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Peter Grösche

Housing, Energy Cost, and the Poor

Counteracting Effects in Germany's Housing Allowance Program

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Technische Universität Dortmund, Department of Economic and Social Sciences
Vogelpothsweg 87, 44227 Dortmund, Germany

Universität Duisburg-Essen, Department of Economics
Universitätsstraße 12, 45117 Essen, Germany

Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI)
Hohenzollernstr. 1/3, 45128 Essen, Germany

Editors:

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RUB, Department of Economics
Empirical Economics
Phone: +49 (0) 234/3 22 83 41, e-mail: thomas.bauer@rub.de

Prof. Dr. Wolfgang Leininger
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Economics – Microeconomics
Phone: +49 (0) 231 /7 55-32 97, email: W.Leininger@wiso.uni-dortmund.de

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Prof. Dr. Christoph M. Schmidt
RWI
Phone: +49 (0) 201/81 49-227, e-mail: christoph.schmidt@rwi-essen.de

Editorial Office:

Joachim Schmidt
RWI, Phone: +49 (0) 201/81 49-292, e-mail: joachim.schmidt@rwi-essen.de

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Peter Grösche*

Housing, Energy Cost, and the Poor – Counteracting Effects in Germany's Housing Allowance Program

Abstract

Adequate housing and affordable warmth are essential human needs, the lack of which may seriously harm people's health. Germany provides an allowance to low-income households, covering the housing as well as the space heating cost, to protect people from the consequences of poor housing conditions and fuel poverty. In order to limit public expenditures, payment recipients are required to choose low-cost dwellings, with the consequence that they probably occupy flats with a poor thermal performance. Recipients are thus likely to have a higher energy consumption and energy expenditures. Using a large data set of German households, this paper demonstrates that this counteracting effect is of negligible magnitude. Yet, from an ecological perspective, the allowance scheme creates distorted incentives and should be reformed.

JEL Classification: C33, H53, Q48

Keywords: Housing allowance, energy efficiency, simultaneous-equation system

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1 Overview

Housing is an essential human need, one that not only impacts spiritual and material well-being but also health (Cattaneo et al. 2009, Thomson et al. 2001). People spend a considerable share of their income for housing, and an integral part of decent housing are sufficiently warm rooms. Consequently, expenses for space heating comprise a substantial share of the energy budget of people living in moderate or cold climates.

In the face of rising energy prices in recent years, the notion of fuel poverty – the struggle of low-income households to obtain affordable warmth – has become popular in political discussions. Such households typically live in rented accommodations and have little incentive to invest in the thermal efficiency of property they do not own. Hence, they have little option but to pay the higher energy cost.

Following Bradshaw and Hutton (1983), fuel poverty can be mitigated by an increase of income or a reduction of energy expenditures. Policy usually provides some mixture of financial assistance to tackle the challenge of energy poverty. For instance, France, Italy, Belgium and Spain provide special energy tariffs that reduce the energy price for low-income residents (EPEE 2008a, 2008b). Germany provides a housing allowance to households reliant on social assistance payment (SAP), which is designed to permit SAP recipients to choose a dwelling of the lower rental price segment, and additionally covers the entire energy expenses for space heating. The annual public spending amounts to more than €12 billion (ARGE 2008, 2009).

The theoretical implications of this program are highly controversial. Rather than giving recipients incentives to save energy and thereby reduce their expenditures, the allowance program sends the opposite price signal as it essentially lowers the price for space heating to nil. Moreover, since only low-cost dwellings are covered by the program, it is very likely that the respective flats in turn exhibit a low energy efficiency. Beneficiaries of the allowance may thus consume considerably more energy for space heating than households outside the program. This gives rise to a counteracting effect: the enlarged energy expenditures for SAP recipients may even outbalance the imposed limitations on their rent spending. Other undesirable implications also arise from this counteracting effect: a higher consumption of space heating fuels like natural gas and fuel oil yields higher carbon-dioxide emissions and contradicts the climate protection strategy of the German government. Further, the possible escalated energy consumption of welfare recipients intensifies Germany's dependency on fossil fuels – ironically financed by public spending.

Though the principal mechanics underlying the counteracting effect might raise concerns about the design of the German housing allowance program, it is an open empirical question as to whether the magnitude of this effect is large enough to be of political and practical importance. To the best of our knowledge, this is the first paper that aims at assessing this effect. We proceed by reviewing some details of the German housing allowance program in section 2. Section 3 describes the data and methodology and provides subsequently the empirical results. Section 4 finally concludes.

2 Germany's Housing Allowance Program: Framework and Implications

People who are either long-term unemployed or are unable to participate on the labor market are entitled to receive a SAP to cover their daily expenses, as long as the respective household's income is below a certain threshold. A housing allowance is also provided following the extensive redesign of the SAP at the beginning of 2005. The allowance is designed to permit eligible households to occupy a dwelling of the lower rental price segment, and covers their rent and space heating expenditures. Almost 3 million households – nearly 8% of all households in Germany (ARGE 2008:55) – have received benefits from the allowance program in 2007, yielding program expenses of €12.5 billion.

About 90% of the recipients were tenant households, for whom the program framework defines the maximal admissible dwelling size according to the household's size, and limits the maximal rental price per square meter living space, depending on the price level of the respective municipality. If the actual rent expenditures exceed the permissable amount, the program authority usually provides a grace time of six months in which the recipient is required to move to a cheaper dwelling, and pays thereafter only the permissable amount.

To pursue the implications of the program framework more formally, we delineate household i as living in location k, and compute its per-square meter rent r_{ik} and its energy consumption per m^2 e_{ik}:

$$(1) \qquad r_{ik} = \frac{R_{ik}}{Q_{ik}}, \qquad e_{ik} = \frac{E_{ik}/p_k}{Q_{ik}},$$

where R and E denote rent and energy expenditures, respectively; Q denotes i's living space, and p_k refers to the price for energy at location k.

Let w denote an allowance receiving household. While people are generally free to choose any dwelling they can afford, the allowance program requires from their recipients that $r_{wl} < \bar{r}_l$, with $\bar{r}_l$ being the market average rent in location l. Thus, dwellings priced above the average rent can only be occupied by non-recipients, and program participants should therefore posses on average a smaller ratio between actual and market rent per square meter:

$$(2) \qquad \frac{r_{wl}}{\bar{r}_l} < \frac{r_{ik}}{\bar{r}_k}.$$

Unlike rent expenditures, the allowance program also covers the actual energy expenditures for space heating. Nevertheless, no clear-cut ex-ante criterion exists to appraise the appropriate amount of energy costs to be covered, as these costs are triggered e.g. by climatic effects. While it is generally intuitive that low-cost dwellings are not endowed with up-to-date and energy-efficient equipment, the concept of *hedonic prices* and the implications of what is known as *filtering* theoretically suggest that the dwelling's rent is linked to its amenities, including its energy efficiency. Hedonic prices refer to the characteristics approach by Lancaster (1966), where the product price is a composition of the individual prices of the product's attributes. Given that quality and energy efficiency are attributes of a specific dwelling, poor quality and an inferior energy efficiency is thought to be associated with a low rent. Filtering refers to the successive shift of the dwelling's occupation from high- to low-income households during its life cycle: as the building ages and deteriorates, it becomes less expensive and more affordable to households with lower income. Filtering thereby implies that the building's quality – defined for instance as technical obsolescence of the heating equipment – is correlated with the building's age (Lowry 1960, Weicher and Thibodeau 1988), and entails that low-income households live in dwellings at the lower tail of the quality distribution.[1]

Along the lines of hedonic prices and filtering we expect that allowance recipients consume comparably more energy per square meter:

$$\frac{e_{wl}}{HDD_l} > \frac{e_{ik}}{HDD_k}. \tag{3}$$

Since local climatic conditions trigger differences in energy consumption, e is normalized by local heating degree days (HDD), a measure for the local heating requirement.[2] While equation (2) denotes that allowance program participants will presumably pay a comparably lower rent per square meter, conditional on the local rental price level, equation (3) implies that they have in turn a higher energy consumption for space heating and thus higher energy cost, conditional on the local energy price level and the local climate conditions. The inverse

[1] A strong association between income and the thermal performance was observed by Santamouris et al. (2007), who combined the socioeconomic background of surveyed Greek households with information on the insulation standard of their occupied dwelling.

[2] The calculation of HDD is described in the appendix.

directions of the inequality signs depict the counteracting effect inherent in the housing allowance program. While it is unclear whether and to what extent this effect exists, it would cast doubts about the benefits of the program design if the offset is large.

3 Empirical Framework

3.1 Data Set

The housing allowance program was established at the beginning of 2005 and affects almost exclusively tenant households. We hence restrict our attention to tenant households and draw data from the German Socioeconomic Panel, a representative longitudinal study of private households in Germany. Our data set includes 5 988 tenant households for the years 2005 and 2006 and is structured as an unbalanced panel: we observe 1 010 households exclusively in 2005, 603 households exclusively in 2006, and 4 375 households in both years. Sublets are excluded from the data because of difficulties separating out their energy expenditures from those of the main-tenant. The official welfare statistics shows that recipient-households consisting of only a single person often share their accommodation with other persons (ARGE 2008). This group of recipients is therefore somewhat less frequently observed in our data set compared to the population.[3]

The data set contains information on the household's rent and space heating expenditures in €, the occupied dwelling space in m^2, a dummy indicating whether the household has received welfare, and a location identifier at the county level. Using this location information, we supplement the household data with the local heating degree days (HDD), the price in €-Cent/kWh for natural gas from the local utility, and the average rent for average dwellings (in €/m^2) within the

[3]Following ARGE (2008), about 48% of all welfare receiving households consist of a single person. Of these, about 12% share their accommodation.

Table 1: Sample Average Statistics

	2005		2006	
	Welfare	No Welfare	Welfare	No Welfare
Observations*	650	4 469	638	4 071
Living Space (m^2)	66	73	67	73
Monthly Rent Expenditures**				
total (€)	366	450	366	456
per m^2 (€/m^2)	5.62	6.30	5.62	6.33
Monthly Energy Expenditures				
total (€)	72	77	82	84
per m^2 (€/m^2)	1.12	1.09	1.25	1.16

	2005	2006
Gas Price (Cent/kWh)	5.58	6.57
Heating Degree Days (HDD)	3 606	3 449
Average Rent** (€/m^2)	5.20	5.24

*The sample consist of 9 828 observations, but due to the panel structure we observe 5 988 separate households. **The monthly rent expenditures include the dwelling's service and operating cost (e.g. trash removal). The average rent is free of these cost.

respective county, and conditional on the sample year. Details on the assembly of these regional data are given in the appendix.

Table 1 denotes sample statistics of all variables used in the analysis. The upper panel outlines household specific information, and the lower panel summarizes variables specific for a county. As expected, welfare recipients indeed exhibit a lower rent but higher space heating expenditures per square meter. However, the expenditure differences per square meter are rather small between the groups. T-tests suggest a statistically significant higher average spending on energy per square meter for welfare recipients in 2006, while no significant difference arises for 2005.[4] This mixed finding for the sample years might be due to the sharp rise of energy prices between the two years, since higher energy prices emphasize existing differences in the dwelling's energy efficiency.

[4]The t-statistic for the per-square-meter energy expenditures for the year 2006 is 2.8, while $t = 1.2$ for 2005. Respective tests for the per-square-meter rent suggest significant lower expenditures for welfare recipients in both years, with $t = 6.63$ (2006) and $t = 7.17$ (2005).

3.2 Model Specification

The econometric analysis also incorporates the local climate conditions and the local prices for rent and energy, and proceeds with the following very general two-equation structure:

$$y_{Rit} = \alpha_R + \boldsymbol{x}'_{Rit}\boldsymbol{\beta}_R + u_{it}, \tag{4a}$$

$$y_{Eit} = \alpha_E + \boldsymbol{x}'_{Eit}\boldsymbol{\beta}_E + v_{it}, \tag{4b}$$

to examine the differences in rent and energy expenditures between welfare-receiving households and non-recipients. We refer to (4a) as the rent expenditure equation and denote (4b) as the energy expenditure equation. The vectors $\boldsymbol{x}_{Rit}$ and $\boldsymbol{x}_{Eit}$ contain the respective covariates, and α_R and α_E are the respective constant terms of the equations.

For every household we observe both equations jointly, and we observe most of the households in both sample years. The regression residuals u_{it} and v_{it} might therefore possess household-individual aspects and are likely to be correlated across equations and – given the panel structure of our data set – might also be correlated across the sample years. To address this feature we use a maximum-likelihood version of Zellner's (1962) seemingly unrelated regression (SUR) model. The used model – described in Gould et al. (2003:229-239) – captures intragroup correlation by clustering all observations coming from the same household. The computed robust (Huber-White) standard errors relax the assumption of independent observations but only require independence between households.

We pursue two different model specifications for equation (4):

Model 1:

$$y_{Rit} = \ln(R_{it}) \qquad \boldsymbol{x}'_{Rit} = \begin{pmatrix} \ln(Q_{it}) & \ln(\bar{r}_t) & W_{it} \end{pmatrix}$$

$$y_{Eit} = \ln(E_{it}) \qquad \boldsymbol{x}'_{Eit} = \begin{pmatrix} \ln(Q_{it}) & \ln(p_t) & \ln(HDD_t) & W_{it} \end{pmatrix}$$

Model 2:

$$y_{Rit} = R_{it} \qquad \boldsymbol{x}'_{Rit} = \begin{pmatrix} Q_{it} & \bar{r}_t & W_{it} & Q_{it}W_{it} \end{pmatrix}$$

$$y_{Eit} = E_{it} \qquad \boldsymbol{x}'_{Eit} = \begin{pmatrix} Q_{it} & p_t & HDD_t & HDD_t^2 & W_{it} & Q_{it}W_{it} \end{pmatrix}.$$

Model 1 is specified in log-log form, meaning that the coefficient for the logarithm of the household's living space Q_{it}, for example, can be interpreted as the percentage change of rent expenditures if the living space increases by 1%. The same elasticity interpretation applies for the parameters of the log of the local natural gas price p, the log of the local average rent $\bar{r}$, and the log of the local climate variable HDD. The binary variable W_{it} equals one if the household i receives welfare at time $t \in \{2005, 2006\}$, and is zero otherwise. The parameters for W_{it} capture any percentage difference in rent and energy expenditures between the two groups of households that cannot be attributed to the other covariates, including quality effects due to substandard dwellings.

Model 2 gathers the differences in rent and energy expenses between welfare recipients and non-recipients via the welfare dummy and an interaction of the welfare dummy with the household's living space. We keep this as the only meaningful interaction, since welfare-specific slope parameters for the local average rent, the local gas price, or the weather appear implausible. Possible nonlinear effects of local climate variation on space heating expenditures are captured by including HDD and squared HDD into the energy expenditure equation of model 2.[5]

[5] A nonlinear relationship between climate and the household's energy consumption was found, for instance, by Grösche (2009) for US households.

The counteractive incentives in the housing allowance program imply a negative sign for the welfare coefficients in the rent expenditure equations of both models, and a positive signs in the energy expenditure equations, respectively.

3.3 Parameter Estimates

The results for model 1 are depicted in the upper panel of table 2; the lower panel shows the results for model 2. The respective first two columns refer to the estimated coefficients and the robust standard errors of the rent equation, while the last two columns report the results for the energy expenditure equation. The last row of each panel reports Wald test statistics, clearly indicating the superior fit of the specification compared to a constant-only model.

Both models basically tell the same story. Each additional square meter of living space increases the rent spending by on average €5.64, a value consistent with the average per-square meter rent reported in table 1. Also, the average energy expenditures raise by €0.92 per additional square meter. The elasticity estimates of model 1 suggest that rent and energy spending will increase with a lower rate than living space, a plausible finding in line with the market observation in Germany, where smaller apartments typically exhibit a comparably larger per-square-meter price.

As expected, rent and energy cost are both positively correlated to its respective local price level, stressing the importance of accounting for differences in average rent and the local energy prices in the analysis. Living in a location with an average rent €1 above the "overall mean rent" yields increasing housing expenditures of some €67, a figure corresponding to the average dwelling size given in table 1. In turn, raising the gas price by one cent per kWh would increase the monthly space heating expenditures on average by €4. The elasticity estimates of model 1 show that the short-term response to such a market price increase is inelastic.

Table 2: Results SUR Models

Model 1	*ln(Rent Expenditures)* Coefficient	Robust Std.Error	*ln(Energy Expenditures)* Coefficient	Robust Std.Error
ln(Living Space)	0.858**	0.019	0.837**	0.022
ln(Avr. Rent)	0.760**	0.035		
ln(Gas Price)			0.361**	0.072
ln(HDD)			−0.112	0.066
Welfare	−0.092**	0.014	0.038	0.019
Constant	1.150**	0.104	0.997	0.547
Wald-Test	$\chi^2(df = 3) = 2427$		$\chi^2(df = 4) = 1541$	

Model 2	*Rent Expenditures* Coefficient	Robust Std.Error	*Energy Expenditures* Coefficient	Robust Std.Error
Living Space	5.640**	0.211	0.920**	0.032
Avr. Rent	67.561**	4.000		
Gas Price			3.994**	0.748
HDD			−0.010	0.016
HDD^2 ($\times 10^{-5}$)			0.122	0.213
Welfare	49.852*	21.753	8.383	5.277
Welfare × Living Space	−1.315**	0.350	−0.092	0.081
Constant	−312.612**	27.882	8.029	29.919
Wald-Test	$\chi^2(df = 4) = 1195$		$\chi^2(df = 6) = 940$	

**(*) significant at the 1% (5%) level

While the parameters for the welfare dummies exhibit the expected signs in both models, only those in the rent equations are statistically significant.[6] But even beyond statistical significance one can generally question whether the counteracting effect is of practical and political importance, since our results indicate that the financial offset is of limited scope. For instance, the estimated coefficients of model 1 suggest that welfare recipients exhibit a 9% lower rent but in turn spend 4% more on energy. The descriptive statistics in table 1 clarify that the level of rent expenditures, to which the 9% difference refer, is well above the

[6]In light of the sharp rise of energy prices in 2005 and 2006 we checked the robustness of our results by estimating all models conditional on the respective sample year. The outcomes of this exercise show the same pattern like table 2 and thus confirm our findings.

level of monthly energy cost. By means of the results of model 2, we can compute for the average allowance recipient from 2006 a rent expenditure difference of €38, while the associated rise in energy expenditures amount to only €2. Thus, even if the observed energy expenditure differences would be statistically significant, the offsetting effect would be of small magnitude.

Finally, neither of the coefficients for the climate variables are statistically significant. However, one should not infer that weather has no impact on the space heating demand. The finding simply suggests that the variation of HDD in Germany (regional and across the years) is not large enough to denote significant differences in space heating demand.

4 Summary and Conclusion

About 3 million households in Germany receive social assistance from a housing allowance program. The program covers the cost of housing and space heating for welfare recipients, and yielded program expenses of more than €12 billion in 2007. By requiring that the rent of beneficiaries be low, the program design may result in a high energy consumption of recipients, meaning high energy cost for the public. This paper has empirically assessed the scope of this effect. Our results show that recipients have indeed comparably lower rent spending, but we found no convincing evidence for a substantially higher energy consumption.

Notwithstanding our findings, one can question the incentive structure inherent in the allowance program. Currently, the program does not provide any stimulus to the beneficiaries for saving energy but subsidizes their energy consumption. Although improved energy efficiency of the building stock is a key political goal of the German government, the program yet provides an opposite market signal as it sustains a permanent demand for low-cost/low-quality dwellings. Landlords serving this demand have actually no incentive to retrofit their property. To the contrary, a retrofit will usually raise the dwellings's rent, and the home might become too expensive to be covered by the allowance program.

In summary, although the program design obviously limits public expenditures, the current design perpetuates the emissions of greenhouse gases and thereby contradicts Germany's climate protection efforts.

5 Appendix: Data Assembly of Regional Data

To compute the household's heating degree days (HDD) we make use of temperature data, metered by a grid of 140 weather stations from Germany's National Meteorological Service.[7] Subsequently, the HDD are calculated as the difference between 20°C indoor temperature and the daily average outdoor temperature below 20°C, summed over all days of a year for which the average outdoor temperature is below 12°C. To obtain overlapping coverage of the weather data with household locations, we use a Geographic Information System (GIS) and spatially interpolate the metered temperature to the household locations.

The majority of dwellings in Germany are heated with natural gas. We thus approximate the local energy price p_k with the average end-user price of natural gas, charged by the utilities operating in the respective county and including the standing charge for the gas meter. Because the provided utility data denote prices of August 2008, the data are discounted using an energy price index to obtain prices of 2005 and 2006, respectively.[8]

For many of the household locations we lack observed data for the respective average rent. To proceed, we impute this figure via a two-step procedure. In the first step, we regress observed average rent of 325 German cities from 167 counties on a set of county-specific variables. Using the estimation results, predicted values

[7] *Deutscher Wetterdienst*, for more information see `http://www.dwd.de`.

[8] The cost data are provided by the internet database `http://www.verivox.de` for a household consuming 20,000 kWh natural gas per year and include the annual standing charge for the gas meter. Dividing the total cost by the consumption figure yields the average price in €/kWh. The German Federal Statistical Office publishes a gas price index of 100 for 2005, this value rises to 117.6 for 2006, and amounts to 131.6 for August 2008 (StaBuA 2008:27-28).

Table 3: Imputation of Average Rent

	Coefficient	Standard Error
Population Density	0.442**	0.125
Population Density^2	−0.014	0.041
Income Tax	−7.015*	3.489
Income Tax^2	26.479**	5.764
Living Space	−0.513**	0.185
Living Space^2	0.006**	0.002
East	0.397	0.249
Constant	14.856**	3.614
$N = 325, F(7, 317) = 66.43$, adj. $R^2 = 0.59$		

**(*) indicates significance at the 1% (5%) level,
Population Density is measured in 1000 inhabitants/km^2,
Income Tax is measured in 1000 €/inhabitant.

of average rent for all 440 Germany counties are derived in the second step. The model estimated in the first-stage:

$$\bar{r}_k = \gamma + \boldsymbol{z}'_k \delta, \tag{5}$$

includes a vector $\boldsymbol{z}_k$ of county covariates, whose elements are: the population density (measured in 1000 people per km^2) to proxy the urban condition of the considered city, the available living space per inhabitant (in m^2), a dummy indicating whether the city is located in eastern Germany, and the average amount of income tax per inhabitant (in €1000/inhabitant) to proxy the relative wealth of the considered city. To allow for possible non-linearities, all variables except the east dummy enter in quadratic terms.

Table 3 reports the estimated coefficients along with their standard errors. As expected, a higher population density goes hand in hand with a rising average rent, suggesting that – ceteribus paribus – a comparable dwelling is more costly in larger cities. The income tax occurrence has a u-shaped relationship to the average rent, with its minimum at a level 132 € per inhabitant. Beyond that level, meaning the inhabitants become more wealthy, the living space becomes more expensive as well. The coefficients for available living space suggest likewise a convex relationship to the average rent, with a minimum at 42.75 m^2 per inhabitant. However, a closer inspection of the data from the 325 cities reveal, that 90% of the observations lie below this minimum, suggesting the expected negative correlation between available living space and average rent. Finally, the east dummy does not appear to be significant, an unsurprising finding after having controlled for many county-specific circumstances.

Finally, the average rent of all 440 German counties is imputed using the estimates from table 3 and the county specific elements of the vector $\boldsymbol{z}$.

References

ARGE (2009), Geldleistung für Bedarfsgemeinschaften, Berichtsmonat Januar 2009, *Grundsicherung für Arbeitssuchende*, Statistik der Bundesagentur für Arbeit, Nürnberg, Internet: `http://statistik.arbeitsagentur.de`.

ARGE (2008), Bedarfe, Leistungen und Haushaltsbudget, *Grundsicherung für Arbeitssuchende*, Statistik der Bundesagentur für Arbeit, Nürnberg,
Internet: `http://statistik.arbeitsagentur.de`.

Bradshaw, J., and S. Hutton (1983), Social Policy Options and Fuel Poverty, *Journal of Economic Psychology*, Vol.3:249-266.

Cattaneo, M.D., S. Galiani, P.J. Gertler, S. Martinez, and R. Titiunik (2009), Housing, Health, and Happiness, *American Economic Journal: Economic Policy*, Vol.1:75-105.

EPEE (2008a), *Detailed report on the Different Types of Existing Mechanisms to Tackle Fuel Poverty*, as from 4th Feb. 2008, The European Fuel Poverty and Energy Efficiency Project, Internet: `http://www.fuel-poverty.org`.

EPEE (2008b), *Good Practices Experienced in Belgium, Spain, France, Italy and United Kingdom to Tackle Fuel Poverty*, as from 27th June 2008, The European Fuel Poverty and Energy Efficiency Project, Internet: `http://www.fuel-poverty.org`.

Gould, W., J. Pitblado, and W. Sribney (2003), *Maximum Likelihood Estimation with Stata*, 2nd Edition, Stata Press, College Station, USA.

Grösche, P. (2008), Measuring Residential Energy Efficiency Improvements with DEA, *Journal of Productivity Analysis*, Vol.31:87-94.

Lancaster, K.J. (1966), A New Approach to Consumer Theory, *Journal of Political Economy*, Vol.74:132-157.

Lowry, I.S. (1960), Filtering and Housing Standards: A Conceptual Analysis, *Land Economics*, Vol.36:362-370.

StaBuA (2008), *Harmonisierte Verbraucherpreisindizes*, Deutschland, August 2008, Statistisches Bundesamt, Wiesbaden.

Thomson, H., M. Petticrew, and D. Morrison (2001), Health Effects of Housing Improvement: Systematic Review of Intervention Studies, *British Medical Journal*, Vol.323:187-190.

Weicher, J.C., and T.G. Thibodeau (1988), Filtering and Housing Markets: An Empirical Analysis, *Journal of Urban Economics*, Vol.23:21-40.

Zellner, A. (1962), An Efficient Method of Estimating Seemingly Unrelated Regression Equations and Tests for Aggregation Bias, *Journal of the American Statistical Association*, Vol.57:348-368.