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CONSUMERS' LIFESTYLES AND POLLUTANT EMISSIONS

SUMMARY FINAL REPORT

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I. OBJECTIVES

Environmental quality has become a major political issue in the European Union within the last two decades and an important preoccupation of its citizens as well. Also the responsibility of each citizen for the environmental quality is often stressed and the impact of consumers' behaviour on the environment emphasised. Thus the Fifth Environment Action Programme of the European Union "Towards Sustainability" addresses the importance of the patterns of consumption and production for environmental quality and the achievement of a sustainable development path. In the global warming debate too the need for changes in lifestyles is often mentioned. However, the discourses about lifestyle usually stay at the conceptual level or at best include piecemeal quantitative evidence. Therefore the research project "Consumers' Lifestyles and Pollutant Emissions" aimed at an integrated approach to investigate households' patterns of consumption and their impact on the environment in the field of energy and airborne emissions. Hence energy and emissions are analysed in a consumer perspective, yet the scope is not restricted on the energy consumption and the emissions directly caused by households, but includes also the indirect energy use and emissions occurring during the production of the consumed goods and services.

In order to remain not only at the conceptual level, household sample data have to be analysed covering the different fields of environmentally relevant household behaviour. Therefore, in addition to the direct energy use by households, the factors influencing household equipment and other household expenditures have also to be investigated. Furthermore, the relationships between household consumption and the total energy and emissions occurring during their production have to be analysed. Investigations are carried out for the countries of origin of the three contractors, being Germany, France and The Netherlands in order to facilitate the acquisition and interpretation of the data.
These empirical investigations should provide a general improved understanding of the behaviour-environment links and factors influencing this behaviour. The implementation of the established relationships in a set of computer models provides the possibility to assess scenarios of future developments. By composing and evaluating scenario projections, the environmental implications of different societal and political choices can be explored.

II. METHODOLOGY

As an analytical framework for analysing the links between lifestyles and energy consumption as well as airborne emissions a model has been developed. Distinct model parts deal with developments in the socio-economic-cultural sphere and their impact on household frequencies and characteristics model (model part (1)), the equipment of households with energy consuming devices (appliances, cars and dwellings, model part (2)), the direct energy use of households (electricity, motor fuel and stationary fuel consumption, model part (3)) and the remainder of household expenditures (model part (4)). Whereas direct emissions of households are evaluated by means of emission factors (model part (5)), the environmental effects both of energy supply and production of non-energetic goods are determined via an Input-Output (model) (part (6)).

The research focused on factors related to longer term structural changes in society and having an impact on the volume and composition of consumption patterns. This could be termed the long-term lifestyle, i. e. in the context of this study lifestyles are understood as the patterns of equipment ownership, expenditures and energy use of households. Similar to most lifestyle concepts in sociological research, lifestyles are perceived as dependent variables, of which influencing factors are investigated. Contrary to approaches often found in marketing research no lifestyle groups have been identified since earlier attempts in this direction provided no satisfactory results. Rather, households have been differentiated by household types according to their position in the lifecycle (young singles, young couples, middle-aged families etc.) in order to account for the impact of the position in the lifecycle on household consumption. Additionally, the influence of socio-economic household characteristics such as income, education level, type and number of employment, and size of municipality is investigated.

For the empirical investigations, data sets from the household surveys conducted by the national statistical offices - Statistisches Bundesamt in Germany, Centraal Bureau voor de Statistiek (CBS) in the Netherlands and Institut National de la Statistique et des Etudes Economiques (INSEE) in France - have been employed. Although all surveys cover a wide range of energy and emission relevant patterns of household consumption some items are not available for all countries. For example, in the Dutch survey the floor space of the dwelling is not recorded, whereas in the French data set information on domestic energy consumption is mostly given in monetary units only. Due to the differences in available data, in several points of the analysis country specific approaches had to be chosen. A further difficulty arose from the fact that in Germany and France large household surveys are not

conducted every year but only every five years respectively in irregular intervals. Therefore no common year of analysis could be retained. Also, these surveys do not cover possible motivational or cognitive factors.

The influence of socio-economic household characteristics on environmentally relevant behaviour has been analysed by means of regression models. Thereby for the equipment with appliances and cars, regression models with qualitative dependent variables, so-called discrete choice models have been employed. Households' dwelling choice has been analysed as far as the important parameter dwelling size is concerned using linear regression models. For the direct energy use of households, the simultaneous influence of equipment and socio-economic factors has been captured by defining utilisation intensities, measuring the degree of utilisation of the given equipment. The influence of socio-economic characteristics on appliance and car use as well as space heating was then analysed on behalf of regression models for these utilisation intensities. Furthermore, expenditure patterns of households were analysed using a two-stage budgeting approach. Besides the analysis of socio-economic factors based on cross-section data, on the basis of time-series data price effects have also been evaluated.

In order to determine the overall environmental impact of these aspects of household behaviour, the emissions resulting from the production of both energy carriers and other goods delivered to households have to be investigated. Thereby an Input-Output approach was adopted. However the accuracy of the results was considerably improved by using a mixed monetary-energetic Input-Output model for a refined treatment of energy deliveries and energy sectors. Furthermore a detailed treatment of transport requirements and the corresponding emissions has been developed.

Based on these empirical results two families of computer models have been elaborated. On the one hand the lifestyle-oriented energy, economy, environment models ELSA and E^3life, focusing on detailed representations of household behaviour and their energy and emission implications. On the other hand the structural economy-environment simulation models SEESM emphasising dynamic aspects based on a system dynamics approach and particularly designed for long-term investigations. In addition to changes in consumer activities induced by changes in economic, social and cultural scenario variables the models include also the effects of technological changes. Therefore, energy efficiencies of distinct energy applications at home and in cars are included as well as energy efficiency improvements and emission factor changes in the productive system.

III. MAIN RESULTS

This research project has provided a deepened comprehension of the behaviour-environment links in the fields of energy consumption and airborne emissions. Through the empirical investigation of the different aspects of environmental relevant behaviour, large amounts of quantitative and qualitative information on the factors influencing environmental behaviour have been obtained.

For appliance ownership, the explanatory power of the various factors was found to vary considerably according to the appliances considered, e. g. dish washer ownership is most strongly influenced by household income. For many of the other appliances household size has the largest impact. As regards freezer ownership, the dwelling type and the size of the municipality are however even more important. For different appliances the considered variables explain different shares of the observed variance. Whereas washing machine and dish washer ownership were well explained by the socio-economic factors included in this research, for tumbler and multiple TV ownership explanation was far less satisfactory. Here the inclusion of attitudinal factors may lead to considerable improvements. For car ownership and dwelling size, income turns out to have the largest impact, followed by household size. In both cases the degree of explanation is rather good. However that does not apply to multiple car ownership. Thus, for the explanation of ownership of more luxury equipment, motivational and cognitive factors seem to be of more importance than for standard equipment.

For the use of the electric equipment, household size turned out to be by far the most important factor, the same holds true for tap water use. Space heating, by contrast, appeared to be influenced only to a small degree by socio-economic household characteristics. A major finding in this field was, that the insulation standards issued in the past have been probably far less effective than presumed. Further research should clarify whether this is due to lack of control in the application of the standards or whether changes in tenants' behaviour occur in the better insulated buildings. Car use turned out to be influenced mostly by income although there the degree of explanation was not very satisfactory. This was however partly due to restrictions of the data bases used which mostly contained only motor fuel expenditures and no mileages.

For household expenditures a wide range of influences has been identified, with important differences between household groups. Prices on which traditional economic theory is often focusing thereby turned out to exert only a limited influence.

The backtracking of the energy and emission consequences of the consumed goods showed that more than 50 % of the total energy consumption induced by household consumption are related to direct household energy use.

The same holds for the emissions of CO_2 (see) and NO_x, whereby in the case of NO_x the most important fraction is stemming from private car use.

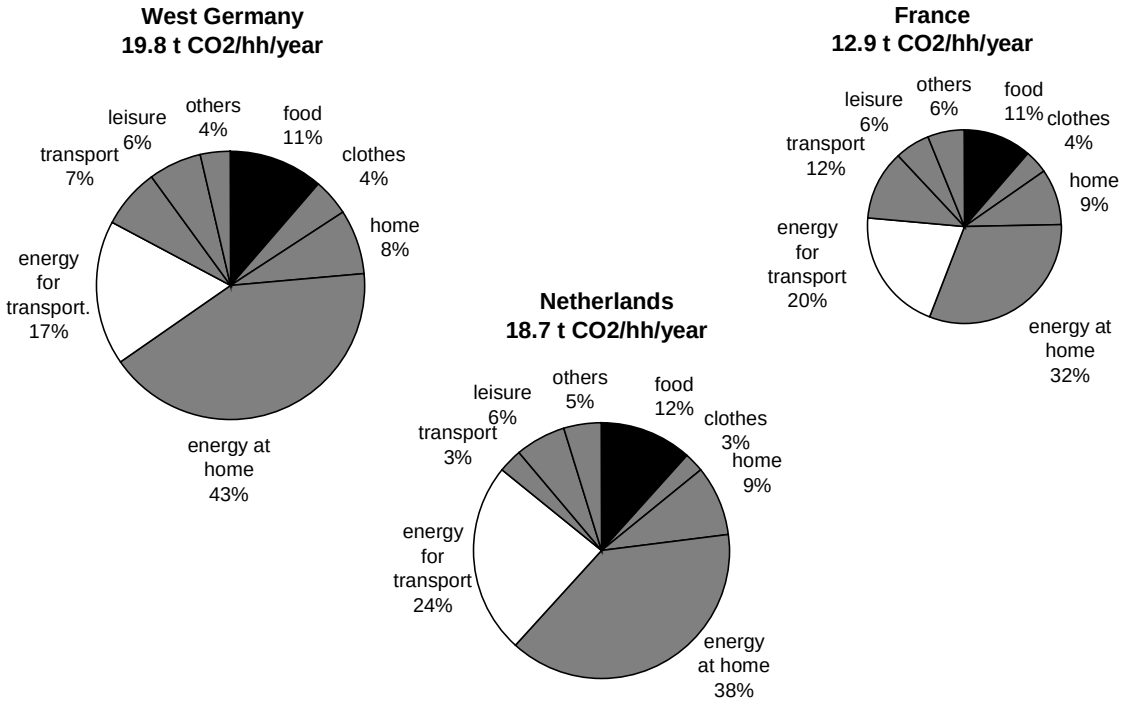

Fig. 1: Comparison of total CO_2 emissions per household for France, Western Germany and The Netherlands in 1990

For CO_2 important differences appear between countries as indicated in Fig. 2. Particularly the absolute level of emissions per household is considerably lower in France then in Germany and The Netherlands. This is partly due to climatic differences, degree-days in France are on average 25 % lower than in Germany and The Netherlands and correspondingly energy use for space heating both in households and in the production sectors is lower. Therefore also the share of *energy at home* is considerably lower in France than in the two other countries. The major part of the difference has however to be attributed to the largely fossil-free electricity generation in France and the higher share of electricity in final energy use of households and production sectors. Besides these international differences, important differences within one country may be observed between different household types. Here not only the absolute figures differ among household groups by almost a factor three, but also the shares of the various contributions: e.g. young singles have on average higher CO_2 emissions due to private transportation than middle-aged singles although their overall CO_2 emissions are lower.

On the basis of the emission profiles of different household types, it was possible to determine to what extent the various household types are affected by an energy and/or CO_2 tax. By and large it holds, that a household will be more affected by an energy or CO_2 tax if its energy or emission intensity per unit of expenditure is higher. However, it was found that the relative CO_2 and energy intensities of the different household groups vary notably according to the country considered. This is at least partly attributable to differences in the income transfer and social security systems of the countries in question.

A decomposition of causes of emission changes in the past revealed that the important emission reduction observed for SO_2 has been mainly achieved through implementation of technical measures. For $NO_{x,}$ emission reduction techniques have not been similarly effective during the analysed period (1978 to 1990) since the implementation of catalytic converters for automobiles and denitrification of power plants has started later. For CO_2 only small emission decreases have been observed, which have been achieved through fuel switches and improvements of energy efficiency. Remarkably, for all the emissions considered, the changes in the industrial production structure had - on balance - almost no effect on the emission levels. The impact of private consumption, however, is clearly contributing to an increase in emissions, except for the time period from 1978 to 1982 which included the second oil price shock and the subsequent recession.

In order to explore the implications of the empirical relationships established so far with respect to future emission developments, four scenarios have been composed reflecting different visions of future societal developments:

I "Stagnation" (Tendencial Bleak);
II "Business As Usual" (Tendencial Rosy);
III "Sustainability through Technological Breakthrough";
IV "Sustainability through Reflective Consumption".

Thereby a fundamental bifurcation principle has been applied for scenario design turning around the ways in which, and the extent to which, environmental quality and nature conservation ideals of "sustainability" are envisaged to achieve real standing relative to concerns of competitivity. The tendencial scenarios give *de facto* weight to economic liberalisation at the expense of social and environmental ideals of sustainability and justice. In the sustainability oriented scenarios, there are two quite different pictures: in scenario IV, ideals of increase in commodity consumption are moderated or abandoned in favour of environmental quality and social solidarity goals; in the scenario III the technological optimism strikes to achieve output growth and environmental quality and safety simultaneously.

The four scenarios showed a wide range of possible emission developments in the future. Thereby for classical airborne emissions such as $NO_{x,}$ future emission reductions are obtained in all scenarios, although at differing degrees. For CO_2 however, the range of possible outcomes is far larger, varying from an emission reduction by more than 20 % for the sustainability oriented scenarios in Germany to an increase by almost 20 % for the tendencial scenarios in The Netherlands. The results depend strongly on the development of lifestyles and consumption patterns in the scenarios but also on the assumptions on technological improvements. Here data from various national studies have been used, since research within this field was beyond the scope of this research. The comparability of these data must however remain subject to caution. Another limitation of the studies undertaken so far is that only three European countries, Germany, The Netherlands and France have been investigated. These were found to show important national specificities and therefore an extrapolation to the whole EU was not undertaken. However by an extension to further Member States, a tool could be provided for a common analysis of environmental policies at the EU level. The approach could also be extended beyond airborne emissions to cover other environmental effects such as wastes and sewage.

IV. SCIENTIFIC INTEREST AND POLICY RELEVANCE

a. Scientific interest and novelty

Although various aspects of the behaviour-environment links have been investigated before, the approach developed in the present research provided for the first time a comprehensive methodology to determine the impact of household behaviour, and in particular consumption patterns, on environmental degradation. For the factors influencing environmentally relevant behaviour, a wide range have been covered and applied to the different fields of household behaviour connected to airborne emissions, namely household equipment, household direct energy use and household expenditures - detailed by categories in each case. From a scientific point of view particularly the variety of the observed influencing patterns is of particular interest. So far however motivational and cognitive factors could not be included as explanatory factors, given the data base used - this issue should be addressed in future research.

The computation of the overall energy and emission impact by means of an Input-Output model is a commonly employed procedure. However, the developed extensions of the Input-Output model by relating emission coefficients to energy use and by a detailed modelling of the transport requirements improved considerably both the accuracy and the analytical capabilities of the model. The application to the computation of energy and emission profiles as well as the distributive impacts of a CO_2 and/or energy tax were a feature of this research.

A point of interest, which arose during the project work, would be a detailed treatment of the energy and emissions embodied in transboundary commodity flows. However, a consistent and extensive treatment of imports and exports between European countries in an Input-Output framework was beyond the scope of the current project. This issue should be addressed in future research.

b. Policy relevance

Although the research was in the first place designed to improve the general understanding of interconnections of household behaviour and pollutant emissions, its results are also of interest for policy making processes. The analysis of all emissions in a consumer and citizen perspective provides a possibility for policy making to deal with "Sustainable Development" by having a "Customer orientation". The determined energy and emission profiles and influencing factors give an easily interpretable image of the energy and emission consequences of consumer behaviour and thus contribute to an increased transparency of complex economic and ecological interconnections. This could be used in the future in the context of information campaigns to raise the environmental

awareness of the general public, e. g. in the form of a multi-media tool which shows both general environmental implications of consumer behaviour and concrete possibilities for modifying individual conduct.

It also enables public agencies to develop policies that create favourable conditions for sustainable consumption patterns, e. g. in the context of spatial and transport policies.

The evaluation of the distributive aspects of CO_2 and/or energy taxes on households by considering not only the direct but also the indirect emissions of households has provided no unequivocal results. The household groups most seriously affected by the tax vary for the different countries analysed, and the differences between household groups are not that important. Therefore according to the results of the study the distributive effects have not to be considered as main obstacle for the implementation of a moderate CO_2 and/or energy tax.

Another application which has been pursued within this research was the elaboration of a set of simulation tools to evaluate scenarios of possible future emission developments. The lifestyle-oriented energy, economy and emission models ELSA and E^3life respectively can be used to make micro-analytically and empirically founded projections of future evolutions of behaviour-environment links. The scenarios analysed within this research showed that a wide range of evolution is possible in the future depending on political, economic and societal choices. Not surprisingly CO_2 emission reduction is far more difficult to achieve for France with currently low CO_2 emissions per capita than for Germany with important substitution possibilities for coal. But according to the results also in The Netherlands, emission abatement is more difficult to realise, although the current emission level per capita is comparable to the German one. Here further investigations are necessary to determine whether this is mainly due to inevitable differences in the appreciation of possible technical improvements or whether other reasons have to be invoked.