Cost Liability and Residential Space Heating Expenditures of Welfare Recipients in Germany

Katrin Rehdanz[*] and Sven Stöwhase[†‡]

Working Paper FNU-139

July 2007

Abstract

Within the German welfare system, heating expenditures of recipients are in general fully covered by the government. This paper empirically tests for the hypothesis that households receiving welfare payments turn to over consumption of residential space heating. We use microdata from two different data sources to explore whether conditional heating expenditures of these households significantly differ from those of other households. Our empirical findings suggest that even when controlling for a range of other factors this is indeed the case as heating expenditures lie about 10 percent above those of other households. These results are fairly robust to sensitivity analyses. Our results imply that there is potential scope for cost savings if this policy is changed.

Keywords: Social welfare; Germany; Space heating; Economic incentives

JEL Classification: H23, Q41, Q48

[*] Research Unit Sustainability and Global Change, Hamburg University and Centre for Marine and Atmospheric Science, Bundesstrasse 55, 20146 Hamburg, Germany, email: katrin.rehdanz@zmaw.de.

[†] Fraunhofer Institute for Applied Information Technology (FIT), Microeconomic Modelling Group, Schloss Birlinghoven, 53754 Sankt Augustin, Germany, email: sven.stoewhase@fit.fraunhofer.de.

[‡] Corresponding author.

I. Introduction

Within the European welfare states, households receiving social welfare payments account for a sizeable fraction of total households. In 2003, nearly 1.25 million German households, comprising 2.8 million single persons, received social welfare payments (Sozialhilfe). This is equivalent to 4 percent of the German population and more than 3 percent of all German households. With the recent social policy reform, cutting benefits for those being in long-term unemployment, these numbers increased dramatically and now exceed 4 million households. With respect to these numbers, it seems necessary to evaluate the institutional design of this particular welfare program in more detail. While benefits are means-tested, they basically consist of lump-sum payments for each household member as well as the costs of housing. Additionally, benefits do as well cover expenditures for heating as long as they are judged to be "reasonable". This, however, is in sharp contrast to other countries. For instance, in France, under the minimum income allocation system (RMI), welfare recipients can claim additional housing benefits which depend on household characteristics, the rent and the location. In the UK, low income households can claim housing benefits, too. In the former case, heating costs are fully ignored, in the latter case households can apply for a warm front grant which covers a part of heating costs in form of a lump-sum payment.

Clearly, the German policy helps diminishing the problem of fuel poverty, as often discussed for the UK (see e.g. Sefton, 2002; Dresner and Ekins, 2006). On the other hand, it fails to create incentives to reduce heating consumption: Even though the term "reasonable" suggests that the coverage of heating costs is limited to a certain threshold, actual expenditures for heating are typically covered to one hundred percent.[1] As a consequence, any policy that aims to reduce the consumption of residential space heating, e.g. with means of a tax on heating fuel, is less efficient for this specific group of households.

[1] According to the Bundesagentur für Arbeit (2006), on average, only 85 percent of claimed heating costs were actually covered in 2006. For approximately one half of all households receiving social welfare payments, heating costs were fully covered. These relatively low numbers, however, are due to the fact that households often claim costs for hot water supply and other energy costs as heating costs. Instead, these costs have to be defrayed from the lump-sum payment.

Moreover, economic theory predicts that the missing cost liability of households receiving social welfare leads to an over consumption of heating compared to other households which have to pay heating costs by their own.[2] This will be the case as long as more heating increases household utility, either through increased well-being at higher room temperatures, or, more indirectly, by a less elaborate temperature management.[3] It is straightforward, from the perspective of the government, that such a policy, which covers the expenditures of households receiving welfare payments fully, is not desirable for at least two reasons. First, welfare expenditures for those receiving benefits are too high such that there is scope for potential savings. Second, with the quasi non-liability for heating expenditures, current welfare recipients are advantaged against other low income households, i.e. those households just above the income level that qualifies them for social welfare payments. In this respect, any welfare-to-work policy is more difficult in the German welfare system, as those leaving it and starting to work do not only loose utility from leisure but from over consumption of heating as well.

While the theoretical argumentation is quite clear, to our knowledge no study so far has been conducted, that empirically tests for the hypothesis that heating costs among welfare recipients are higher than average heating costs and if so to what extend. This is the aim of the present study.

Econometric analyses of residential energy demand including space heating are numerous. An extensive, if somewhat dated, overview is provided by Madlener (1996). The focus of most of these studies is on price and income elasticities to estimate changes in energy demand mainly based on aggregated data and for electricity. Studies using individual household-level data are relatively rare due to data availability. Most studies are for the US.

Dubin and McFadden (1984) were among the first to investigate the choice of energy-using equipment and energy use using micro-level data for the US. For Europe, most

[2] In the context of in-kind versus cash transfer programs, Murray (1980a, 1980b) has already noted, that, e.g. public (subsidized) housing imposes about 50 percent more housing than households would choose otherwise.

[3] For instance, it can be assumed that regular airing, which has a positive effect on room temperature and heating expenditures, has some physical or psychological costs. If these costs can be avoided by higher heating consumption, household utility will increase.

of the studies were conducted for Norway (Halvorsen and Larsen, 2001; Nesbakken, 1999; Vaage, 2000). Baker and Blundell (1991) applied data for the UK. Those studies are based on the so-called discrete/continuous modelling framework where the decisions concerning energy consumption are split into decisions relating to adjustments in technology and adjustments in the consumption of energy conditional on the available technology. As this approach requires large data sets another line of studies models conditional demand only (see eg. Baker *et al.*, 1989; Wu *et al.* 2004). These studies include different sets of demographic and other socio-economic characteristics to explain differences in residential energy demand. The age of household members was found significant as well as the size of the household and the minority/majority household type (Poyer and Williams, 1993). In our analysis, we follow this latter approach.

To our knowledge, there are only two other studies investigating expenditure for heating in Germany at the household level. Schuler *et al.* (2000) use 1988 data from the German income and expenditure survey (EVS) to examine the extent to which socio-economic variables can explain differences in households' behaviour concerning space heating. The results are used to evaluate energy-efficiency factors from technical simulations. More recently, Rehdanz (2007) examined the determinants of household expenditures on space heating and hot water supply on more than 12,000 households for the years 1998 and 2003 using data from the German socio-economic panel (SOEP). In her work, she distinguishes between different types of households, but excludes welfare recipients from the analysis. We base our current analysis on her previous findings by extending the household sample to those receiving welfare payments. The drawback is the small number of welfare recipients included in the data. To test whether this has an effect on the empirical results, we employ a second household sample, taken from the EVS of the year 2003. While this sample is more than three times larger than that from the SOEP, it includes less exploitable information on the household level. We formally test whether the estimated coefficients for welfare recipients are homogenous over the two different data sets as well as different model specifications.

The remainder of the paper is organised as follows: the next section briefly describes the data and the differences between the two samples used. Section III presents and discusses the regression results for different model specifications. In the subsequent

section IV we then test for homogeneity among different model specifications and carry out a sensitivity analysis. Section V concludes with some policy implications.

II. Data employed

Our analysis is based on two microdata-sets from two different sources. The first data used in this study stems from the 2003 wave of the German socio-economic panel (SOEP) and includes information for about 10,966 households. In 1998 and 2003 this annually conducted survey comprises detailed information on household's heating and hot water supply systems important for the conduct of an analysis on the determinants of household's demand for energy. In order to take advantage of this information but also to compare the results to those obtained from the second dataset we consider the 2003 wave only. As we want to test whether there exist systematic differences between welfare recipients and other households concerning the expenditures on residential space heating, a sample including as many welfare recipients as possible is desirable. To do so, we employ a second data set which has the advantage of a much larger sample size. However, the drawback of this sample is that it does not include as detailed information on housing and heating characteristics as covered by the SOEP. The second dataset used in the study is based on the German income and expenditure survey (EVS). This household survey is conducted every five years by the German statistical office. With the most recent data available for the year 2003, this sample covers about 43,000 representative households. Compared to the 214 households receiving welfare in the SOEP, the number of 730 households included in the latter sample is markedly higher and guarantees that single outliers among welfare recipients do not bias our regression results.

Apart from the information, whether a household receives social welfare payments, both samples include information about expenditure for space heating at the household level. These expenditures, measured per square meter of dwelling size, serve as the dependent variable in our analysis.[4] Next to dwelling size, which acts as

[4] Please note, that the definition of the expenditure variable slightly differs between the two samples: while the SOEP survey directly asks for monthly expenditure for space heating and hot water, the

an explanatory variable itself, our regression controls for a number of socio-economic characteristics which are available in both datasets. These include the household size; the number of children in the household; the net household income; the average age of the adult household members; and whether one or more household members are being officially registered as unemployed. Additional information is provided indicating owner occupied or rented accommodation and whether the household lives in the Western or the Eastern part of Germany. Our regression further controls for the type of heating system, the vintage class of the building and the size of the community where the household lives. While this latter information is available for both of the two datasets, the corresponding variables differ with respect to their exact definition and data classification.

Additionally, within the SOEP sample, controls are also included for building characteristics including a property's state of renovation, the type of property (flat, detached house etc), whether the house has central heating, a bath or shower, if it is a subsidized apartment, whether the property got a new heating system, new windows or other modernisation in the previous year, and in which federal state the household resides. As this data is extensively discussed in Rehdanz (2007), we abstain from a more detailed description here. Table 1 summarizes the definition of variables and the differences between the two samples used.

Finally, both samples, the SOEP as well as the EVS, include a number of households which do not report expenditures on residential space heating or where these costs are already included in the rent.[6] These households are excluded from our analysis. Also excluded are households with more than one source of heating system. This reduces the number of observations to 8,055 in the SOEP and 35,895 in the EVS sample.

*** Table 1 about here ***

EVS asks for expenditure on different kinds of heating energy carriers. Total expenditures thus have to be computed from the raw data.

[6] These include, for example, households living in residential homes, student halls or hostels.

III. Empirical analysis

Using ordinary least squares, the logarithm of monthly expenditures for space heating per square meter is regressed on a number of socio-economic, building and heating characteristics as described above.[7] Table 2 presents regression results for six different model specifications. The first four specifications include observations drawn from the SOEP while the last two refer to results obtained using the EVS data. Separate regressions are presented for specifications including all observations and rented accommodation only. We do so for two reasons. First, owners are more likely to invest in energy-efficient construction, appliances or insulation, which will have effects on heating consumption. Second, within our two data samples, there are hardly any cases in which households receiving welfare payments have property. Restricting the analysis on rented accommodations may thus reduce unobserved heterogeneity which can not be controlled for with our *OWNER* variable. The difference between the first two specifications using the SOEP data and the next two is the number of control variables included. The second two specifications limit the number of variables to those available in the EVS. These specifications were chosen to allow for a better comparison between the results of the SOEP and the EVS data as well as to test the homogeneity of the estimated coefficients. The latter issue is discussed further in the next section.

*** Table 2 about here ***

The estimated coefficients for welfare recipients show a strong positively significant effect on expenditures for space heating even when controlling for a large number of other factors. This is independent of data used and model specification. The results indicate that heating expenditures generally lie about 10 percent above those of other households, with somewhat lower values for those regressions limited to rented accommodations.[8] Even when we compare expenditures with those being officially registered as unemployed, which can be assumed to be a much better group for

[7] Different transformations of the dependent variable were considered. The semi-logarithm model provided the most consistent results judging by tests for functional form.

[8] As the coefficients of the variable *SOCIAL* can be interpreted as semi-elasticities, the percentage to which heating costs differ can be derived by multiplication of the corresponding coefficient with the value of one hundred.

comparison than the average household, there are significant differences. Not only is the corresponding coefficient for these households statistically less significant (or not significant at all), with expenditures about 3 percent higher than that of other households, the effect is furthermore quite small. Fortunately, our modelling approach allows us to directly calculate the difference in expenditures for heating between welfare recipients and unemployed by subtracting the two coefficients from each other. While the maximum difference in expenditures between these two groups of households is about 8 percent, it is 6 percent on average for the different regressions presented in Table 2.

Turning to the other variables included in the regressions, we find similar results to that reported by previous studies. In particular, our regression results resemble those of Rehdanz (2007). The negative sign for the variable *SQM* implies that heating expenditures increase below-average with dwelling size. Contrary, more household members,[9] a higher average age of the adult household members as well as higher household income increase expenditures. The estimated coefficients for household income show an income elasticity ranging from 0.03 to 0.11 depending on the exact specification of the model. Other studies using different data and different model specifications found income elasticities ranging from –0.27 to 0.61 (Berkhout *et al.*, 2004). However, the majority of studies estimated income elasticities comparable to those presented above with values ranging between 0.01 and 0.17 (Baker *et al.* 1989; Bernard *et al.*, 1989; Nesbakken, 1999 and Poyer and Williamsen, 1993). These studies are based on household energy consumption.

While our two datasets provide consistent results for the above mentioned variables, there are also some variables for which results are not that clear and/or consistent. As already discussed at the beginning of this section, owners are assumed to be more likely to invest in energy efficiency enhancing technologies. Using the full SOEP data, this is confirmed by the statistical significant negative coefficient for the *OWNER* variable in column 1 of Table 2. For the EVS sample, in contrast, the corresponding coefficient is insignificant (compare fifth column of Table 2). Results obtained from a

[9] The household size effect could have been removed by normalizing the dependent variable to population. However, this procedure would not lead to consistent results as most independent variables are measured at the level of the household or housing unit and cannot be transformed in per capita terms.

regression limited on those additional explanatory variables included in both datasets (column 3), however, show that this primarily stems from the exclusion of those variables explaining building characteristics. Similar effects can be found for the question whether households live in the Western or the Eastern part of Germany. While results for the full SOEP sample imply that this has no significant effect, the exclusion of additional explanatory variables leads to a significant negative coefficient for renters in East Germany. The most striking difference between the two datasets relates to children. Using SOEP data, results suggest that more children decrease expenditures for residential space heating. Using EVS data, we get the contrary result. Baker *et. al.* (1989) found a positive relationship between household energy consumption and the number of children, supporting the latter results.[10] More recent studies for Norway found no significant relationship. Nesbakken (1999) included the number of children under the age of 16 years and Vaage (2000) included the number of young children in a household. To solve for this inconsistency, we tested different transformations of the *CHILD* variable. Reducing the size and the significance of the *CHILD* coefficients, these alternative specifications had only little impact on the opposing effects, neither did they change our general results.[11]

Not displayed in Table 2 are the coefficients for the additional dummy variables included in the six regressions. Most of them are significant and suggest that there is, for example, a strong effect of the kind of heating system on household's expenditures for heating. Properties built before 1980 are more expensive to heat than more recently built ones. This is especially true for properties built in the period after World War II. Also, as expected, expenditures are higher for houses than for flats, regardless of the size. The variables measuring the condition of the property have the expected sing indicating that better conditions include better insulation, energy-efficient construction and appliances which reduces expenditures on heating. The interested reader is referred to Rehdanz (2007) where this is discussed in more detail.

To summarize, regression results for the two different datasets are in general consistent and show the expected signs. In particular, they confirm the hypothesis that those households receiving social welfare payments have significantly higher expenditures on residential space heating when compared to other households. Even

[10] Baker *et al.* (1989) included children younger than 5 years only.

[11] Results for this as for all other specifications discussed are available from the authors upon request.

when compared to households which are more comparable than the average household, these results persist.

IV. Homogeneity of estimated coefficients and sensitivity analysis

The results obtained from our different model specifications and datasets discussed in Section III indicate that the estimated coefficients describing the effect for welfare recipients on expenditures for space heating are similar in magnitude. In this section we now formally test the homogeneity of estimated coefficients. These tests involve the use of chi-squared statistic described in Hedges and Olkin (1985). Tables 3a and 3b report the results for two test specifications; using the results of the specifications based on the SOEP sample (full and reduced); and using the results of the reduced SOEP and the EVS sample. The coefficients refer to those estimated for the welfare recipients included in Table 2 above.

The test results indicate that the hypothesis of parameter homogeneity can not be rejected and the estimated coefficients are highly significant for all specifications. This is independent of the kind of model specification tested.[12]

*** Tables 3a and 3b about here ***

Apart from parameter homogeneity, we use limited sensitivity analyses to test the robustness of our results. The way we measured the presence of unemployment (if a member is being officially registered as unemployed), for example, is just one possibility of measuring the difference in expenditures for heating for those particular households. An alternative is to measure the share of household members being unemployed assuming that a higher share increases expenditures. Also, our definition of net household income including transfers might bear some problems in an analysis focusing on welfare recipients. To address this issue we reduced the net household income by social welfare payments. These alternative definitions of unemployment

[12] Tests for parameter homogeneity among the estimated coefficients measuring if unemployment is present indicate that the parameters are homogenous, but the estimated coefficients are mostly insignificant. The results are not displayed.

and income as well as specifications omitting insignificant variables or measuring the presence of children in terms of age lead to basically the same results as the ones discussed above and are not displayed therefore.

Finally, we attempt to reduce the heterogeneity between households receiving welfare benefits and those that do not. We restrict the analysis to welfare recipients and households where unemployment is present and exclude all the remaining observations. Table 4 displays the results for two different specifications using the EVS as well as the reduced SOEP sample. The estimated coefficients are very similar in size and have the same sign for most variables compared to those obtained from the total sample (see Table 2). Interestingly, the variable measuring the presence of children has the same negative sign for both samples, the SOEP as well as the EVS, but the estimated coefficient is not significant. A further test on parameter homogeneity revealed that the estimated coefficients for welfare recipients are homogenous and significant for the two specifications. The results are not displayed.

*** Table 4 about here***

V. Conclusion

The analysis presented in this paper started with the hypothesis that the legal provisions for social welfare recipients in Germany lead to an over consumption of residential space heating as heating expenditures are in general fully covered by the government. Using two different, representative, micro-datasets and controlling for a range of factors, we empirically found that expenditures of these particular households in 2003 were indeed significantly higher than those of the average household. This result is fairly robust to sensitivity analyses and provides a striking example on how restricted or lacking cost liability affects expenditures.

Taken these results serious, the policy implications are straightforward. Switching from a full coverage of actual heating expenditures to lump-sum payments, perhaps orientated at the expenditures of the average household, will unambiguously reduce incentives for over consumption. This, in turn, has a positive effect on public funds as

well. Using information from the Bundesagentur für Arbeit (2006), total expenditures for heating among welfare recipients in Germany for the year 2005 can be expected to be roughly as high as two billion Euros.[13] Applying our results to these numbers, with welfare recipients' expenditures about 10 percent higher than those of the average household, nearly 200 million Euros could thus be saved per year. Even with lump-sum payments equal to the average expenditures of comparable households, i.e. those being officially registered as unemployed, savings could sum up to approximately 100 million Euros per year. Clearly, there is possibility that such a lump-sum payment may disregard the special needs of individual households leading to fuel poverty in some cases. To prevent this, practical solutions have to be found that allow for lump-sum payments targeted for these specific households.

As for most empirical studies, however, even though our results are robust to numerous model specifications and resemble the findings of other studies using different data and regions, they should be interpreted with due care. Neither do the variables included in our data samples give a totally complete picture of the households analysed, nor can our results, evaluated for the year 2003, unrestrictedly carried over for the years after 2004 as the recent policy reform involved some minor changes on the responsibility for reimbursements. With respect to the latter point, it would be interesting to evaluate heating expenditures for recent years. This should be possible in the near future with the availability of more recent waves of the German socio-economic panel. In our opinion further research on this topic is needed in order to control for the robustness of our findings over time.

[13] Official statistics on government expenditures for heating within social welfare do not exist. For the period before 2003, as well as for recent years after the reformation of the social welfare system, published statistics only include the joint expenditures on accommodation and heating.

Table 1

Definition of variables included in the regressions

Variable by source		Definition
SOEP	EVS	
EXP_SQ		Log of monthly expenditure for space heating and hot water per square meter
	EXP_SQ	Log of quarterly expenditure for heating energy (excl. electricity) per square meter
SOCIAL	SOCIAL	Unity if household receives welfare payments, zero otherwise
SQM	SQM	Log of dwelling size in square meter
HHGR	HHGR	Log of household size
CHILD	CHILD	Log of number of children in household
INCOME	INCOME	Log of household net income
AGE	AGE	Log of average age of adult household members
OWNER	OWNER	Unity if property is owned, zero otherwise
UNEMPL	UNEMPL	Unity if a household member is being officially registered as unemployed, zero otherwise
EAST	EAST	Federal States belonging to Eastern Germany (Berlin is matched to the West German sample): unity or zero
HEAT		Heating system (oil, gas, coal (including wood and briquette), electricity, solar, municipal heat distribution or else (i.e. liquid gas): unity or zero
	HEAT	Heating energy carrier (oil, gas, municipal heat distribution or else (i.e. coal, wood or briquette): unity or zero
BUILT		Vintage class (before 1919, 1919–1948, 1949–1971, 1972–1980, 1981–1990, 1991 or later): unity or zero
	BUILT	Vintage class (before 1948, 1949-1990, 1991 or later): unity or zero
GGK		Community size (less than 2000, 2000–20,000, 20,000–100,000, 100,000–500,000, more than 500,000 inhabitants): unity or zero
	GGK	Community size (less than 5000, 5000–20,000, 20,000–100,000, 100,000–500,000, more than 500,000 inhabitants): unity or zero
RENOV		Condition of property (good, needs renovation, needs complete renovation, ready for demolition): unity or zero
NEW		Modernisation in last year (new central heating, new windows or other): unity or zero
TYPE		Building type (agricultural building, single or double house, terrace house, flat in building with 3 to 4 flats, flat in building with 5 to 8 flats, flat in building with 9 or more flats, flat in high rise building or else): unity or zero
C_HEAT		Unity if property has central heating, zero otherwise
BATH		Unity if property has a bath or shower, zero otherwise
COUNCIL		Unity if the property is a council house, zero otherwise
STATE		Federal State (Schleswig-Holstein, Hamburg, Lower Saxony, Bremen, North Rhine-Westphalia, Hesse, Rhineland-Palatinate and Saarland, Baden-Wuerttemberg, Bavaria, Berlin, Brandenburg, Mecklenburg Western-Pommerania, Saxony, Saxony-Anhalt, Thuringia): unity or zero

Source: German socio-economic panel (SOEP)/ German income and expenditure survey (EVS).

Table 2

Baseline Regression

Dependent Variable = logarithm of heating expenditures per square meter						
Data Sample	SOEP				EVS	
Variable	All coefficients	Renter coefficient	All coefficients	Renter coefficient	All coefficients	Renter coefficient
SOCIAL	0.097***	0.072***	0.093***	0.075***	0.115***	0.076***
SQM	-0.463***	-0.331***	-0.408***	-0.313***	-0.513***	-0.445***
HHGR	0.106***	0.086***	0.100***	0.0786***	0.141***	0.134***
CHILD	-0.076***	-0.043	-0.076***	-0.045*	0.022	0.058***
INCOME	0.060***	0.031*	0.070***	0.049***	0.114***	0.074***
AGE	0.121***	0.073***	0.124***	0.072***	0.156***	0.112***
OWNER	-0.098***	-	-0.011	-	-0.003	-
UNEMPL	0.027*	0.019	0.026*	0.014	0.035**	0.045***
EAST	0.013	-0.050	0.010	-0.028*	0.023*	-0.037***
HEAT	yes	yes	yes	yes	yes	yes
BUILT	yes	yes	yes	yes	yes	yes
GGK	yes	yes	yes	yes	yes	yes
RENOV	yes	yes	no	no	no	no
NEW	yes	yes	no	no	no	no
TYPE	yes	yes	no	no	no	no
C_HEAT	yes	yes	no	no	no	no
BATH	yes	yes	no	no	no	no
COUNCIL	yes	yes	no	no	no	no
STATE	yes	yes	no	no	no	no
No. of observations	8 055	3 938	8 055	3 938	35 895	17 165
Adjusted R-Squared	0.166	0.086	0.125	0.063	0.176	0.079

Source: Own calculations.

Significance at 1%, 5% and 10% is indicated by ***, ** and * respectively.

Dummy variable included in the regression = yes; Dummy variable not included in the regression = no.

Constant term included in all regressions.

Table 3a

Parameter homogeneity among coefficients using the SOEP model specifications		
	Coefficient welfare recipients	
	All	**Renter**
SOEP 2003	0.097***	0.072***
SOEP 2003 (reduced)	0.093***	0.075***
Parameter Homogeneity Test	$\chi(1) = 0.026$	$\chi(1) = 0.001$
Variance Weighted Estimate	0.094***	0.072***

Source: Own calculations.

Significance at 1%, 5% and 10% is indicated by ***, ** and * respectively.

Table 3b

Parameter homogeneity among coefficients using the reduced SOEP and the EVS specifications		
	Coefficient welfare recipients	
	All	**Renter**
SOEP 2003 (reduced)	0.093***	0.075***
EVS 2003	0.115***	0.076***
Parameter Homogeneity Test	$\chi(1) = 0.006$	$\chi(1) = 0.000$
Variance Weighted Estimate	0.091***	0.073***

Source: Own calculations.

Significance at 1%, 5% and 10% is indicated by ***, ** and * respectively.

Table 4

Sensitivity analysis				
Data Sample	SOEP reduced Only unemployed and welfare recipients		EVS Only unemployed and welfare recipients	
Variable	All coefficients	Renter coefficient	All coefficients	Renter coefficient
SOCIAL	0.075**	0.083**	0.068**	0.048(*)
SQM	-0.391***	-0.265***	-0.561***	-0.447***
HHGR	0.118***	0.038	0.168***	0.218***
CHILD	-0.016	-0.016	-0.024	-0.046
INCOME	0.039	0.064	0.146***	0.062*
AGE	0.103**	0.033	0.126***	0.111***
OWNER	0.01	-	-0.040	-
EAST	0.054*	0.005	0.027	-0.014
HEAT	yes	yes	yes	yes
BUILT	yes	yes	yes	yes
GGK	yes	yes	yes	yes
RENOV	no	no	no	no
NEW	no	no	no	no
TYPE	no	no	no	no
C_HEAT	no	no	no	no
BATH	no	no	no	no
COUNCIL	no	no	no	no
STATE	no	no	no	no
No. of observations	1 289	812	3 733	2 470
Adjusted R-Squared	0.111	0.051	0.139	0.057

Source: Own calculations.

Significance at 1%, 5% and 10% is indicated by ***, ** and * respectively.

(*) Significant at the level of 12%.

Dummy variable included in the regression = yes; Dummy variable not included in the regression = no.

Constant term included in all regressions.

References

Baker, P. and Blundell, R. (1991), "The microeconometric approach to modelling energy demand: some results for UK households", O*xford Review of Economic Policy*, vol. 7, pp. 54-76.

Baker, P., Blundell, R. and Micklewright, J. (1989), "Modelling household energy expenditures using micro-data", *Economic Journal,* vol. 99, pp. 720-738.

Berkhout, P. H. G., Ferrer-I-Carbonell, A. and Muskens, J. C. (2004), "The ex post impact of an energy tax on household energy demand", *Energy Economics*, vol. 26, pp. 297-317.

Bernard, J.-T., Bolduc, D. and Bélanger, D. (1996), "Quebec residential electricity demand: a microeconometric approach", *Canadian Journal of Economics*, vol. XXIX, pp. 92-113.

Bundesagentur für Arbeit (2006), "Grundsicherung für Arbeitssuchende: Wohnsituation und Wohnkosten", Nuremberg.

Dresner, S. and Ekins, P. (2006), "Energy Instruments to Improve UK Home Energy Efficiency without Negativ Social Impacts", *Fiscal Studies*, vol. 27(1), pp. 47-74.

Dubin, J. A. and McFadden, D. L. (1984), "An econometric analysis of residential electric appliance holdings and consumption", *Econometrica*, vol. 52, pp. 345-362.

Halvorsen, B. and Larson, B. M. (2001), "The flexibility of household electricity demand over time", *Resource and Energy Economics*, vol. 23, pp. 1-18.

Hedges, L., and Olkin, I. (1985), "Statistical methods for meta-analysis", Academic Press: San Diego.

Madlener, R. (1996), "Econometric Analysis of residential energy demand: a survey", *Journal of Energy Literature*, vol. II(2), pp. 3-32.

Murray, M. P. (1980a), "A reinterpretation of the traditional income-leisure model, with application to in-kind subsidy programs", *Journal of Public Economics*, vol. 14, pp. 69-81.

Murray, M. P. (1980b), "Tenant Benefits in Alternative Federal Housing Programs", *Urban Studies*, vol. 17(1), pp. 25-34.

Nesbakken, R. (1999), "Price sensitivity of residential energy consumption in Norway", *Energy Economics*, vol. 21, pp. 493-515.

Poyer, D. and Williams, M. (1993), "Residential energy demand: additional empirical evidence by minority household type", *Energy Economics*, vol. 15, pp. 93-100.

Rehdanz, K. (2007), "Determinants of residential space heating expenditures in Germany", *Energy Economics*, vol. 29, pp. 167-182.

Sefton, T. (2002), "Targeting fuel poverty in England: is the government getting warm?" *Fiscal Studies*, vol. 23(3), pp. 369-399.

Schuler, A., Weber, C. and Fahl, U. (2000), "Energy consumption for space heating of West-German households: empirical evidence, scenario projections and policy implications", *Energy Policy*, vol. 28, pp. 877-894.

Vaage, K. (2000), "Heating technology and energy use: a discrete/continuous choice approach to Norwegian household energy demand", *Energy Economics*, vol. 22, pp. 649-666.

Wu, X., Lampietti, J. and Meyer, A. S. (2004),"Coping with the cold: space heating and the urban poor in developing countries", *Energy Economics*, vol. 26, pp. 345-357.

Working Papers

Research Unit Sustainability and Global Change

Hamburg University and Centre for Marine and Atmospheric Science

Rehdanz, K. and S. Stöwhase (2007), *Cost Liability and Residential Space Heating Expenditures of Welfare Recipients in Germany*, **FNU-139** (submitted)

Schleupner, C. and P.M. Link (2007), *Potential impacts on bird habitats in Eiderstedt (Schleswig-Holstein) caused by agricultural land use changes*, **FNU-138** (submitted)

Link, P.M. and C. Schleupner (2007), *Agricultural land use changes in Eiderstedt: historic developments and future plans*, **FNU-137** (submitted)

Anthoff, D., R.J. Nicholls and R.S.J. Tol (2007), *Global Sea Level Rise and Equity Weighting*, **FNU-136** (submitted)

Schleupner, C. (2007), *Wetland Distribution Modelling for Optimal Land Use Options in Europe*, **FNU-135** (submitted)

Mayor, K. and R.S.J. Tol (2007), *The Impact of the EU-US Open Skies Agreement on International Travel and Carbon Dioxide Emissions*, **FNU-134** (submitted)

Schneider, U.A., M. Obersteiner, and E. Schmid (2007), *Agricultural adaptation to climate policies and technical change*, **FNU-133** (submitted)

Lychnaras, V. and U.A. Schneider (2007), *Dynamic Economic Analysis of Perennial Energy Crops - Effects of the CAP Reform on Biomass Supply in Greece*, **FNU-132** (submitted)

Mayor, K. and R.S.J. Tol (2007), The Impact of the UK Aviation Tax on Carbon Dioxide Emissions and Visitor Numbers, **FNU-131** (submitted)

Ruane, F. and R.S.J. Tol (2007), *Refined (Successive) h-indices: An Application to Economics in the Republic of Ireland*, **FNU-130** (submitted)

Yohe, G.W., R.S.J. Tol and D. Murphy (2007), *On Setting Near-Term Climate Policy as the Dust Begins the Settle: The Legacy of the Stern Review*, **FNU-129** (forthcoming, *Energy & Environment*)

Maddison, D.J. and K. Rehdanz (2007), *Happiness over Space and Time*, **FNU-128** (submitted).

Anthoff, D. and R.S.J. Tol (2007), *On International Equity Weights and National Decision Making on Climate Change*, **FNU-127** (submitted).

de Bruin, K.C., R.B. Dellink and R.S.J. Tol (2007), *AD-DICE: An Implementation of Adaptation in the DICE Model*, **FNU-126** (submitted).

Tol, R.S.J. and G.W. Tol (2007), *The Stern Review: A Deconstruction*, **FNU-125** (submitted).

Keller, K., L.I. Miltich, A. Robinson and R.S.J. Tol (2007), *How Overconfident Are Current Projections of Anthropogenic Carbon Dioxide Emissions?*, **FNU-124** (submitted).

Cowie, A., U.A. Schneider and L. Montanarella (2006), *Potential synergies between existing multilateral environmental agreements in the implementation of Land Use, Land Use Change and Forestry activities*, **FNU-123** (submitted)

Kuik, O.J., B. Buchner, M. Catenacci, A. Goria, E. Karakaya and R.S.J. Tol (2006), *Methodological Aspects of Recent Climate Change Damage Cost Studies*, **FNU-122** (submitted)

Anthoff, D., C. Hepburn and R.S.J. Tol (2006), *Equity Weighting and the Marginal Damage Costs of Climate Change*, **FNU-121** (submitted)

Tol, R.S.J. (2006), *The Impact of a Carbon Tax on International Tourism*, **FNU-120** (*Transportation Research D: Transport and the Environment*, **12** (2), 129-142).

Rehdanz, K. and D.J. Maddison (2006), *Local Environmental Quality and Life Satisfaction in Germany*, **FNU-119** (*Ecological Economics*)

Tanaka, K., R.S.J. Tol, D. Rokityanskiy, B.C. O'Neill and M. Obersteiner (2006), *Evaluating Global Warming Potentials as Historical Temperature Proxies: An Application of ACC2 Inverse Calculation*, **FNU-118** (submitted)

Berrittella, M., K. Rehdanz and R.S.J. Tol (2006), *The Economic Impact of the South-North Water Transfer Project in China: A Computable General Equilibrium Analysis*, **FNU-117** (submitted)

Tol, R.S.J. (2006), *Why Worry about Climate Change? A Research Agenda*, **FNU-116** (submitted, *Review of Environmental Economics and Policy*)

Hamilton, J.M. and R.S.J. Tol (2006), *The Impact of Climate Change on Tourism in Germany, the UK and Ireland: A Simulation Study*, **FNU-115** (submitted, *Regional Environmental Change*)

Schwoon, M., F. Alkemade, K. Frenken and M.P. Hekkert (2006), *Flexible transition strategies towards future well-to-wheel chains: an evolutionary modelling approach*, **FNU-114** (submitted).

Ronneberger, K., L. Criscuolo, W. Knorr and R.S.J. Tol (2006), *KLUM@LPJ: Integrating dynamic land-use decisions into a dynamic global vegetation and crop growth model to assess the impacts of a changing climate. A feasibility study for Europe*, **FNU-113** (submitted)

Schwoon, M. (2006), *Learning-by-doing, Learning Spillovers and the Diffusion of Fuel Cell Vehicles*, **FNU-112** (submitted).

Strzepek, K.M., G.W. Yohe, R.S.J. Tol and M. Rosegrant (2006), *The Value of the High Aswan Dam to the Egyptian Economy*, **FNU-111** (submitted, *Ecological Economics*).

Schwoon, M. (2006), *A Tool to Optimize the Initial Distribution of Hydrogen Filling Stations*, **FNU-110** (*Transportation Research D: Transport and the Environment*, **12** (2), 70-82).

Tol, R.S.J., K.L. Ebi and G.W. Yohe (2006), *Infectious Disease, Development, and Climate Change: A Scenario Analysis*, **FNU-109** (forthcoming, *Environment and Development Economics*).

Lau, M.A. (2006), *An analysis of the travel motivation of tourists from the People's Republic of China*, **FNU-108** (submitted).

Lau, M.A. and R.S.J. Tol (2006), *The Chinese are coming – An analysis of the preferences of Chinese holiday makers at home and abroad*, **FNU-107** (submitted, *Tourism Management*).

Röckmann, C., R.S.J. Tol, U.A. Schneider, and M.A. St.John (2006), *Rebuilding the Eastern Baltic cod stock under environmental change - Part II: The economic viability of a marine protected area.* **FNU-106** (submitted)

Ronneberger, K., M. Berrittella, F. Bosello and R.S.J. Tol (2006), *KLUM@GTAP: Introducing biophysical aspects of land-use decisions into a general equilibrium model. A coupling experiment,* **FNU-105** (submitted).

Link, P.M. and Tol, R.S.J. (2006), *Economic impacts on key Barents Sea fisheries arising from changes in the strength of the Atlantic thermohaline circulation*, **FNU-104** (submitted).

Link, P.M. and Tol, R.S.J. (2006), *The Economic Impact of a Shutdown of the Thermohaline Circulation: An Application of FUND*, **FNU-103** (submitted).

Tol, R.S.J. (2006), *Integrated Assessment Modelling*, **FNU-102** (submitted).

Tol, R.S.J. (2006), *Carbon Dioxide Emission Scenarios for the USA*, **FNU-101** (submitted, *Energy Policy*).

Tol, R.S.J., S.W. Pacala and R.H. Socolow (2006), *Understanding Long-Term Energy Use and Carbon Dioxide Emissions in the USA*, **FNU-100** (submitted).

Sesabo, J.K, H. Lang and R.S.J. Tol (2006), *Perceived Attitude and Marine Protected Areas (MPAs) establishment: Why households' characteristics matters in Coastal resources conservation initiatives in Tanzania*, **FNU-99** (submitted).

Tol, R.S.J. (2006), *The Polluter Pays Principle and Cost-Benefit Analysis of Climate Change: An Application of* FUND, **FNU-98** (submitted, *Environmental and Resource Economics*)

Tol, R.S.J. and G.W. Yohe (2006), *The Weakest Link Hypothesis for Adaptive Capacity: An Empirical Test*, **FNU-97** (forthcoming, *Global Environmental Change*)

Berrittella, M., K. Rehdanz, R.Roson and R.S.J. Tol (2005), *The Economic Impact of Water Pricing: A Computable General Equilibrium Analysis*, **FNU-96** (submitted, *Water Policy*)

Sesabo, J.K. and R. S. J. Tol (2005), *Technical Efficiency and Small-scale Fishing Households in Tanzanian coastal Villages: An Empirical Analysis*, **FNU-95** (submitted)

Lau, M.A. (2005), *Adaptation to Sea-level Rise in the People's Republic of China – Assessing the Institutional Dimension of Alternative Organisational Frameworks*, **FNU-94** (submitted)

Berrittella, M., A.Y. Hoekstra, K. Rehdanz, R. Roson and R.S.J. Tol (2005), *The Economic Impact of Restricted Water Supply: A Computable General Equilibrium Analysis*, **FNU-93** (*Water Research*, **42**, 1799-1813)

Tol, R.S.J. (2005), *Europe's Long Term Climate Target: A Critical Evaluation*, **FNU-92** (*Energy Policy*, **35** (1), 424-434)

Hamilton, J.M. (2005), *Coastal Landscape and the Hedonic Price of Accommodation*, **FNU-91** (submitted)

Hamilton, J.M., D.J. Maddison and R.S.J. Tol (2005), *Climate Preferences and Destination Choice: A Segmentation Approach*, **FNU-90** (submitted)

Zhou, Y. and R.S.J. Tol (2005), *Valuing the Health Impacts from Particulate Air Pollution in Tianjin*, **FNU-89** (submitted)

Röckmann, C. (2005), *International Cooperation for Sustainable Fisheries in the Baltic Sea*, **FNU-88** (forthcoming, in Ehlers,P./Lagoni,R. (Eds.): *International Maritime Organisations and their Contribution towards a Sustainable Marine Development*.)

Ceronsky, M., D. Anthoff, C. Hepburn and R.S.J. Tol (2005), *Checking the price tag on catastrophe: The social cost of carbon under non-linear climate response* **FNU-87** (submitted, *Climatic Change*)

Zandersen, M. and R.S.J. Tol (2005), *A Meta-analysis of Forest Recreation Values in Europe*, **FNU-86** (submitted, *Journal of Environmental Management*)

Heinzow, T., R.S.J. Tol and B. Brümmer (2005), Offshore-Windstromerzeugung in der Nordsee -eine ökonomische und ökologische Sackgasse? **FNU-85** (*Energiewirtschaftliche Tagesfragen*, **56** (3), 68-73)

Röckmann, C., U.A. Schneider, M.A. St.John, and R.S.J. Tol (2005), *Rebuilding the Eastern Baltic cod stock under environmental change - a preliminary approach using stock, environmental, and management constraints*, **FNU-84** (forthcoming, *Natural Resources Modelling*)

Tol, R.S.J. and G.W. Yohe (2005), *Infinite uncertainty, forgotten feedbacks, and cost-benefit analysis of climate policy*, **FNU-83** (submitted, *Climatic Change*)

Osmani, D. and R.S.J. Tol (2005), *The case of two self-enforcing international agreements for environmental protection*, **FNU-82** (submitted)

Schneider, U.A. and B.A. McCarl, (2005), *Appraising Agricultural Greenhouse Gas Mitigation Potentials: Effects of Alternative Assumptions*, **FNU-81** (submitted)

Zandersen, M., M. Termansen, and F.S. Jensen, (2005), *Valuing new forest sites over time: the case of afforestation and recreation in Denmark*, **FNU-80** (submitted)

Guillerminet, M.-L. and R.S.J. Tol (2005), *Decision making under catastrophic risk and learning: the case of the possible collapse of the West Antarctic Ice Sheet*, **FNU-79** (submitted, *Climatic Change*)

Nicholls, R.J., R.S.J. Tol and A.T. Vafeidis (2005), *Global estimates of the impact of a collapse of the West Antarctic Ice Sheet: An application of FUND*, **FNU-78** (submitted, *Climatic Change*)

Lonsdale, K., T.E. Downing, R.J. Nicholls, D. Parker, A.T. Vafeidis, R. Dawson and J.W. Hall (2005), *Plausible responses to the threat of rapid sea-level rise for the Thames Estuary*, **FNU-77** (submitted, *Climatic Change*)

Poumadère, M., C. Mays, G. Pfeifle with A.T. Vafeidis (2005), *Worst Case Scenario and Stakeholder Group Decision: A 5-6 Meter Sea Level Rise in the Rhone Delta, France*, **FNU-76** (submitted, *Climatic Change*)

Olsthoorn, A.A., P.E. van der Werff, L.M. Bouwer and D. Huitema (2005), *Neo-Atlantis: Dutch Responses to Five Meter Sea Level Rise*, **FNU-75** (submitted, *Climatic Change*)

Toth, F.L. and E. Hizsnyik (2005), *Managing the inconceivable: Participatory assessments of impacts and responses to extreme climate change*, **FNU-74** (submitted, *Climatic Change*)

Kasperson, R.E. M.T. Bohn and R. Goble (2005), *Assessing the risks of a future rapid large sea level rise: A review*, **FNU-73** (submitted, *Climatic Change*)

Schleupner, C. (2005), *Evaluation of coastal squeeze and beach reduction and its consequences for the Caribbean island Martinique*, **FNU-72** (submitted)

Schleupner, C. (2005), *Spatial Analysis As Tool for Sensitivity Assessment of Sea Level Rise Impacts on Martinique*, **FNU-71** (submitted)

Sesabo, J.K. and R.S.J. Tol (2005), *Factors affecting Income Strategies among households in Tanzanian Coastal Villages: Implication for Development-Conservation Initiatives*, **FNU-70** (submitted)

Fisher, B.S., G. Jakeman, H.M. Pant, M. Schwoon. and R.S.J. Tol (2005), *CHIMP: A Simple Population Model for Use in Integrated Assessment of Global Environmental Change*, **FNU-69** (*Integrated Assessment Journal*, **6** (3), 1-33)

Rehdanz, K. and R.S.J. Tol (2005), *A No Cap But Trade Proposal for Greenhouse Gas Emission Reduction Targets for Brazil, China and India*, **FNU-68** (submitted, *Climate Policy*)

Zhou, Y. and R.S.J. Tol (2005), *Water Use in China's Domestic, Industrial and Agricultural Sectors: An Empirical Analysis*, **FNU-67** (*Water Science and Technoloy: Water Supply*, **5** (6), 85-93)

Rehdanz, K. (2005), *Determinants of Residential Space Heating Expenditures in Germany*, **FNU-66** (*Energy Economics* ***29***)

Ronneberger, K., R.S.J. Tol and U.A. Schneider (2005), *KLUM: A Simple Model of Global Agricultural Land Use as a Coupling Tool of Economy and Vegetation*, **FNU-65** (submitted, *Climatic Change*)

Tol, R.S.J. (2005), *The Benefits of Greenhouse Gas Emission Reduction: An Application of* FUND, **FNU-64** (submitted, *Global Environmental Change*)

Röckmann, C., M.A. St.John, U.A. Schneider, F.W. Köster, F.W. and R.S.J. Tol (2006), *Testing the implications of a permanent or seasonal marine reserve on the population dynamics of Eastern Baltic cod under varying environmental conditions*, **FNU-63-revised** (*Fisheries Research*, **85**, 1-13)

Letsoalo, A., J. Blignaut, T. de Wet, M. de Wit, S. Hess, R.S.J. Tol and J. van Heerden (2005), *Triple Dividends of Water Consumption Charges in South Africa*, **FNU-62** (forthcoming, *Water Resources Research*)

Zandersen, M., Termansen, M., Jensen,F.S. (2005), *Benefit Transfer over Time of Ecosystem Values: the Case of Forest Recreation*, **FNU-61** (submitted)

Rehdanz, K., Jung, M., Tol, R.S.J. and Wetzel, P. (2005), *Ocean Carbon Sinks and International Climate Policy*, **FNU-60** (*Energy Policy*, **34**, 3516-3526)

Schwoon, M. (2005), *Simulating the Adoption of Fuel Cell Vehicles*, **FNU-59** (submitted)

Bigano, A., J.M. Hamilton and R.S.J. Tol (2005), *The Impact of Climate Change on Domestic and International Tourism: A Simulation Study*, **FNU-58** (submitted)

Bosello, F., R. Roson and R.S.J. Tol (2004), *Economy-wide estimates of the implications of climate change: Human health*, **FNU-57** (*Ecological Economics*, **58**, 579-591)

Hamilton, J.M. and M.A. Lau (2004) *The role of climate information in tourist destination choice decision-making*, **FNU-56** (forthcoming, Gössling, S. and C.M. Hall (eds.), Tourism and Global Environmental Change. London: Routledge)

Bigano, A., J.M. Hamilton and R.S.J. Tol (2004), *The impact of climate on holiday destination choice*, **FNU-55** (*Climatic Change*, **76** (3-4), 389-406)

Bigano, A., J.M. Hamilton, M. Lau, R.S.J. Tol and Y. Zhou (2004), *A global database of domestic and international tourist numbers at national and subnational level*, **FNU-54** (forthcoming, *International Journal of Tourism Research*)

Susandi, A. and R.S.J. Tol (2004), *Impact of international emission reduction on energy and forestry sector of Indonesia*, **FNU-53** (submitted)

Hamilton, J.M. and R.S.J. Tol (2004), *The Impact of Climate Change on Tourism and Recreation*, **FNU-52** (forthcoming, Schlesinger et al. (eds.), Cambridge University Press)

Schneider, U.A. (2004), *Land Use Decision Modelling with Soil Status Dependent Emission Rates*, **FNU-51** (submitted)

Link, P.M., U.A. Schneider and R.S.J. Tol (2004), *Economic impacts of changes in fish population dynamics: the role of the fishermen's harvesting strategies*, **FNU-50** (submitted)

Berritella, M., A. Bigano, R. Roson and R.S.J. Tol (2004), *A General Equilibrium Analysis of Climate Change Impacts on Tourism*, **FNU-49** (*Tourism Management*, **27** (5), 913-924)

Tol, R.S.J. (2004), *The Double Trade-Off between Adaptation and Mitigation for Sea Level Rise: An Application of* FUND, **FNU-48** (forthcoming, *Mitigation and Adaptation Strategies for Global Change*)

Erdil, E. and Yetkiner, I.H. (2004), *A Panel Data Approach for Income-Health Causality*, **FNU-47**

Tol, R.S.J. (2004), *Multi-Gas Emission Reduction for Climate Change Policy: An Application of* FUND, **FNU-46** (forthcoming, *Energy Journal*)

Tol, R.S.J. (2004), *Exchange Rates and Climate Change: An Application of* FUND, **FNU-45** (*Climatic Change*, **75**, 59-80)

Gaitan, B., Tol, R.S.J, and Yetkiner, I. Hakan (2004), *The Hotelling's Rule Revisited in a Dynamic General Equilibrium Model*, **FNU-44** (submitted)

Rehdanz, K. and Tol, R.S.J (2004), *On Multi-Period Allocation of Tradable Emission Permits*, **FNU-43** (submitted)

Link, P.M. and Tol, R.S.J. (2004), *Possible Economic Impacts of a Shutdown of the Thermohaline Circulation: An Application of* FUND, **FNU-42** (*Portuguese Economic Journal*, **3**, 99-114)

Zhou, Y. and Tol, R.S.J. (2004), *Evaluating the costs of desalination and water transport*, **FNU-41** (*Water Resources Research*, **41** (3), W03003)

Lau, M. (2004), *Küstenzonenmanagement in der Volksrepublik China und Anpassungsstrategien an den Meeresspiegelanstieg*,**FNU-40** (*Coastline Reports*, Issue 1, pp.213-224.)

Rehdanz, K. and Maddison, D. (2004), *The Amenity Value of Climate to German Households*, **FNU-39** (submitted)

Bosello, F., Lazzarin, M., Roson, R. and Tol, R.S.J. (2004), *Economy-wide Estimates of the Implications of Climate Change: Sea Level Rise*, **FNU-38** (submitted, *Environmental and Resource Economics*)

Schwoon, M. and Tol, R.S.J. (2004), *Optimal CO_2-abatement with socio-economic inertia and induced technological change*, **FNU-37** (submitted, *Energy Journal*)

Hamilton, J.M., Maddison, D.J. and Tol, R.S.J. (2004), *The Effects of Climate Change on International Tourism*, **FNU-36** (*Climate Research*, **29**, 255-268)

Hansen, O. and R.S.J. Tol (2003), *A Refined Inglehart Index of Materialism and Postmaterialism*, **FNU-35** (submitted)

Heinzow, T. and R.S.J. Tol (2003), *Prediction of Crop Yields across four Climate Zones in Germany: An Artificial Neural Network Approach*, **FNU-34** (submitted, *Climate Research*)

Tol, R.S.J. (2003), *Adaptation and Mitigation: Trade-offs in Substance and Methods*, **FNU-33** (*Environmental Science and Policy*, **8** (6), 572-578)

Tol, R.S.J. and T. Heinzow (2003), *Estimates of the External and Sustainability Costs of Climate Change*, **FNU-32** (submitted)

Hamilton, J.M., Maddison, D.J. and Tol, R.S.J. (2003), *Climate change and international tourism: a simulation study*, **FNU-31** (*Global Environmental Change*, **15** (3), 253-266)

Link, P.M. and R.S.J. Tol (2003), *Economic impacts of changes in population dynamics of fish on the fisheries in the Barents Sea*, **FNU-30** (*ICES Journal of Marine Science*, **63** (4), 611-625)

Link, P.M. (2003), *Auswirkungen populationsdynamischer Veränderungen in Fischbeständen auf die Fischereiwirtschaft in der Barentssee*, **FNU-29** (*Essener Geographische Arbeiten*, **35**, 179-202)

Lau, M. (2003), *Coastal Zone Management in the People's Republic of China – An Assessment of Structural Impacts on Decision-making Processes*, **FNU-28** (*Ocean & Coastal Management*, No. 48 (2005), pp. 115-159.)

Lau, M. (2003), *Coastal Zone Management in the People's Republic of China – A Unique Approach?*, **FNU-27** (*China Environment Series*, Issue 6, pp. 120-124; http://www.wilsoncenter.org/topics/pubs/7-commentaries.pdf)

Roson, R. and R.S.J. Tol (2003), *An Integrated Assessment Model of Economy-Energy-Climate – The Model Wiagem: A Comment*, **FNU-26** (*Integrated Assessment*, **6** (1), 75-82)

Yetkiner, I.H. (2003), *Is There An Indispensable Role For Government During Recovery From An Earthquake? A Theoretical Elaboration*, **FNU-25**

Yetkiner, I.H. (2003), *A Short Note On The Solution Procedure Of Barro And Sala-i-Martin for Restoring Constancy Conditions*, **FNU-24**

Schneider, U.A. and B.A. McCarl (2003), *Measuring Abatement Potentials When Multiple Change is Present: The Case of Greenhouse Gas Mitigation in U.S. Agriculture and Forestry*, **FNU-23** (submitted)

Zhou, Y. and Tol, R.S.J. (2003), *The Implications of Desalination to Water Resources in China - an Economic Perspective*, **FNU-22** (*Desalination*, **163** (4), 225-240)

Yetkiner, I.H., de Vaal, A., and van Zon, A. (2003), *The Cyclical Advancement of Drastic Technologies*, **FNU-21**

Rehdanz, K. and Maddison, D. (2003) *Climate and Happiness*, **FNU-20** (*Ecological Economics*, **52** 111-125)

Tol, R.S.J., (2003), *The Marginal Costs of Carbon Dioxide Emissions: An Assessment of the Uncertainties*, **FNU-19** (*Energy Policy*, **33** (16), 2064-2074).

Lee, H.C., B.A. McCarl, U.A. Schneider, and C.C. Chen (2003), *Leakage and Comparative Advantage Implications of Agricultural Participation in Greenhouse Gas Emission Mitigation*, **FNU-18** (submitted).

Schneider, U.A. and B.A. McCarl (2003), *Implications of a Carbon Based Energy Tax for U.S. Agriculture*, **FNU-17** (submitted).

Tol, R.S.J. (2002), *Climate, Development, and Malaria: An Application of* FUND, **FNU-16** (forthcoming, *Climatic Change*).

Hamilton, J.M. (2003), *Climate and the Destination Choice of German Tourists*, **FNU-15** (revised and submitted).

Tol, R.S.J. (2002), *Technology Protocols for Climate Change: An Application of* FUND, **FNU-14** (*Climate Policy*, **4**, 269-287).

Rehdanz, K (2002), *Hedonic Pricing of Climate Change Impacts to Households in Great Britain*, **FNU-13** (*Climatic Change* **74**).

Tol, R.S.J. (2002), *Emission Abatement Versus Development As Strategies To Reduce Vulnerability To Climate Change: An Application Of* FUND, **FNU-12** (forthcoming, *Environment and Development Economics*).

Rehdanz, K. and Tol, R.S.J. (2002), *On National and International Trade in Greenhouse Gas Emission Permits*, **FNU-11** (*Ecological Economics*, **54**, 397-416).

Fankhauser, S. and Tol, R.S.J. (2001), *On Climate Change and Growth*, **FNU-10** (*Resource and Energy Economics*, **27**, 1-17).

Tol, R.S.J.and Verheyen, R. (2001), *Liability and Compensation for Climate Change Damages – A Legal and Economic Assessment*, **FNU-9** (*Energy Policy*, **32** (9), 1109-1130).

Yohe, G. and R.S.J. Tol (2001), *Indicators for Social and Economic Coping Capacity – Moving Toward a Working Definition of Adaptive Capacity*, **FNU-8** (*Global Environmental Change*, **12** (1), 25-40).

Kemfert, C., W. Lise and R.S.J. Tol (2001), *Games of Climate Change with International Trade*, **FNU-7** (*Environmental and Resource Economics*, **28**, 209-232).

Tol, R.S.J., W. Lise, B. Morel and B.C.C. van der Zwaan (2001), *Technology Development and Diffusion and Incentives to Abate Greenhouse Gas Emissions*, **FNU-6** (submitted).

Kemfert, C. and R.S.J. Tol (2001), *Equity, International Trade and Climate Policy*, **FNU-5** (*International Environmental Agreements*, **2**, 23-48).

Tol, R.S.J., Downing T.E., Fankhauser S., Richels R.G. and Smith J.B. (2001), *Progress in Estimating the Marginal Costs of Greenhouse Gas Emissions*, **FNU-4**. (*Pollution Atmosphérique – Numéro Spécial: Combien Vaut l'Air Propre?*, 155-179).

Tol, R.S.J. (2000), *How Large is the Uncertainty about Climate Change?*, **FNU-3** (*Climatic Change*, **56** (3), 265-289).

Tol, R.S.J., S. Fankhauser, R.G. Richels and J.B. Smith (2000), *How Much Damage Will Climate Change Do? Recent Estimates*, **FNU-2** (*World Economics*, **1** (4), 179-206)

Lise, W. and R.S.J. Tol (2000), *Impact of Climate on Tourism Demand*, **FNU-1** (*Climatic Change*, **55**