		0.02	0.01
Heating	0.02	0.03		0.02	0.02
Leisure male	0.24	0.15		0.30	0.10
Leisure female	0.22	0.12		0.23	0.08
Other non-durables	0.46	0.20		0.40	0.10

Notes: The consumption budget and expenditures are in euro per month. The hours worked are hours per week and the wages are in euro per hour.

Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

much from the one for one-adult households. Accounting for the censoring leaves 72,869 out of 77,910 observations in the sample.

In the lower part of Table 2, descriptive information on leisure/labor is presented for men and women separately, as they both enter separately the model. The men work more on average than the women and earn higher wages. Note that the estimation sample includes only households, in which the man is younger than 65 or the woman is younger than the age of 63, at least one of them is working and additionally mobility and electricity expenditure shares of each with at least 1% (calculated without leisure consumption). This leaves the estimation sample with 53,078 observations. Separately considered, there are 49,587 households with a working male person and 43,571 households with a working female person. The average net wage for working men is 10.70 euro per hour, while it is 6.93 euro per hour for working women. Interestingly, the marginal burden for women is only a bit smaller on average than for men, which results from joint assessment to the income tax for married couples.

The share for male leisure time is 24% and for female leisure time 22% in the unconditional sample, while it is 30% for males and 23% for females in the demand system estimation sample.

5 Results

In this section, the estimation results for the demand elasticities of Eq. (12) are presented separately for one-adult and two-adult households. First the extensive reactions to labor supply are discussed, then the unconstrained estimation results from the demand system without implementing the constraints on symmetry and homogeneity (see Section 2) are shown. For welfare analyses and tax revenue simulations, the fully consistent demand system with the cross-equation restrictions has to be used, which is then presented and discussed afterwards.

Results for the One-Adult Households

Firstly, the results from the "structural" probit model for the participation decision to work are presented in Table 3. These results refer to the elasticities with respect to changes in the commodity prices and the wage. It is differentiated between male and female wage responses by interacting the wage with a dummy indicating the gender. Confidence intervals are calculated using the delta method (see Greene, 2003, p. 913).[20]

Unfortunately, the price for electricity cannot be included in this model, because of the high correlation with the time dummies. It is the only price effect that oscillates heavily if time

[20] The estimation results from the probit can be found in Table B.4 in Appendix B.1.

Table 3: Compensated Price and Own Wage and Income **Elasticities of Extensive Leisure** for One-Adult Households[1]

Prices	Mobility	Heating	Own wage (m)	Own wage (f)	Others
	0.031	**-0.000**	**-0.244**	**-0.365**	**0.619**
	[0.025 : 0.037]	[-0.001 : 0.001]	[-0.466 : -0.023]	[-0.583 : -0.146]	[0.422 : 0.816]
Income			Male	Female	
			0.031	**0.056**	
			[0.027 : 0.035]	[0.052 : 0.060]	

Notes: 95%-Confidence intervals of robust standard errors in parentheses.
[1]: All elasticities are evaluated at the respective means of the explanatory variables.
Reading example: A 1% increase in the price of mobility increases the demand for leisure by 0.031%.
Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

dummies are included in the probit and is therefore excluded.[21] The extensive compensated demand for leisure increases if the prices for mobility and the other non-durable goods increases. A 1% increase in these prices rises leisure by about 0.03% (mobility) and 0.62% (other goods). The elasticity for the price of heating is not significant. Importantly, the extensive wage elasticity for men is -0.24 and for women -0.37 and both significantly different from zero. The standard errors of the wage effects are quite high, which could be explained by the first stage Heckit. There is maybe too less variation in the predicted wage and no strong exclusion restriction since only single households are in the sample. However, the income elasticities are estimated very precisely and significantly different from zero with 0.03 for men and 0.06 for women. So, the uncompensated wage effect for men is about -0.2 and only significant at the 10% level, while it is -0.3 and still significant at the 5% level for women.

Next, the results for the demand system are considered in Table 4. The leisure demand elasticities here correspond to reactions at the intensive margin.[22] These results are also best evaluated by considering the price and budget elasticities of demand. They show the compensated and uncompensated effects of price changes on the quantitative demand (hours in the leisure case). The corresponding parameters of the share equations are reported in Table B.6 in the Appendix, but the interpretation is not intuitive. They refer to the marginal effects on the expenditure shares and are used to calculate the elasticities. Additionally, the implica-

[21] Setting the leisure demand elasticity with respect to the electricity price to zero is justified by the constrained demand system estimation, which can be seen anticipatory in Table 5.
[22] Elasticities at the *intensive margin* are always referring to effects conditioned on labor market participation in the following.

Table 4: Compensated Price and Budget Elasticities[1] for Commodity Demand and **Intensive Leisure** (Unconstrained Estimation for One-Adult Households)

Compensated	Mobility	Electricity	Heating	Leisure	Others
Mobility price	**-0.88**	**-0.14**	**-0.10**	**0.19**	**-0.09**
	[-1.02 : -0.75]	[-0.26 : -0.02]	[-0.29 : 0.09]	[0.15 : 0.22]	
Electricity price	**0.51**	**-0.55**	**-0.24**	**-0.39**	**0.38**
	[0.23 : 0.79]	[-0.80 : -0.29]	[-0.65 : 0.18]	[-0.46 : -0.32]	
Heating price	**0.14**	**0.06**	**-0.62**	**0.01**	**0.01**
	[0.06 : 0.21]	[-0.01 : 0.13]	[-0.72 : -0.52]	[-0.01 : 0.02]	
Wage	**0.31**	**0.05**	**0.03**	**-0.13**	**0.10**
	[0.18 : 0.44]	[-0.07 : 0.17]	[-0.16 : 0.22]	[-0.16 : -0.10]	
Others price	**1.11**	**0.73**	**1.23**	**0.92**	**-1.13**
	[0.55 : 1.67]	[0.21 : 1.25]	[0.41 : 2.05]	[0.78 : 1.07]	
Budget elasticities[2]					
	1.05	**0.71**	**0.98**	**0.35**	**1.01**
	[0.87 : 1.23]	[0.54 : 0.88]	[0.71 : 1.25]	[0.26 : 0.44]	

Notes: Confidence intervals in parentheses.
[1]: All elasticities are evaluated at the respective mean expenditures.
[2]: The budget elasticities presented here for the consumer goods refer to changes in the expenditure budget rather than to changes in the virtual budget including leisure consumption. This allows to compare the budget effects with demand systems neglecting leisure consumption.
Reading example: A 1% increase in the price of mobility decreases the demand for mobility by 0.88%.
Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

tions of homogeneity and symmetry are tested with the estimated parameters, which are then constrained in a second estimation to impose these conditions.

As the total budget is instrumented by non-labor and transfer income in the 3SLS model, some diagnostics are made to check the validity of the instrumentation. The partial R^2 is 8% and exogeneity has to be rejected by the Hausman-Wu test (Hausman, 1978; Wu, 1973) in all equations, which shows an acceptable correlation between the instrument and the total budget and the need for instrumentation. Also, the included density terms for the selection correction are reported in Table B.6 in the Appendix. They are included in every equation because of the system dependency of every parameter. The density term for heating is not significant in the heating equation, but highly significant in other equations and can therefore not be neglected. The density term for leisure is not significant in any equation but will be of statistical relevance if the cross-equation restriction are set later on. Furthermore, the insignificance of the density term does not imply that there is no sample selection bias because the price respectively wage variable is also adjusted in the correction procedure.

The elasticities for the unconstrained estimation are shown in Table 4. The sample con-

tains 17,333 households, as discussed in the descriptive section. The elasticities are evaluated regarding the formulas of Eq. (2)-(5) at the mean expenditures of the sample.

Table 4 presents the compensated price elasticities on top and the budget elasticities below. The quantities are put in the columns, while the prices are in the lines. The table is read in the following way: A 1% price increase, e.g. in the price of electricity, yields a 0.54% increase in the demand for mobility.

The own-price elasticities are on the main diagonal and they are all negative, which means that the negativity condition is fulfilled. There are inelastic own-price effects found for mobility (-0.9), electricity (-0.55), heating (-0.62) and leisure (-0.13). A reaction of -1 is found for the other non-durable goods. The budget effects for the goods can be found in the bottom row and indicate that all goods can not be rejected to have a proportional reaction of one according to *Cobb-Douglas* preferences except for electricity and leisure, which are normal goods. The budget effects for the commodities refer to changes in the expenditure budget without the expenditures on leisure, which are *virtual* expenditures, to make them comparable with demand systems that exclude leisure. The uncompensated price elasticities have to be calculated indeed with the budget effects including leisure.[23]

The compensated leisure own-wage effect is -0.13 and significant. The respective elasticity on labor supply would be +0.13 in this case, because the time endowment is set to two times the working time (working time equals leisure time at the mean). The corresponding budget elasticity is estimated to about 0.35 and the uncompensated price elasticity of leisure would then be nearly zero. The respective labor supply elasticities, extensive from Table 3 and intensive from Table 4, are in the range of estimated values in the literature (see Fuchs, Krueger, and Poterba, 1998, for a review), even though a differentiation between male and female labor supply at the intensive margin for single households brought no additional insight in another specification because there were no significant interaction effects found. Furthermore, the estimates of the leisure budget effect are significantly affected by the instrumentation. OLS estimates would give an income elasticity of 0.7.

The unconstrained estimation violates clearly the conditions on homogeneity and symmetry. The χ^2-test with the null of symmetry of the cross-price effects has to be rejected with a value of 160 (6 degrees of freedom) and homogeneity holds only in the electricity and heating equations, but does not hold in the mobility and leisure equations (χ^2-values of 27 respectively 107).

However, the restrictions for symmetry and homogeneity are set in order to estimate a fully consistent demand system. The respective elasticities are presented in Table 5, the compensated ones on top, the uncompensated ones below and the budget effects in the bottom row.

[23] The uncompensated price elasticities are left out in Table 4 for lack of space but can be seen in Appendix B.2, Table B.10.

Table 5: Compensated and Uncompensated Price and Budget Elasticities[1] for Commodity Demand and **Intensive Leisure**
(Constrained Estimation for One-Adult Households)

Compensated	Mobility	Electricity	Heating	Leisure	Others
Mobility price	**-0.40**	**-0.02**	**0.23**	**0.02**	**0.01**
	[-0.49 : -0.32]	[-0.14 : 0.09]	[0.13 : 0.32]	[0.01 : 0.03]	
Electricity price	**-0.01**	**-0.61**	**0.03**	**0.00**	**0.02**
	[-0.05 : 0.03]	[-0.81 : -0.41]	[-0.02 : 0.07]	[-0.00 : 0.01]	
Heating price	**0.11**	**0.04**	**-0.80**	**0.01**	**0.02**
	[0.07 : 0.15]	[-0.03 : 0.11]	[-0.88 : -0.71]	[0.00 : 0.02]	
Wage	**0.24**	**0.04**	**0.17**	**-0.23**	**0.20**
	[0.15 : 0.34]	[-0.07 : 0.14]	[0.03 : 0.31]	[-0.26 : -0.20]	
Others price	**0.06**	**0.56**	**0.37**	**0.20**	**-0.24**
	[-0.07 : 0.19]	[0.39 : 0.72]	[0.19 : 0.55]	[0.17 : 0.23]	
Uncompensated					
Mobility price	**-0.47**	**-0.08**	**0.16**	**0.02**	**-0.08**
	[-0.56 : -0.39]	[-0.19 : 0.04]	[0.07 : 0.25]	[0.01 : 0.03]	
Electricity price	**-0.03**	**-0.63**	**0.00**	**0.00**	**-0.01**
	[-0.08 : 0.01]	[-0.83 : -0.42]	[-0.04 : 0.05]	[-0.00 : 0.00]	
Heating price	**0.08**	**0.01**	**-0.83**	**0.01**	**-0.02**
	[0.03 : 0.12]	[-0.06 : 0.08]	[-0.91 : -0.74]	[0.00 : 0.01]	
Wage	**1.00**	**0.60**	**0.92**	**-0.21**	**1.12**
	[0.84 : 1.16]	[0.44 : 0.77]	[0.68 : 1.15]	[-0.25 : -0.16]	
Others price	**-0.64**	**0.03**	**-0.32**	**0.17**	**-1.10**
	[-0.81 : -0.46]	[-0.16 : 0.22]	[-0.56 : -0.07]	[0.13 : 0.22]	
Budget elasticities[2]					
	0.83	**0.62**	**0.81**	**0.05**	**1.04**
	[0.69 : 0.96]	[0.49 : 0.75]	[0.62 : 1.01]	[-0.02 : 0.12]	

Notes: Confidence intervals in parentheses.
[1]: All elasticities are evaluated at the respective mean expenditures.
[2]: The budget elasticities presented here for the consumer goods refer to changes in the expenditure budget rather than to changes in the virtual budget including leisure consumption. This allows to compare the budget effects with demand systems neglecting leisure consumption.

Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

While the compensated own-price elasticity for electricity bears similar magnitudes compared to the unconstrained estimation, smaller effects are found for mobility (-0.40) and the other non-durables (-0.24) and a slightly higher for heating (-0.80). The wage elasticity of leisure is with -0.23 significantly higher than in the unconstrained model. If the cross-price elasticities are considered, mobility is found to be a substitute for heating and leisure. Electricity is only related to the other non-durables as a substitute, while heating and the composite good are substitutes to each other and to leisure. Considering labor supply (and therefore switching the sign for leisure), the complementary relationship between labor and mobility seems plausible because more labor supply may be accompanied with a longer or more comfortable way to work to compensate for the more exhausting day. This is an interesting result for optimal taxation in context of energy goods. Significantly negative cross-price elasticities of labor supply lower the optimal tax on these respective goods in a second-best setting (also see West and Williams, 2004a, who found a positive elasticity of the gasoline price with respect to labor supply). Not so intuitive is the complementary link between heating and labor, which also did not appear in the extensive analysis. The complementary relationship seems to come in over the set cross-equation restrictions because it is not clearly identified in the unconstrained model but it is not significant at the 1% level here.

The density term for leisure is now strongly significant in the leisure equation and also relevant in the mobility and heating equations (see Table B.7 in the Appendix).

Interesting results from the uncompensated elasticities, which reflect the observed demand responses, are the wage elasticity of leisure of -0.21, which is not significantly different from the compensated one due to the small and insignificant income elasticity. Significant cross-price elasticities of leisure are found for mobility, heating and non-durables. Another result is that the own-price effect for other non-durables is close to the elasticity of *Cobb-Douglas* preferences, which is -1. Changes in the wage have big impacts on the consumption of the goods due to the budget effect.

The effects of leisure demand at the intensive and the extensive margin can be combined to total leisure demand elasticities (see Section 3.4 for the respective formula in Eq. (14)), which are shown in Table 6. In the table, the results from the constrained estimates at the intensive margin are combined with the extensive elasticities. The uncompensated own-wage elasticity is estimated to -0.24 for males and -0.30 for females and the other effects show only small differences to the results from the intensive margin.[24]

[24]The effect regarding the electricity price at the extensive margin is set to zero, as no extensive effect could be identified.

Table 6: Compensated and Uncompensated Price and Own Wage Elasticities[1] (Extensive and Intensive Elasticities Combined) for One-Adult HH

Mobility	Electricity[2]	Heating	Own wage (m)	Own wage (f)	Others
Comp.					
0.031	**0.001**	**0.005**	**-0.270**	**-0.342**	**0.468**
[0.020 : 0.042]	[-0.002 : 0.004]	[-0.002 : 0.012]	[-0.493 : -0.047]	[-0.561 : -0.123]	[0.343 : 0.593]
Uncomp.					
0.028	**0.000**	**0.003**	**-0.241**	**-0.298**	**0.423**
[0.017 : 0.039]	[-0.002 : 0.002]	[-0.004 : 0.010]	[-0.466 : -0.016]	[-0.519 : -0.077]	[0.265 : 0.581]

Notes: 95%-Confidence intervals in parentheses. Standard errors calculated using the delta method.
[1]: All elasticities are evaluated at the respective means of the explanatory variables.
[2]: The commodity electricity has only estimates for the intensive elasticities, while the extensive ones are set to zero.
Reading example: A 1% increase in the price of mobility increases the compensated demand for leisure by 0.031%.
Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Results for the Two-Adult Households

In the sample of two-adult households, there are two leisure/work decisions per household, which are taken into account in the model. The estimated extensive elasticities of leisure from the bivariate probit model are shown in Table 7, symmetry in the cross-wage effects is imposed. The between-equation correlation coefficient ρ is estimated to 0.18 and significant (the estimated parameters from the model can be found in Table B.5 in Appendix B.1). Again, the electricity price elasticity is assumed to be zero because of the same issues noted for one-adult households. The male compensated leisure demand elasticities with respect to the prices are found in a similar magnitude like for singles. The own-wage effect is estimated to be -0.15, while the cross-wage effect to the female net wage is about 0.1. The income elasticity is found to be 0.05, which gives an uncompensated own-wage elasticity of -0.11 following the Slutsky equation.

The female elasticities differ. The effects with respect to the price of mobility and the composite good are smaller, while the negative elasticity with respect to the heating price is more negative. The compensated own-wage effect is large with -0.42, which is also found in the literature according to Fuchs et al. (1998), but for Germany rather the upper bound.[25] The response to a male wage increase is, at 0.16, slightly higher than the cross-wage effect for men. The spouse's wages have in both cases a crowding-out effect. The income elasticity for females is similar to that of males with a small value of 0.05, which gives an uncompensated elasticity of -0.4.

[25] A labor supply elasticity with a similar magnitude for Germany is e.g. found by Haan and Steiner (2005).

Table 7: Compensated Price and Own Wage and Income **Elasticities of Extensive Leisure** for Two-Adult Households[1]

Mobility	Heating	Own wage	Spouse's wage	Others	Income
Male leisure					
0.022	**-0.003**	**-0.151**	**0.102**	**0.776**	**0.054**
[0.017 : 0.028]	[-0.003 : -0.002]	[-0.174 : -0.127]	[0.083 : 0.120]	[0.616 : 0.935]	[0.048 : 0.061]
Female leisure					
0.008	**-0.005**	**-0.416**	**0.161**	**0.689**	**0.048**
[-0.000 : 0.016]	[-0.006 : -0.004]	[-0.458 : -0.374]	[0.132 : 0.190]	[0.456 : 0.923]	[0.039 : 0.058]

Notes: 95%-Confidence intervals in parentheses.
[1]: All elasticities are evaluated at the respective means of the explanatory variables.
Reading example: A 1% increase in the price of mobility increases the demand for male leisure by 0.022%.
Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Next, Table 8 presents the intensive model for the unconstrained elasticities.[26]

The partial R^2 for the instrument of total budget is only 2%, which yielded to a very poor estimation of the budget effects in the restricted demand system. Therefore, an additional instrument was added in the restricted model but not in the one at hand. The Hausman-Wu test clearly rejects exogeneity in all equations. The three included density terms for selectivity correction (heating, male leisure and female leisure) have a differing relevance in the system of equations. In the unconstrained estimation, the two leisure correction terms show only few significance, while the heating term is significant in all equations except the electricity one in contrast to the one-adult model.

The compensated own-price elasticities for electricity and heating are in range of the ones found for single households. For mobility, it is estimated to -0.57, which is between the unconstrained and the constrained single household elasticity. The response for other non-durables is very elastic and higher than the effect for singles. The own-wage effects for male and female leisure are also negative, which is consistent with the theory. Both are estimated to -0.11.

The cross-wage effect on female leisure is significant and found to be positive, but quite small with 0.06. For male leisure, the cross-wage effect is insignificant.

The budget effects for the consumer goods are also similar to those found for singles but a bit smaller. For both leisure categories, the budget effect is significant but also a bit smaller than the one for singles.

If one converts the intensive leisure elasticities, which are all elasticities in the columns "Male

[26]See Table B.8 in Appendix B.1 for the estimated parameters and Appendix B.2 for the results of the uncompensated elasticities in the unconstrained estimation.

Table 8: Compensated Price and Budget Elasticities[1] for Commodity Demand and **Intensive Leisure** (Unconstrained Estimation for Two-Adult Households)

Compensated	Mobility	Electricity	Heating	Male leisure	Female leisure	Others
Mobility price	**-0.57**	**-0.11**	**-0.29**	**0.21**	**0.12**	**-0.15**
	[-0.66 : -0.48]	[-0.20 : -0.01]	[-0.46 : -0.11]	[0.17 : 0.24]	[0.09 : 0.15]	
Electricity price	**-0.19**	**-0.68**	**0.45**	**-0.32**	**-0.34**	**0.45**
	[-0.37 : 0.00]	[-0.88 : -0.48]	[0.07 : 0.83]	[-0.39 : -0.25]	[-0.41 : -0.27]	
Heating price	**0.26**	**0.18**	**-0.65**	**-0.14**	**-0.07**	**0.14**
	[0.22 : 0.29]	[0.13 : 0.23]	[-0.72 : -0.58]	[-0.16 : -0.13]	[-0.08 : -0.05]	
Male wage	**0.07**	**0.04**	**0.09**	**-0.11**	**0.06**	**0.04**
	[0.04 : 0.10]	[0.00 : 0.07]	[0.02 : 0.15]	[-0.12 : -0.10]	[0.04 : 0.07]	
Female wage	**0.07**	**0.06**	**-0.04**	**0.01**	**-0.11**	**0.04**
	[0.03 : 0.11]	[0.02 : 0.10]	[-0.11 : 0.03]	[-0.00 : 0.03]	[-0.12 : -0.09]	
Others price	**0.60**	**0.38**	**1.01**	**1.71**	**0.98**	**-1.92**
	[0.21 : 0.99]	[-0.04 : 0.80]	[0.24 : 1.78]	[1.55 : 1.86]	[0.84 : 1.13]	
Budget elasticities[2]						
	0.93	**0.49**	**0.80**	**0.25**	**0.15**	**1.03**
	[0.84 : 1.02]	[0.40 : 0.59]	[0.62 : 0.97]	[0.18 : 0.33]	[0.08 : 0.22]	

Notes: Confidence intervals in parentheses.
[1]: All elasticities are evaluated at the respective mean expenditures.
[2]: The budget elasticities presented here for the consumer goods refer to changes in the expenditure budget rather than to changes in the virtual budget including leisure consumption. This allows to compare the budget effects with demand systems neglecting leisure consumption.
Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

leisure" and "Female leisure", into intensive labor supply elasticities, they will not only differ in the sign anymore, but also in the magnitude. The reason is that the time endowment is not normalized in the two-adult sample. The time endowment is 70 hours and the leisure demand elasticity equals the labor supply elasticity only in the case if the hours worked are 35 and the hours for leisure are also 35. The elasticity stands for a percentage effect of hours, which refer to different bases whether one considers leisure or labor. For example, a 10% increase in the wage for men reduces male leisure by 1.1%, which are 0.34 hours at the mean. But these 0.34 hours are only 0.9% of hours worked because men work more than 35 hours at the mean and therefore they consume less than 35 hours leisure. So, the labor supply elasticities for males are -0.78 times the leisure demand elasticities and for females, they are about -1.6 as high as leisure demand because the female labor time share of the time endowment is only 38.5%. Thus, the compensated own-wage elasticity for female labor supply is about 0.17.

The null hypotheses on homogeneity have ambivalent test results. They cannot be rejected in the three goods equations (χ^2-values between 0.93 and 3.77) but are clearly rejected in the leisure equations. Symmetry in the system is clearly rejected (χ^2-value of 786 with 10 degrees of freedom). However, the demand system is restricted on these conditions, and the results can be seen in Table 9.

Table 9: Compensated and Uncompensated Price and Budget Elasticities[1] for Commodity Demand and **Intensive Leisure**
(Constrained Estimation for Two-Adult Households)

Compensated	Mobility	Electricity	Heating	Male leisure	Female leisure	Others
Mobility price	**-0.52**	**-0.08**	**0.28**	**0.04**	**0.02**	**0.00**
	[-0.56 : -0.47]	[-0.16 : 0.00]	[0.22 : 0.33]	[0.04 : 0.04]	[0.02 : 0.03]	
Electricity price	**-0.03**	**-0.70**	**0.08**	**0.01**	**0.00**	**0.02**
	[-0.06 : 0.00]	[-0.82 : -0.57]	[0.05 : 0.11]	[0.00 : 0.01]	[0.00 : 0.01]	
Heating price	**0.13**	**0.12**	**-0.76**	**0.02**	**-0.01**	**0.01**
	[0.10 : 0.15]	[0.08 : 0.16]	[-0.81 : -0.70]	[0.02 : 0.02]	[-0.02 : -0.01]	
Male wage	**0.30**	**0.12**	**0.31**	**-0.19**	**0.02**	**0.08**
	[0.27 : 0.33]	[0.09 : 0.16]	[0.25 : 0.36]	[-0.20 : -0.17]	[0.01 : 0.03]	
Female wage	**0.12**	**0.07**	**-0.13**	**0.02**	**-0.12**	**0.05**
	[0.09 : 0.15]	[0.03 : 0.11]	[-0.19 : -0.08]	[0.01 : 0.03]	[-0.13 : -0.11]	
Others price	**0.00**	**0.48**	**0.22**	**0.10**	**0.08**	**-0.15**
	[-0.05 : 0.05]	[0.40 : 0.56]	[0.14 : 0.31]	[0.09 : 0.11]	[0.07 : 0.10]	
Uncompensated						
Mobility price	**-0.56**	**-0.11**	**0.23**	**0.02**	**0.02**	**-0.08**
	[-0.60 : -0.52]	[-0.18 : -0.03]	[0.18 : 0.29]	[0.02 : 0.03]	[0.01 : 0.02]	
Electricity price	**-0.04**	**-0.70**	**0.07**	**0.00**	**0.00**	**-0.01**
	[-0.07 : -0.02]	[-0.83 : -0.58]	[0.04 : 0.10]	[0.00 : 0.00]	[0.00 : 0.01]	
Heating price	**0.11**	**0.11**	**-0.78**	**0.01**	**-0.01**	**-0.02**
	[0.08 : 0.14]	[0.07 : 0.15]	[-0.83 : -0.73]	[0.01 : 0.01]	[-0.02 : -0.01]	
Male wage	**0.69**	**0.38**	**0.76**	**0.00**	**0.08**	**0.08**
	[0.64 : 0.73]	[0.33 : 0.43]	[0.68 : 0.85]	[-0.01 : 0.02]	[0.06 : 0.09]	
Female wage	**0.26**	**0.16**	**0.03**	**0.24**	**-0.06**	**0.07**
	[0.23 : 0.30]	[0.12 : 0.21]	[-0.03 : 0.10]	[0.23 : 0.26]	[-0.08 : -0.04]	
Others price	**-0.39**	**0.22**	**-0.24**	**-0.09**	**0.03**	**-0.91**
	[-0.46 : -0.33]	[0.13 : 0.31]	[-0.35 : -0.13]	[-0.11 : -0.07]	[0.01 : 0.05]	
Budget elasticities[2]						
	0.47	**0.31**	**0.55**	**0.48**	**0.14**	**1.10**
	[0.43 : 0.51]	[0.26 : 0.35]	[0.48 : 0.62]	[0.45 : 0.51]	[0.11 : 0.17]	

Notes: Confidence intervals in parentheses.
[1]: All elasticities are evaluated at the respective mean expenditures.
[2]: The budget elasticities presented here for the consumer goods refer to changes in the expenditure budget rather than to changes in the virtual budget including leisure consumption. This allows to compare the budget effects with demand systems neglecting leisure consumption.
Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Unfortunately, the constraints on homogeneity and symmetry of the price effects affect the estimated budget effects. While the budget effects are normally estimated well in micro-econometric analyses and cross-equation restrictions on the prices should not alter this fact, the instrumentation of the budget in combination with the binding restrictions lowers the robustness of the estimated budget effects, as already mentioned. For this reason, unlike in the other estimations, the square of the instrument is also included to the instrument equation.[27]

The estimation gives inelastic compensated own-price effects for all goods, which lie close to the unconstrained ones. Mobility has an effect of -0.5, electricity of around -0.7, heating of around -0.8 and for the composite good of -0.2, where all are also similar to the ones in the constrained estimation for singles. The compensated own-wage elasticities for leisure are -0.19 for males and -0.12 for females, which relates to intensive labor supply elasticities of 0.14 for males and 0.20 for females.

Table 10: Compensated and Uncompensated Price and Own Wage Elasticities[1] (Extensive and Intensive Elasticities Combined)

Prices	**Two-Adult Households**			
	Male Leisure		Female Leisure	
	Comp.	Uncomp.	Comp.	Uncomp.
Mobility	**0.027**	**0.017**	**0.011**	**0.008**
	[0.020 : 0.034]	[0.011 : 0.023]	[0.004 : 0.018]	[0.001 : 0.014]
Electricity[2]	**0.003**	**-0.000**	**0.002**	**0.001**
	[0.002 : 0.004]	[-0.001 : 0.001]	[0.000 : 0.003]	[-0.000 : 0.002]
Heating	**0.007**	**0.002**	**-0.006**	**-0.008**
	[0.003 : 0.011]	[-0.002 : 0.006]	[-0.011 : -0.001]	[-0.011 : -0.005]
Male wage	**-0.145**	**-0.047**	**0.072**	**0.102**
	[-0.174 : -0.116]	[-0.078 : -0.016]	[0.053 : 0.091]	[0.078 : 0.126]
Female wage	**0.052**	**0.160**	**-0.211**	**-0.180**
	[0.027 : 0.077]	[0.135 : 0.185]	[-0.239 : -0.183]	[-0.214 : -0.146]
Others	**0.378**	**0.272**	**0.301**	**0.268**
	[0.207 : 0.549]	[0.100 : 0.444]	[0.185 : 0.417]	[0.172 : 0.364]

Notes: 95%-Confidence intervals in parentheses. Standard errors calculated using the delta method.
[1]: All elasticities are evaluated at the respective means of the explanatory variables.
[2]: The commodity electricity has only estimates for the intensive elasticities, while the extensive ones are set to zero.
Reading example: A 1% increase in the price of mobility increases the compensated demand for male leisure by 0.027%.
Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

The cross-price effects are again similar to those found for singles. Mobility is a substitute for heating and both leisure categories. Electricity has only small, but significant substitutional

[27] In an earlier version of this paper in Beznoska (2013), one additional restriction was imposed, which fixed the estimated budget effect for the composite good to the one of the unconstrained model. This is not necessary anymore, since the additional instrument avoids the instability.

relationships to leisure and high effects to the price of other non-durables. Interestingly, heating is complementary to female leisure, as intuition would tell, but substitutional to male leisure. The cross-wage relationship between male and female leisure is substitutional, but with small magnitude.

Considering the uncompensated leisure elasticities reveals effects of about zero for men and small -0.06 for women. So, the budget effect counteracts the substitution effect completely for men. The corresponding labor supply elasticity for women is about 0.1. Another interesting result for tax policy is that a price increase in the composite good has only very small positive effects on female leisure and even negative ones for male leisure, while it had constantly positive effects for singles and in the extensive models. This implies e.g. small intensive labor supply effects for indirect taxation like the value-added tax.

Table 10 summarizes the results at extensive and intensive margin to combined elasticities of leisure. The compensated own-wage elasticity is about -0.15 for males and -0.21 for females in couple households, which is more inelastic for both than the effects found for singles. Higher prices of the commodities increase the demand for leisure, except for the heating price, which lowers female leisure.

6 Conclusion

In this paper, a demand system on energy goods involving the demand for leisure is estimated on German consumption cross-sectional data. For purposes of evaluating the incidence and the welfare effects of indirect tax reforms, e.g. of the so called *green taxes*, three survey waves of the Income and Consumption Survey for Germany (*Einkommens- und Verbrauchsstichprobe*) are used to estimate a demand system that includes the demand for mobility, electricity, heating and other non-durables as well as leisure. The model allows for a reaction of leisure demand at the *extensive*, as well as at the *intensive* margin, to changes in prices and wages and combines both elasticities to a total response elasticity. It is estimated separately for single and couple households to allow for two different types of leisure demand in couple households. Selectivity corrections for heating demand and the leisure/labor choice are introduced to the model and found to be important for the results due to relevant shares of censored observations. To control for endogeneity of the total consumption budget, 3SLS estimation is applied, which instruments the budget with non-labor and transfer income. Exogeneity is strongly rejected and the income effects, especially for the leisure categories change significantly due to the instrumentation from highly positive to small or insignificant values, and are in line with the literature.

The theoretical implication of symmetry is rejected, the one of homogeneity is partly rejected, however they are imposed to estimate a fully consistent demand system. The estimated

compensated own-price elasticities are all negative and in a plausible range for all goods. Mobility, electricity, heating and the other non-durables are estimated to be inelastic goods with elasticities significantly smaller than one.

Importantly, the compensated own-wage elasticity of leisure demand (intensive and extensive margins combined) is estimated to be -0.27 for single men and -0.34 for single women, while for couple households the elasticity for males is -0.15 and -0.21 for females. The respective uncompensated elasticities are a bit smaller for the singles with -0.24 for men and -0.30 for women, but not significantly different from the compensated ones because of high standard errors. For couples, they are -0.05 for men and -0.18 for women. For females in couple households the extensive reaction is significantly higher than the intensive one, while for males, they are nearly equal.

Interesting cross-price elasticities are found that, amongst others, confirm the intuitive view of the substitutional character between mobility and heating and between mobility and leisure. The latter is an important side result, because it lowers the tax on polluting goods that provide mobility in a second-best tax setting. Another result is that there are only small cross-price effects between heating and leisure and between electricity and leisure. They have all a substitutional character except for the relationship between heating and female leisure, which is found to be complementary. In summary, women's substitution between labor and leisure in couple households seems to depend less on other prices and consumption of the commodities that are modeled here than men's decision.

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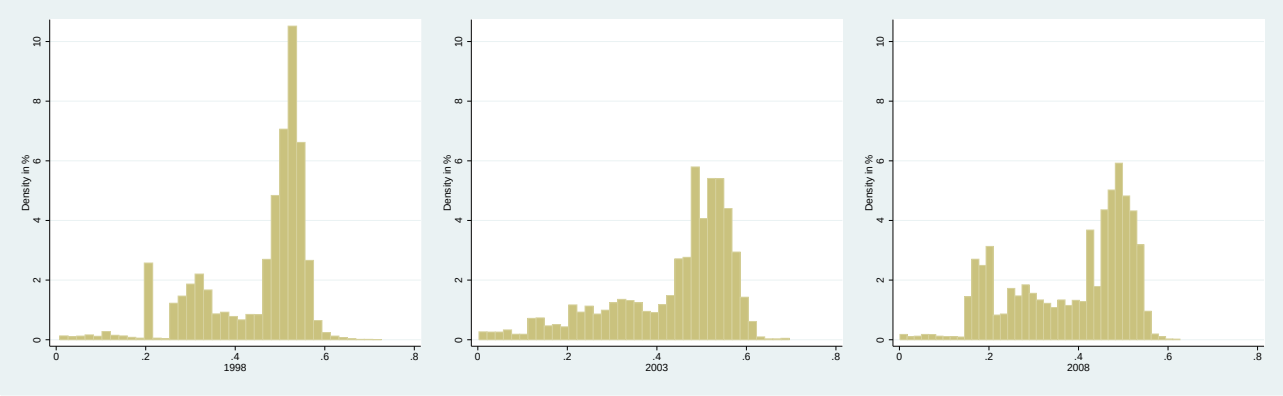
A Appendix - Descriptives

A.1 Distribution of the Simulated Marginal Tax Rates

The calculation of the net wages requires the information on the marginal burden rate. In an income tax simulation module, the marginal burden rates, which include the marginal income tax rate, the solidarity surcharge and the marginal burden on social security contributions, are derived for all used EVS survey years. Figure A.1 presents the histograms of the conditional distribution of the marginal burden rates (tax rate plus SSC) among one-adult households. In 1998, the distribution starts (neglecting small burdens for e.g. marginally employed people) at a rate of about 20% and has its biggest concentration slightly over 50%. The mass at this concentration point shrinks if the years 2003 and 2008 are considered, where more density mass is spread left to this point. This has to do with implemented tax cuts from 2001 to 2007 due to the tax reform from 2000. The starting tax rate in the tariff also shrunk below 20% which can be seen in the histograms.

Figure A.1: Conditional Distributions of the Marginal Burden Rates for One-Adult Households



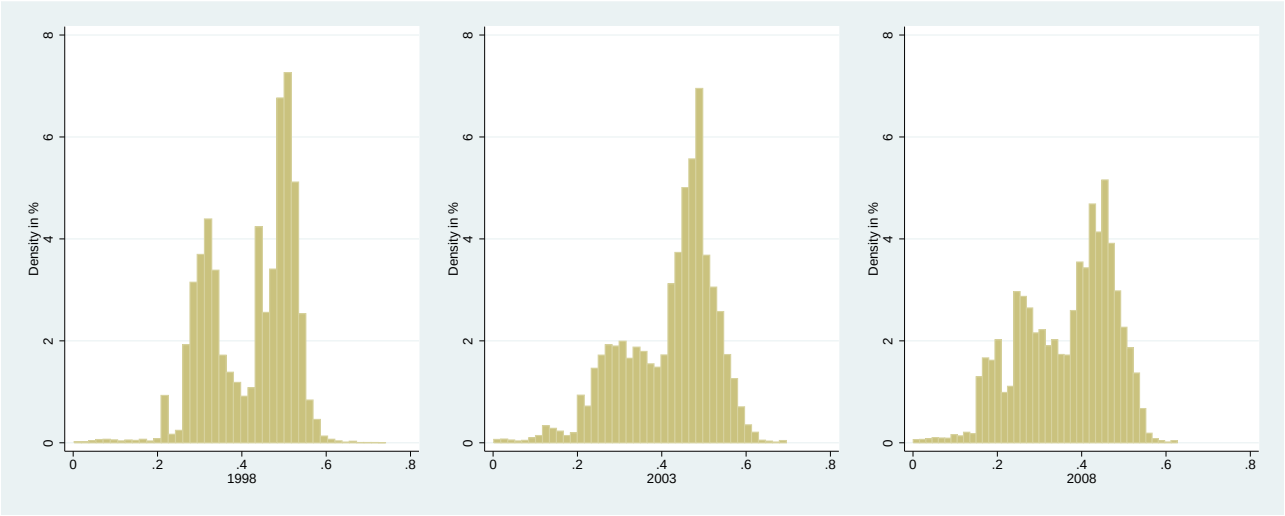
Source: Own calculations using the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Figure A.2 shows the distributions for the two-adult households separated by men and women. The upper part of the figure plots the histograms for men and below is the distribution for women. The findings from the single households are confirmed here. Huge differences do not appear between the marginal burden of men and women because of joint assessment to the income tax for married couples. However, a bit more mass right to the distribution of the men at the top rates can be seen for the women. Men often have a higher income than

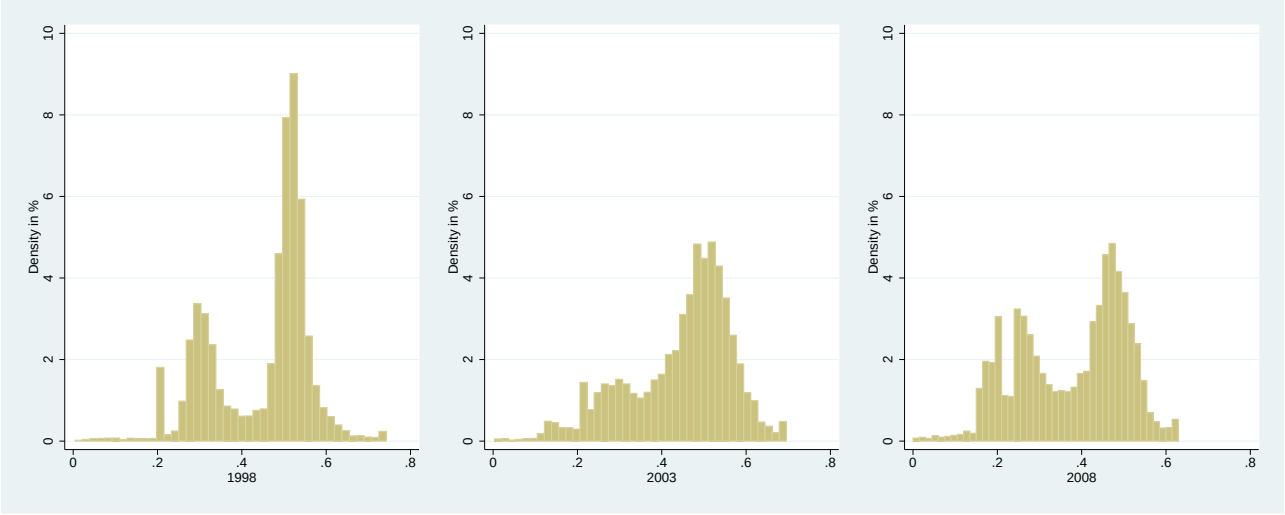
their spouses, which raises the tax rate for the women automatically due to joint assessment, independent from their income. Additionally, the social security contributions come on top to the high income tax rate for the women.

Figure A.2: Conditional Distributions of the Marginal Burden Rates for Two-Adult Households

(a) Men



(b) Women

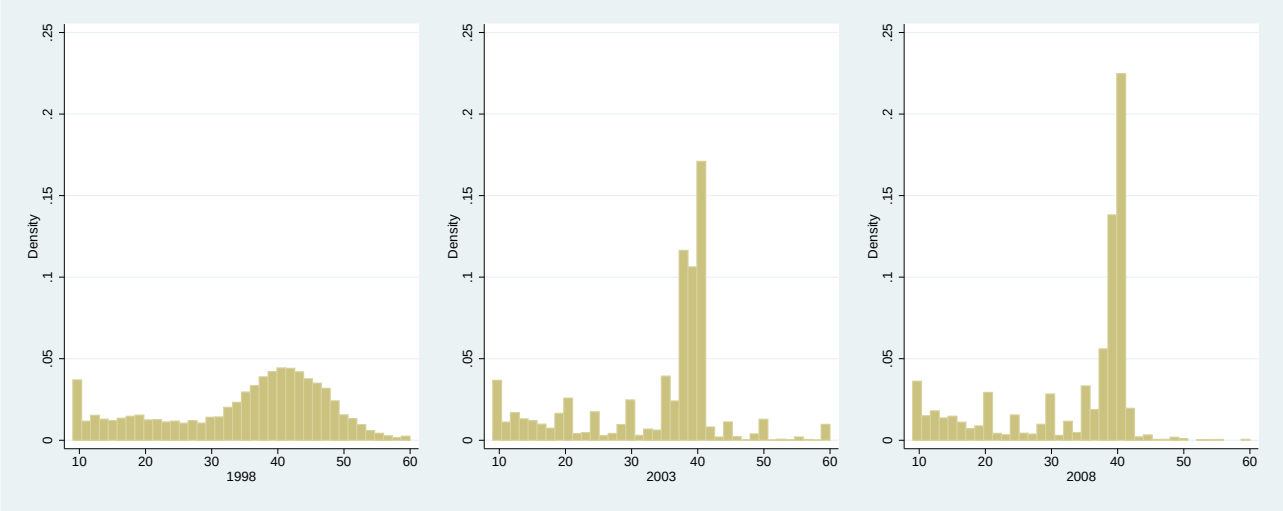


Source: Own calculations using the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

A.2 Distributions of the Hours Worked by Year and Subsample

While there is continuous information about the hours worked only for the EVS survey years 2003 and 2008, the information for 1998 has to be imputed. The EVS 1998 contains only discrete information on the occupational status. There exist five categories, which are "no occupation", "marginally occupied", "part-time occupation", "full-time occupation" and "occupied with no further information". This variable is taken to impute the hours worked using information of an external data set, the microcensus 1998 (*Mikrozensus 1998*). The hours worked are imputed with mean imputation by occupational status and other socio-demographic characteristics like gender and age group. Additionally, a normal distributed error term is added from the original distribution to maintain the variance of hours worked. In Figure A.3, the conditional distribution of hours worked for the working one-adult household population are shown in histograms. Clearly, the artificial distribution for the survey year 1998 differs from the actually observed distributions in 2003 and 2008. It is much smoother due to the drawn error terms, but these have expected values of zero, therefore there should be no bias.

Figure A.3: Conditional Distributions of Hours Worked for One-Adult Households



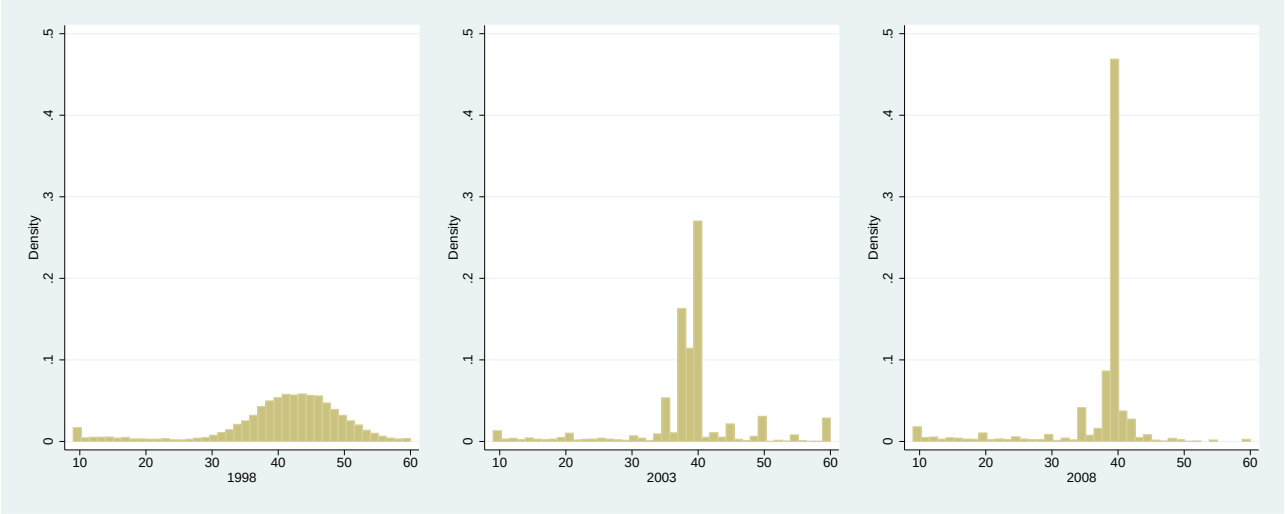
Source: Own calculations using the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

In Figure A.4, the conditional distributions for two-adult households are presented. The upper part of the figure plots the histograms for men and below is the distribution for women. While the excessive smoothness of the distributions in 1998 can be seen for men and women, a clear difference appear compared to Figure A.3. The distribution for men is more concentrated around 40 hours which refers to full-time employment, whereas the distribution for women

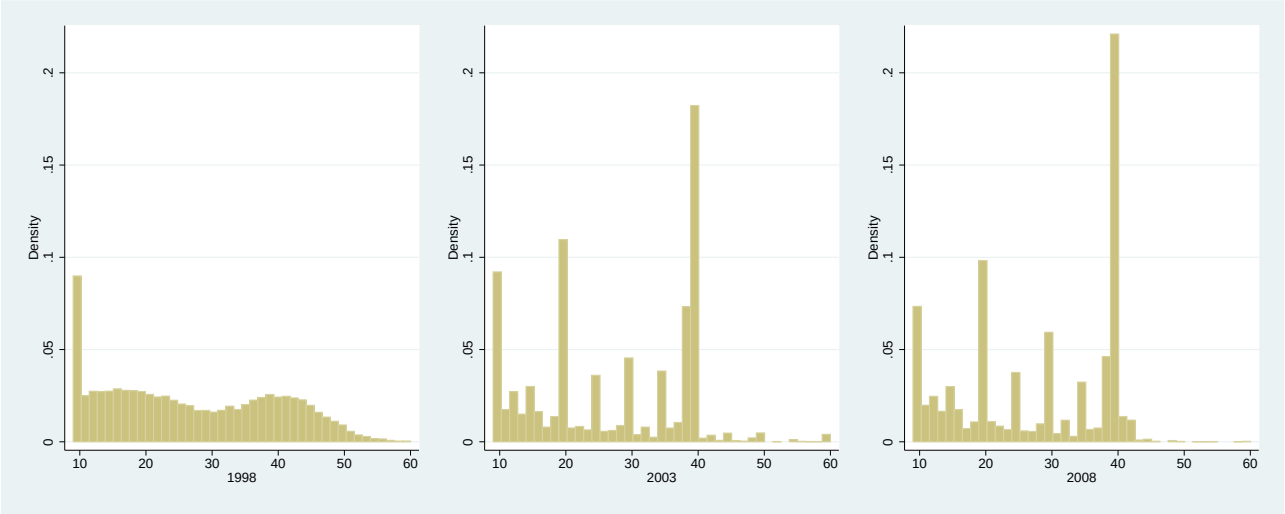
has two humps, one around 17 hours and one around 40 hours. This fits to the observed distributions which have also more mass in the part-time area around 20 hours working time.

Figure A.4: Conditional Distributions of Hours Worked for Two-Adult Households

(a) Men



(b) Women



Source: Own calculations using the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

B Appendix - Results

B.1 Results for the Estimated Parameters

Table B.1: Heckman Wage Equation
for One-Adult Households

	Log Wage		Working =1	
	Coeff	(SE)	Coeff	(SE)
Age	0.078	(0.005)***	0.862	(0.179)***
Age squared	-0.001	(0.000)***	-0.033	(0.007)***
Female	-0.075	(0.007)***	0.156	(0.024)***
Medium skill	0.316	(0.113)***	-0.320	(0.026)***
Low skill	0.378	(0.183)**	-1.109	(0.047)***
Age*Medium skill	-0.025	(0.005)***		
Age^2 * Medium skill	0.000	(0.000)***		
Age*Low skill	-0.044	(0.010)***		
Age^2 * Low skill	0.001	(0.000)***		
East Germany	-0.132	(0.035)***	0.055	(0.105)
Medium agglom.	-0.038	(0.012)***	0.013	(0.041)
Low agglom.	-0.083	(0.014)***	-0.089	(0.046)*
Alc. and tobacco			-0.040	(0.021)*
1 child			-0.330	(0.039)***
2 children			-0.450	(0.053)***
3 children			-0.903	(0.115)***
4 children			-1.183	(0.229)***
Constant	0.581	(0.112)***	-7.136	(1.726)***
Year dum.	Yes		Yes	
Quarterly dum.	Yes		Yes	
Federal States	Yes		Yes	
Observations	17,726			
Uncensored	12,908			
Censored	4,818			
Lambda	-0.145	(0.035)***		

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Log wage equation in the left column and Probit whether to work or not in the right column. Alcohol and tabacco are defined as expenditures for these goods divided by the consumer budget.

Source: Own calculations using the scientific use-files of the EVS (2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Table B.2: Heckman Wage Equation
for Two-Adult Households (Males)

	Log Wage		Work =1	
	Coeff	(SE)	Coeff	(SE)
Age	0.082	(0.006)***	0.775	(0.194)***
Age squared	-0.001	(0.000)***	-0.027	(0.007)***
Age cubic			0.000	(0.000)***
Age quadratic			-0.000	(0.000)***
Medium skill	0.580	(0.109)***	-0.330	(0.023)***
Low skill	0.228	(0.227)	-1.043	(0.053)***
Age*Medium skill	-0.040	(0.005)***		
Age^2 * Medium skill	0.000	(0.000)***		
Age*Low skill	-0.039	(0.012)***		
Age^2 * Low skill	0.000	(0.000)***		
East Germany	-0.292	(0.039)***	-0.119	(0.065)
Medium agglom.	-0.061	(0.008)***	-0.010	(0.025)
Low agglom.	-0.103	(0.010)***	-0.071	(0.030)**
Alc. and tobacco			-0.099	(0.033)***
Age partner			0.010	(0.010)
Age^2 partner			-0.000	(0.000)
Gross wage partner			0.008	(0.001)***
1 child	0.041	(0.007)***	0.006	(0.031)
2 children	0.094	(0.007)***	0.080	(0.034)**
3 children	0.121	(0.011)***	0.056	(0.052)
4 children	0.124	(0.021)***	-0.219	(0.085)**
Constant	0.471	(0.121)***	-7.752	(1.973)***
Year dum.	Yes		Yes	
Quarterly dum.	Yes		Yes	
Partner's Educ.	No		Yes	
Region dum.	No		Yes	
Region * Quarter	No		Yes	
Federal States	Yes		No	
Observations	33,081			
Uncensored	26,907			
Censored	6,174			
Lambda	-0.088	(0.029)***		

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Log wage equation in the left column and Probit whether to work or not in the right column. Alcohol and tabacco are defined as expenditures for these goods divided by the consumer budget.

Source: Own calculations using the scientific use-files of the EVS (2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Table B.3: Heckman Wage Equation
for Two-Adult Households (Females)

	Log Wage		Work =1	
	Coeff	(SE)	Coeff	(SE)
Age	0.109	(0.007)***	-0.543	(0.135)***
Age squared	-0.001	(0.000)***	0.022	(0.005)***
Age cubic			-0.000	(0.000)***
Age quadratic			0.000	(0.000)***
Medium skill	0.404	(0.110)***	-0.258	(0.019)***
Low skill	0.308	(0.181)*	-0.783	(0.038)***
Age*Medium skill	-0.031	(0.005)***		
Age^2 * Medium skill	0.000	(0.000)***		
Age*Low skill	-0.043	(0.010)***		
Age^2 * Low skill	0.000	(0.000)***		
East Germany	-0.063	(0.039)	0.142	(0.052)***
Medium agglom.	-0.023	(0.009)***	0.007	(0.019)
Low agglom.	-0.050	(0.010)***	0.001	(0.023)
Alc. and tobacco			0.066	(0.030)**
Age partner			0.027	(0.007)***
Age^2 partner			-0.000	(0.000)***
Gross wage partner			0.001	(0.001)*
1 child	-0.093	(0.012)***	-0.587	(0.024)***
2 children	-0.164	(0.014)***	-0.726	(0.025)***
3 children	-0.254	(0.023)***	-1.127	(0.034)***
4 children	-0.340	(0.036)***	-1.340	(0.060)***
Constant	-0.150	(0.149)	4.272	(1.336)***
Year dum.	Yes		Yes	
Quarterly dum.	Yes		Yes	
Partner's Educ.	No		Yes	
Region dum.	No		Yes	
Region * Quarter	No		Yes	
Federal States	Yes		No	
Observations	37,760			
Uncensored	24,080			
Censored	13,680			
Lambda	0.133	(0.032)***		

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Log wage equation in the left column and Probit whether to work or not in the right column. Alcohol and tabacco are defined as expenditures for these goods divided by the consumer budget.

Source: Own calculations using the scientific use-files of the EVS (2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Table B.4: Probit Participation Equation for One-Adult Households

	Working =1	
	Coeff	(SE)
Wage	0.688	(0.319)**
Wage * Female	0.355	(0.085)***
Mobility price	-0.087	(0.009)***
Heating price	0.001	(0.001)
Others price	-1.761	(0.286)***
Female	-0.157	(0.180)
Non-labor inc.	-0.087	(0.006)***
Non-labor inc. * Female	-0.072	(0.008)***
Age	0.080	(0.020)***
Age squared	-0.001	(0.000)***
Medium skill	-0.105	(0.093)
Low skill	-0.522	(0.146)***
East Germany	0.019	(0.092)
Medium agglom.	0.037	(0.037)
Low agglom.	0.022	(0.050)
Alc. and tobacco	-0.075	(0.021)***
1 child	-0.093	(0.032)***
2 children	-0.209	(0.043)***
3 children	-0.545	(0.085)***
4 children	-0.765	(0.183)***
Constant	12.980	(1.681)***
Year dum.	Yes	
Quarterly dum.	Yes	
Federal States	Yes	
Observations	26,991	
Pseudo R^2	0.21	

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The prices and the wage are defined in logs. Alcohol and tabacco are defined as expenditures for these goods divided by the consumer budget.

Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Table B.5: Bivariate Probit Participation Equations for Two-Adult Households

	Man Working		Woman Working	
	Coeff	(SE)	Coeff	(SE)
Male wage	0.414	(0.033)***	-0.279	(0.026)***
Female wage	-0.279	(0.026)***	0.723	(0.037)***
Mobility price	-0.062	(0.008)***	-0.013	(0.007)*
Heating price	0.007	(0.001)***	0.008	(0.001)***
Others price	-2.134	(0.224)***	-1.198	(0.207)***
Non-labor and partner's inc.	-0.150	(0.009)***	-0.084	(0.008)***
Age male	0.161	(0.008)***	0.065	(0.006)***
Age squared male	-0.002	(0.000)***	-0.001	(0.000)***
Age female	0.058	(0.008)***	0.192	(0.007)***
Age squared female	-0.001	(0.000)***	-0.003	(0.000)***
East Germany	0.072	(0.080)	0.120	(0.074)
Medium agglom.	0.062	(0.022)***	0.035	(0.019)*
Low agglom.	0.060	(0.028)**	0.090	(0.025)***
Alc. and tobacco	-0.117	(0.031)***	-0.016	(0.030)
1 child	-0.127	(0.019)***	-0.585	(0.018)***
2 children	-0.137	(0.020)***	-0.680	(0.019)***
3 children	-0.300	(0.029)***	-0.981	(0.026)***
4 children	-0.476	(0.047)***	-1.167	(0.044)***
Constant	12.038	(1.306)***	2.034	(1.198)*
Year dum.	Yes		Yes	
Quarterly dum.	Yes		Yes	
Federal States	Yes		Yes	
Observations	62,616			
Rho	0.181	(0.010)***		

Notes: Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
The prices and the wages are defined in logs. Alcohol and tabacco are defined as expenditures for these goods divided by the consumer budget.

Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Table B.6: Estimated Parameters of 3SLS for One-Adult Households (Unconstrained Estimation)

	Log Budget		Mobility		Electricity		Heating		Leisure	
	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)
Non-labor inc.	0.049	(0.002)***								
Mobility price			0.003	(0.003)	-0.003	(0.001)**	-0.003	(0.002)	0.065	(0.008)***
Electricity price			0.023	(0.007)***	0.007	(0.002)***	-0.006	(0.005)	-0.189	(0.016)***
Heating price			0.005	(0.002)**	0.001	(0.001)	0.008	(0.001)***	-0.008	(0.004)
Wage			-0.007	(0.003)*	-0.007	(0.001)***	-0.010	(0.002)***	0.189	(0.008)***
Others price			0.030	(0.013)*	0.004	(0.004)	0.018	(0.009)	0.216	(0.033)***
Log Budget			0.043	(0.008)***	0.005	(0.003)	0.018	(0.006)**	-0.300	(0.021)***
Age	0.002	(0.001)	-0.003	(0.000)***	-0.000	(0.000)	-0.000	(0.000)	0.005	(0.001)***
Age squared	0.000	(0.000)	0.000	(0.000)***	0.000	(0.000)	0.000	(0.000)	-0.000	(0.000)**
Medium skill	-0.043	(0.003)***	0.002	(0.002)	0.002	(0.000)***	0.003	(0.001)*	-0.010	(0.004)**
Low skill	-0.042	(0.007)***	0.008	(0.003)*	0.004	(0.001)***	0.002	(0.002)	-0.028	(0.008)**
East Germany	-0.072	(0.012)***	-0.001	(0.003)	-0.002	(0.001)	0.001	(0.002)	0.016	(0.007)*
Medium agglom.	-0.017	(0.005)***	0.001	(0.001)	-0.000	(0.000)	0.001	(0.001)*	0.007	(0.002)**
Low agglom.	-0.042	(0.006)***	0.009	(0.001)***	0.002	(0.000)***	0.004	(0.001)***	-0.008	(0.003)**
Correction term leisure			-0.005	(0.005)	-0.001	(0.002)	-0.006	(0.004)	-0.006	(0.013)
Correction term heat			-0.128	(0.016)***	-0.008	(0.005)	-0.014	(0.011)	0.595	(0.040)***
Constant	7.277	(0.025)***	-0.414	(0.093)***	-0.048	(0.031)	-0.171	(0.067)*	1.683	(0.243)***
Living space	No		Yes		Yes		Yes		Yes	
Quarterly dum.	Yes		Yes		Yes		Yes		Yes	
Federal states	Yes		Yes		Yes		Yes		Yes	
Social status	Yes		Yes		Yes		Yes		Yes	
Observations	17,333									
R^2	0.421		0.089		0.092		0.068		0.395	

Notes: Significance levels: $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. The dependent variables of the demand system are defined in shares of the budget. The prices and the wage are defined in logs. The non-labor income is defined in 1000 Euro units. Reading example: 1000 Euro more non-labor income increases the budget by 4.9%.

Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Table B.7: Estimated Parameters of 3SLS for One-Adult Households (Constrained Estimation)

	Log Budget		Mobility		Electricity		Heating		Leisure	
	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)
Non-labor inc.	0.070	(0.002)***								
Mobility price			0.025	(0.002)***	-0.001	(0.001)	0.004	(0.001)***	-0.010	(0.002)***
Electricity price			-0.001	(0.001)	0.006	(0.002)***	0.000	(0.001)	-0.007	(0.001)***
Heating price			0.004	(0.001)***	0.000	(0.001)	0.004	(0.001)***	-0.006	(0.002)***
Wage			-0.010	(0.002)***	-0.007	(0.001)***	-0.006	(0.002)***	0.142	(0.006)***
Others price			-0.018	(0.003)***	0.002	(0.001)	-0.002	(0.002)	-0.119	(0.007)***
Log Budget			0.024	(0.006)***	0.002	(0.002)	0.011	(0.004)**	-0.437	(0.016)***
Age	0.006	(0.001)***	-0.003	(0.000)***	-0.000	(0.000)*	-0.001	(0.000)**	0.012	(0.001)***
Age squared	-0.000	(0.000)	0.000	(0.000)***	0.000	(0.000)	0.000	(0.000)*	-0.000	(0.000)***
Medium skill	-0.044	(0.003)***	-0.000	(0.001)	0.002	(0.000)***	0.004	(0.001)***	-0.038	(0.003)***
Low skill	-0.055	(0.008)***	0.005	(0.003)	0.004	(0.001)***	0.005	(0.002)**	-0.088	(0.007)***
East Germany	-0.081	(0.013)***	-0.001	(0.003)	-0.002	(0.001)*	0.000	(0.002)	-0.011	(0.007)
Medium agglom.	-0.005	(0.005)	0.001	(0.001)	-0.000	(0.000)	0.001	(0.001)	0.007	(0.003)**
Low agglom.	-0.019	(0.006)**	0.007	(0.001)***	0.001	(0.000)***	0.004	(0.001)***	-0.010	(0.003)**
Correction term leisure			-0.001	(0.004)	-0.000	(0.001)	-0.004	(0.003)	-0.099	(0.011)***
Correction term heat			-0.114	(0.011)***	-0.014	(0.005)**	-0.043	(0.008)***	0.465	(0.028)***
Constant	7.284	(0.026)***	-0.047	(0.045)	-0.016	(0.016)	-0.066	(0.032)*	3.724	(0.121)***
Living space	No		Yes		Yes		Yes		Yes	
Quarterly dum.	Yes		Yes		Yes		Yes		Yes	
Federal states	Yes		Yes		Yes		Yes		Yes	
Social status	Yes		Yes		Yes		Yes		Yes	
Observations	17,333									
R^2	0.419		0.110		0.102		0.078		0.208	

10 restrictions in the system estimation

Notes: Significance levels: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. The dependent variables of the demand system are defined in shares of the budget. The prices and the wage are defined in logs. The non-labor income is defined in 1000 Euro units. Reading example: 1000 Euro more non-labor income increases the budget by 7.0%.

Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Table B.8: Estimated Parameters of 3SLS for Two-Adult Households (Unconstrained Estimation)

	Log Budget		Mobility		Electricity		Heating		Male leisure		Female leisure	
	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)
Non-labor inc.	0.022	(0.001)***										
Mobility price			0.016	(0.002)***	-0.002	(0.001)**	-0.006	(0.002)***	0.050	(0.005)***	0.018	(0.004)***
Electricity price			-0.008	(0.004)*	0.004	(0.001)**	0.008	(0.003)*	-0.101	(0.011)***	-0.079	(0.008)***
Heating price			0.010	(0.001)***	0.002	(0.000)***	0.006	(0.001)***	-0.048	(0.002)***	-0.019	(0.002)***
Male wage			-0.009	(0.001)***	-0.004	(0.000)***	-0.004	(0.001)***	0.176	(0.002)***	-0.054	(0.001)***
Female wage			-0.006	(0.001)***	-0.002	(0.000)***	-0.005	(0.001)***	-0.063	(0.002)***	0.149	(0.002)***
Others price			0.008	(0.008)	-0.000	(0.003)	0.011	(0.007)	0.390	(0.024)***	0.128	(0.017)***
Log Budget			0.038	(0.004)***	0.001	(0.001)	0.013	(0.004)***	-0.223	(0.012)***	-0.189	(0.008)***
Age male	0.001	(0.001)	-0.000	(0.000)*	0.000	(0.000)	-0.000	(0.000)*	0.001	(0.000)**	-0.001	(0.000)**
Age squared male	0.000	(0.000)	0.000	(0.000)	-0.000	(0.000)	0.000	(0.000)*	-0.000	(0.000)*	0.000	(0.000)***
Age female	0.013	(0.001)***	-0.001	(0.000)***	-0.000	(0.000)**	-0.000	(0.000)	0.001	(0.001)	0.005	(0.000)***
Age squared female	-0.000	(0.000)***	0.000	(0.000)***	0.000	(0.000)**	0.000	(0.000)	-0.000	(0.000)	-0.000	(0.000)***
East Germany	-0.076	(0.009)***	0.003	(0.002)*	-0.002	(0.001)***	-0.001	(0.001)	0.002	(0.005)	-0.005	(0.003)
Medium agglom.	-0.016	(0.002)***	0.004	(0.000)***	0.000	(0.000)	0.003	(0.000)***	-0.009	(0.001)***	-0.002	(0.001)*
Low agglom.	-0.025	(0.003)***	0.008	(0.000)***	0.001	(0.000)***	0.005	(0.000)***	-0.022	(0.001)***	-0.007	(0.001)***
Correction term male			-0.000	(0.003)	-0.003	(0.001)*	0.004	(0.003)	-0.012	(0.009)	-0.004	(0.007)
Correction term female			-0.001	(0.001)	0.000	(0.001)	0.000	(0.001)	0.006	(0.004)	-0.005	(0.003)
Correction term heat			-0.063	(0.005)***	-0.000	(0.002)	-0.039	(0.005)***	0.217	(0.015)***	0.137	(0.011)***
Constant	7.710	(0.015)***	-0.294	(0.054)***	0.003	(0.021)	-0.145	(0.049)**	0.408	(0.163)*	1.319	(0.111)***
Living space	No		Yes		Yes		Yes		Yes		Yes	
Quarterly dum.	Yes		Yes		Yes		Yes		Yes		Yes	
Federal states	Yes		Yes		Yes		Yes		Yes		Yes	
Social status m/f	Yes		Yes		Yes		Yes		Yes		Yes	
Skill m/f	Yes		Yes		Yes		Yes		Yes		Yes	
Observations	53,078											
R^2	0.478		0.101		0.118		0.066		0.486		0.660	

Notes: Significance levels: $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. The dependent variables of the demand system are defined in shares of the budget. The prices and the wages are defined in logs. The non-labor income is defined in 1000 Euro units. Reading example: 1000 Euro more non-labor income increases the budget by 2.2%.

Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Table B.9: Estimated Parameters of 3SLS for Two-Adult Households (Constrained Estimation)

	Log Budget		Mobility		Electricity		Heating		Male leisure		Female leisure	
	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)	Coeff	(SE)
Non-labor inc.	0.069	(0.001)***										
- squared	-0.003	(0.000)***										
Mobility price			0.018	(0.001)***	-0.002	(0.001)**	0.004	(0.001)***	-0.000	(0.001)	-0.004	(0.001)***
Electricity price			-0.002	(0.001)**	0.004	(0.001)***	0.001	(0.000)***	-0.003	(0.000)***	-0.002	(0.000)***
Heating price			0.004	(0.001)***	0.001	(0.000)***	0.004	(0.000)***	0.000	(0.001)	-0.007	(0.001)***
Male wage			-0.000	(0.001)	-0.003	(0.000)***	0.000	(0.001)	0.154	(0.002)***	-0.061	(0.001)***
Female wage			-0.004	(0.001)***	-0.002	(0.000)***	-0.007	(0.001)***	-0.061	(0.001)***	0.146	(0.002)***
Others price			-0.016	(0.001)***	0.001	(0.001)	-0.003	(0.001)***	-0.090	(0.002)***	-0.071	(0.002)***
Log Budget			-0.001	(0.002)	-0.005	(0.001)***	0.003	(0.001)	-0.156	(0.004)***	-0.192	(0.003)***
Age male	0.004	(0.001)***	-0.002	(0.000)***	-0.000	(0.000)	-0.001	(0.000)***	0.005	(0.000)***	0.000	(0.000)
Age squared male	-0.000	(0.000)*	0.000	(0.000)***	0.000	(0.000)**	0.000	(0.000)***	-0.000	(0.000)***	0.000	(0.000)
Age female	0.014	(0.001)***	-0.001	(0.000)***	-0.000	(0.000)**	0.000	(0.000)	0.000	(0.000)	0.006	(0.000)***
Age squared female	-0.000	(0.000)***	0.000	(0.000)***	0.000	(0.000)**	-0.000	(0.000)	-0.000	(0.000)	-0.000	(0.000)***
East Germany	-0.091	(0.009)***	0.002	(0.001)	-0.002	(0.001)***	-0.000	(0.001)	-0.000	(0.004)	-0.010	(0.003)***
Medium agglom.	-0.005	(0.002)*	0.003	(0.000)***	-0.000	(0.000)	0.003	(0.000)***	-0.005	(0.001)***	-0.000	(0.001)
Low agglom.	-0.005	(0.003)	0.007	(0.000)***	0.001	(0.000)***	0.005	(0.000)***	-0.012	(0.001)***	-0.003	(0.001)***
Correction term male			0.001	(0.003)	-0.003	(0.001)*	0.005	(0.003)	-0.029	(0.009)**	-0.010	(0.007)
Correction term female			-0.001	(0.001)	0.000	(0.001)	0.000	(0.001)	0.013	(0.004)***	-0.005	(0.003)
Correction term heat			-0.095	(0.004)***	-0.004	(0.002)*	-0.046	(0.004)***	0.353	(0.008)***	0.146	(0.006)***
Constant	7.840	(0.016)***	0.129	(0.015)***	0.047	(0.006)***	-0.005	(0.013)	1.615	(0.038)***	1.948	(0.029)***
Living space	No		Yes		Yes		Yes		Yes		Yes	
Quarterly dum.	Yes		Yes		Yes		Yes		Yes		Yes	
Federal states	Yes		Yes		Yes		Yes		Yes		Yes	
Social status m/f	Yes		Yes		Yes		Yes		Yes		Yes	
Skill m/f	Yes		Yes		Yes		Yes		Yes		Yes	
Observations	53,078											
R^2	0.496		0.158		0.136		0.073		0.552		0.660	

15 restrictions in the system estimation

Notes: Significance levels: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$. The dependent variables of the demand system are defined in shares of the budget. The prices and the wages are defined in logs. The non-labor income is defined in 1000 Euro units.
Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

B.2 Demand System Estimation - Uncompensated Elasticities

Table B.10: Uncompensated Price Elasticities[1] for Commodity Demand and **Intensive Leisure** (Unconstrained Estimation for One-Adult Households)

Uncompensated	Mobility	Electricity	Heating	Leisure	Others
Mobility price	**-0.97**	**-0.20**	**-0.18**	**0.17**	**-0.16**
	[-1.10 : -0.85]	[-0.31 : -0.08]	[-0.37 : 0.00]	[0.14 : 0.20]	
Electricity price	**0.48**	**-0.57**	**-0.26**	**-0.40**	**0.35**
	[0.20 : 0.76]	[-0.83 : -0.31]	[-0.68 : 0.16]	[-0.47 : -0.33]	
Heating price	**0.09**	**0.03**	**-0.66**	**0.00**	**-0.03**
	[0.02 : 0.16]	[-0.04 : 0.11]	[-0.77 : -0.56]	[-0.02 : 0.02]	
Wage	**1.27**	**0.70**	**0.93**	**0.04**	**0.84**
	[1.02 : 1.52]	[0.47 : 0.93]	[0.57 : 1.29]	[-0.02 : 0.11]	
Others price	**0.22**	**0.13**	**0.41**	**0.77**	**-1.82**
	[-0.25 : 0.70]	[-0.31 : 0.57]	[-0.29 : 1.10]	[0.65 : 0.89]	

Notes: Confidence intervals in parentheses.
[1]: All elasticities are evaluated at the respective mean expenditures.
Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

Table B.11: Uncompensated Price Elasticities[1] for Commodity Demand and **Intensive Leisure** (Unconstrained Estimation for Two-Adult Households)

Uncompensated	Mobility	Electricity	Heating	Male leisure	Female leisure	Others
Mobility price	**-0.65**	**-0.15**	**-0.35**	**0.20**	**0.11**	**-0.22**
	[-0.73 : -0.57]	[-0.24 : -0.06]	[-0.52 : -0.19]	[0.17 : 0.23]	[0.08 : 0.15]	
Electricity price	**-0.21**	**-0.69**	**0.43**	**-0.33**	**-0.34**	**0.42**
	[-0.40 : -0.03]	[-0.89 : -0.49]	[0.04 : 0.81]	[-0.40 : -0.25]	[-0.41 : -0.27]	
Heating price	**0.22**	**0.16**	**-0.68**	**-0.15**	**-0.07**	**0.10**
	[0.18 : 0.26]	[0.11 : 0.21]	[-0.76 : -0.61]	[-0.16 : -0.13]	[-0.08 : -0.05]	
Male wage	**0.84**	**0.45**	**0.75**	**-0.01**	**0.12**	**0.17**
	[0.76 : 0.93]	[0.36 : 0.54]	[0.58 : 0.93]	[-0.05 : 0.02]	[0.08 : 0.15]	
Female wage	**0.35**	**0.22**	**0.20**	**0.13**	**-0.04**	**0.32**
	[0.31 : 0.40]	[0.16 : 0.27]	[0.11 : 0.30]	[0.09 : 0.17]	[-0.07 : 0.00]	
Others price	**-0.19**	**-0.04**	**0.33**	**1.61**	**0.92**	**-2.69**
	[-0.52 : 0.14]	[-0.39 : 0.31]	[-0.32 : 0.99]	[1.48 : 1.74]	[0.80 : 1.04]	

Notes: Confidence intervals in parentheses.
[1]: All elasticities are evaluated at the respective mean expenditures.
Source: Own calculations using the scientific use-files of the EVS (1998, 2003 and 2008) provided by the German Federal Statistical Office (*Statistisches Bundesamt*).

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