Households activities and sustainability
- possible uses of potential data -

Ingvar Nilsson & Anders Wadeskog[1]
1998-05-15

THIS PAPER WAS PREPARED FOR EC ENVIRONMENT AND CLIMATE RESEARCH PROGRAMME (1994-1998): RESEARCH THEME 4 - HUMAN DIMENSIONS OF ENVIRONMENTAL CHANGE. PROJECT:

ENVIRONMENTAL FISCAL REFORM **(ENV4-CT 96-0228)**

DRAFT

I Introduction

The Environmental Fiscal Reforms (EFR) project looks at different distributional aspects of trying to influence the economies (primarily) of the European Union in a more sustainable direction by means of different fiscal measures. It is customary to look at the effects on households by estimating the effects on the expenditures and incomes of different household groups.

From a distributional perspective, this is probably a sufficient analysis. But looking at the linkages between the household and the environmental effects of the household, a broader view of the household would be desirable.

The household is not only a consuming unit, it performs activities that can be more or less environmentally sound. In the debate on the role of the household or the consumer in the development of a more sustainable society, the discussion often revolves around a notion of a sustainable life style. There is often an underlying assumption that there is **one** desirable, in a sense optimal, sustainable life style. In the past it has often been the domain of future researchers to come up with different ecologically sound innovative techniques to handle energy supply, transports, etc. Very seldom has this been coupled to any deeper understanding or interest in what households actually do, i.e. how they make ends meet and organise every day life. Without this knowledge it is hard to say anything about the feasibility of the proposed solutions, assuming that they are not all introduced by command. Voluntary measures, as is often implied when discussing changes in life styles, will have to work and maybe also be seen as preferable in the context of every day life.

1) Institute for SocioEcological Economics, Sweden

From a macro point of view the household sector contributes substantially to some environmental problems through their purchases and use of different goods and services. Based on the energy accounts and the input-outputtables of the national accounts, the Swedish Environmental Account gives the following distribution of the emissions of CO_2, SO_2 and NO_x for 1989, 1991 and 1993.

Table 1 Sectors and emissions

Sector	Year	CO_2	SO_2	NO_x
Industry	1989	72	89	72
	1991	74	91	73
	1993	73	93	74
Public Sector	1989	4	3	1
	1991	3	2	1
	1993	4	1	1
Private Consumption	1989	25	8	27
	1991	23	8	27
	1993	23	6	26

Apparently the household sector, primarily through private transportation, account for a large share of CO_2- and NO_x-emissions. From a policy point of view this is interesting and can lead to ideas on changes in fuel taxation etc.

II Purpose of the paper

Although much data is collected on energy consumption, emissions and waste, and sometimes also on a household level, this hasso far been in a more or less ad hoc fashion and, when done through household surveys, usually from a specific perspective, i.e by highlighting for instance the electricity use of households in rented apartments, where other energy uses or the activities of the surveyed household are not studied.

It is most likely necessary for the understanding of the role of the household in the move towards a sustainable future that we have access to data that makes it possible to paint an overall picture of what the household do and the potential environmental effects of this. The presentation is mainly in the data sets and the links between these that can be of interest in thois context.

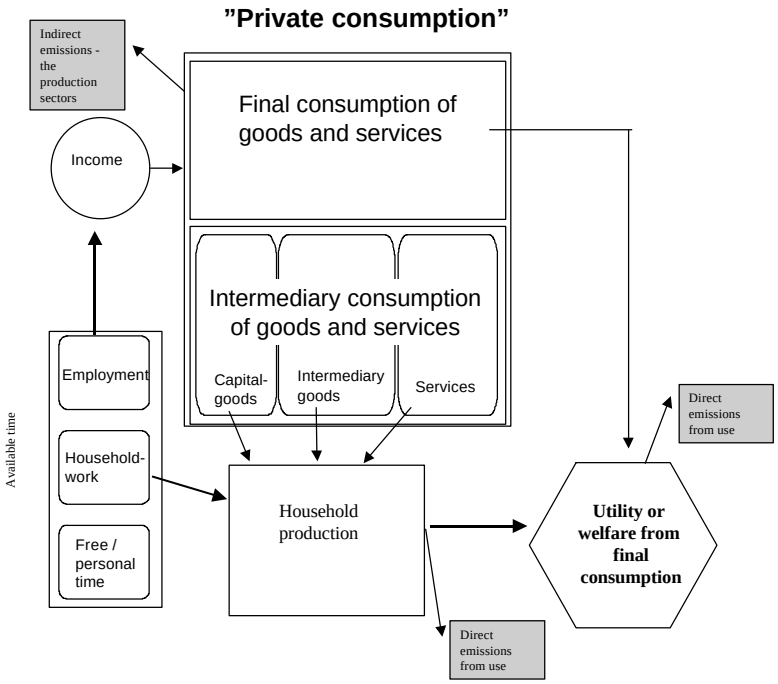
In doing this the perspective will be one of the household as an active entity that makes a multitude of decisions that, taken together, impact the economy and the environment. The partial analysis of aggregate consumption patterns approach is not sufficient.

Starting from one of the most common household surveys - the Household Budget Survey - we will sketch a picture of what kind of relationsships it would be possible to study in the household part of the economy. Some of it will be wishful thinking while other parts will be more feasible in the context of the surveys as they are usually carried out today. Some of the data will be on a household level while other will be groupaverages, over all averages and guesstimates.

III A perspective on the active household

Using an activity perspective of the household the following picture can be used to illustrate the basic reasoning.

Diagram 1 The household model



The simple idea is that, from a household point of view, every day life forces the household to juggle the resources at their disposal. One of the key resources at the disposal of the household is time. The members of the household can allocate their 24 hours a day in many ways and this will affect the situation for the household. For most households, much of the time available appears committed in one way or another. The decision to have children, get a dog, taking a course or to take on a certain job, brings with it restrictions on future time use. Decisions at one point in time certainly can place restrictions on the use of time later. We will disregard this dynamic side to the picture – we assume that the allocation of time within the household illustrate its possible trade offs and preferences among the possible choices facing them today[2].

2) In Gary Beckers terminology they strive to equalize the utility of each unit of time used. Time, together with inputs of goods and services purchased in the market, is used to produce the commodities that enter the utility function time Maximizing the use of time spent in producing a cretain commodity gives the following marginal condition: $U_i = \frac{dU}{dZ_i} = \lambda (p_i b_i + t_i \overline{w})$, where Z is the commodity produced by inputs b and time t - p and $\overline{w}$ are the prices of inputs and the alternative price of time.

Each member of the houshold then has the option to use his/her time on different activities[3]. In the picture these alternative uses have been aggregated to three – to work for a salary, to spend time in houshold work or to spend time on personal or free time activities.

The wage work category is not problematic, but the distinction between what is household work and free/personal time is probably not as apparant. The most commonly used criteria for deciding how to distinguish between what could be labeled “work” as opposed to “non-work” use of time is the so called Third Person Criteria, originating from Margret Reid[4].

> "If any activity is of such character that it might be delegated to a paid worker, then that activity shall be deemed productive"[5]

The simple idea behind this is that when we perform an activity that we could possibly conceive of paying someone else to perform for us we are in fact doing productive work. We can pay someone else to babysit, wash the car, do the dishes and walk the dog. We cannot pay someone else to eat, sleep or take a shower for us.

Given that activities performed in and around the household can be classified as productive avtivities, i.e comparable to the work we do as employed, these activities should ideally also be studied in terms of their environmental effects. There are few, if any, studies that focus on home production in terms of its environmental effects.[6]

The amount of production performed in the household sector, i.e by all households, can be compared to the amount performed in the formal economy by salaried workers. As household production is not paid, the comparison can mainly be made in terms of hours worked in the different sectors, although we will come back to the value of household production. The following diagram illustrates the number of hours worked in 1990/91 for various market and nonmarket sectors/activities, for men and women. Domestic work, i.e cooking, cleaning, washing etc uses around 40% more hours of working time than the service sector. The households time used for purchasing goods and services is comparable with the time used in the wholesale and retail sectors.

---

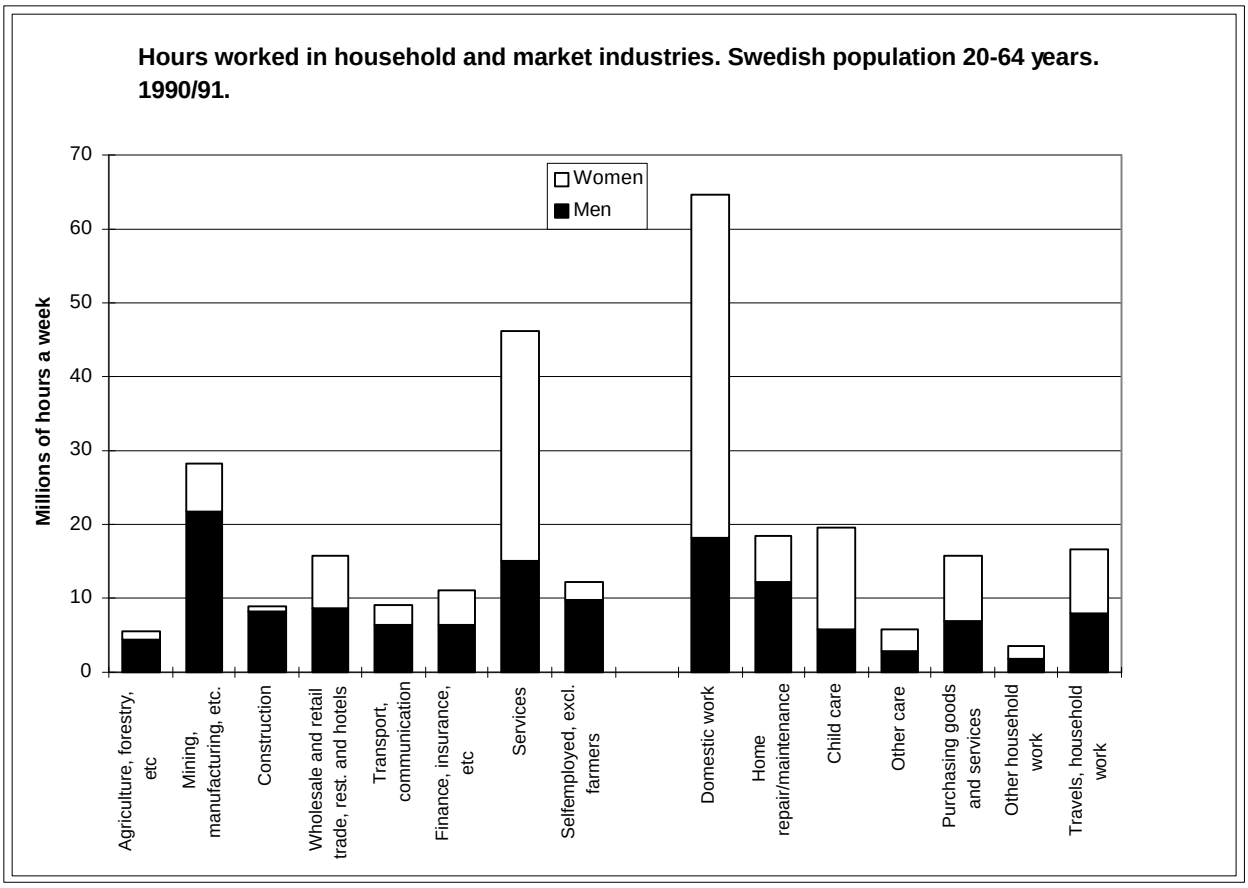
3) This of course depends on the assumptions made about the division of labour within the household and the rules governing this division of labour. In Beckers analysis the allocation decisions are made by an altruistic male.

4) Reid, M "Economics of household production", New York, 1934

5) Quoted in Goldschmidt-Clermont "Unpaid work in the household", ILO, 1982

6) There are a lot of sectoral studies that include households, either as an aggregate or in different groupings. But these do not analyse the environmental effects of the household in the framework of the organisation of every day life. Most often they group the households according to income, type of dwelling, access to car etc.

Chart 1 Hours worked in households and market



That much production, regardless of how we value it, will of course have an environmental impact just as the formal production of the same goods and service do. As an example we can equalise the energy use per hour worked between home production and industrial production. This would produce the following comparisons, which really does nothing more than once again sets the hours worked in household production (in Sweden 1990/91) against to hours worked in industry in Sweden for 1993.[7]

7) Note that the figures calculated for private consumption in the environmental accounts are about $1/5^{th}$ of CO_2 figure presented here and less for the others.

Table 2 Hypothetical emission

	CO_2	SO_2	NO_x
Average emissions in industry in kg/Hour	10	0.031	0.065
Industry emissions/Year	47 million Ton	144000 Ton	299000 Ton
Emissions from Household production/Year	68 million Ton	217000 Ton	448000 Ton

These figures does not say anything about the real emissions. They do however raise an interesting question concerning the relationship between household production and industrial production in terms of environmental effects. What is the environmental pressure generated in household production? Following this line of reasoning – are different production processes allocated in the environmentally most efficient way?

We have no way of answering these questions today. The data available do not enable us to analyse and answer them. That is the problem at hand. In the rest of this paper we will try to outline what a statistical system that could answer these questions would look like? What are the important variables and relationships that we would need to study?

The key to this kind of analysis is the statistics and analytical view on household production in itself. With this at hand one can use available and potential data on the relevant environmental linkages for the relevant household activities to get a better view of what households do in terms of the environment and hopefully a better understanding of how different policy instrument can be put to effective use.

IV Household activities

In order to establish this type of analysis of the household a few central variables have to be covered.

- Information on the use of time for all household members, i.e. what activities they engage in and when during the 24 hours of the day.

- Information on expenditures of all kinds, at a level that makes it possible to trace the product/service in enough detail to make different environmental classifications possible.

- Information on the level and different sources of income for the household

- Relevant background information on the household and all its members as well as type of dwelling, access to cars, summer home, boats and other capital equipment that may be seen as relevant from a household production or an environmental point of view. -

  Information or indicators on what and how much of different goods and services the household produces on its own.

- Information on the emission coefficients of different goods and services the household may purchase.

This may look like an impossible list of requirements. Some of the elements are obviously harder than others, mainly the output from household production, while others are already collected in household expenditure and time use surveys as well as income surveys and social surveys. The environmental data is compiled in different statistics and accounts and can be made useful for analyses of the household. Expenditure surveys are more or less mandatory in the official statistical systems while time use surveys are more ad hoc in many countries.

In the following, we will go through the data required and the linkages between the different component that are desirable in order to get a view of the activities of the household and its environmental effects. It is a genuine microperspective in the sense that we assume that the data can be collected on a household level and then aggregated up to suitable groups. It is most likely that most of this could be done without actually collecting this data on the household level, i.e using the same sample for all the components. It is well known that this kind of extensive household survey is far from easy to carry out and the expected respons rates not very high.

Most of the analysis and relationships would probably work for more synthetic analysis, i.e marrying surveys and data from different samples. This would give the same kind of linkages on a group level. The downside is of course that the links between the households members, their incomes, expenditures and time use on the micro level will be lost. But this may be most relevant for microsimulation purposes which is not really the main focus here.

In the following discussion on data and the links, we look at it from the view of a single household.

V The data and the links

Time use and expenditures

An expenditure survey is assumed to measure all expenditure for a given household during different time intervals, where the daily expenditures for food, etc are measured on a daily basis for a few weeks and goods and services purchased more infrequently, such as white goods, cars etc., are measured on a yearly basis through retrospective questions. The expenditures are coded and can then be aggregated to a suitable level. The lowest level of classification can vary between surveys, and is often decided by the most influential users requirements. For most countries this is the users at national accounts and price index. For environmental purposes, the level of disaggregation is important in sectors that have a heterogeneous basket of goods/services in terms of environmental effects. A simple example of this is of course in the chemicals sector where different labelling systems attempt at distinguishing between the products.

The data from the expenditure surveys can be summaries in the following expression:

Total expenditures (SEK)

$$TE_{tot} = \sum_{e=1}^{n} E_e$$

E_ε is total expenditure for expenditure category ε, e.g. cloths.

Time use surveys collects data on what the members of the household do during one or several days. This data is often collected by means of 24 Hour diaries where the household member is required to enter what they were doing and with whom they were doing it for every 10- or 15-minute interval of the day. The diary can be completely open, i.e. the respondent uses his/hers own words to describe what they were doing, or closed in terms of having the respondent choosing between a given number of defined activities.

The time use survey will provide the following data.

Total time use (Min/Hours)

$$TA = \sum_{a=1}^{q} A_a$$

With a period of:
1 day -> TA = 24 Hours
1 week -> TA = 168 Hours
etc.....

A_a represents the time a member of the household engage in activity α, e.g. child care or watching the TV. The number of activities in open diaries can range from 100 - 300

Given a list of activities the next step is to single out the activities viewed as productive as opposed to those viewed as non productive. This is to group activities that are a part of household production. This is mostly done according to the third person criteria, as described earlier.

During a week, on average for men and women, almost 27 hours are spent doing unpaid productive work.[8] This work produces meals, repairs, care, cleaning etc and uses energy and causes emissions the same way that the corresponding goods and services in the market does. These hours are simply part of the production process in society.

So separating the productive activities ($a = 1....m$) from the non productive activities $a = m+1 .....q$, we can formulate the following expressions.

"Productive" time use

$$TA_{prod} = \sum_{a=1}^{m} A_a$$

A_a is the time spent by a household member on the m productive activities, where $m<q$.

and

8 According to the swedish time use survey from 1990/91, Rydenstam K *I tid och otid – en undersökning om kvinnors och mäns tidsanvändning 1990/1991*, Levnadsförhållanden, Rapport 79, Statistics Sweden 1992

"Non Productive" time use	$TA_{nonprod} = \sum_{a=m+1}^{q} A_a$ $TA_{nonprod} = TA_{tot} - TA_{prod}$	A_a is the time spent by a household member on the *q-m* non productive activities

Continuing on the theme of productive and non productive activities we would also like to allocate total expenditures over the activities as household production needs inputs other than time. The expenditures that are linked to productive activities would be seen as purchases of intermediary goods and services, i.e. goods and services that go into a further value adding process.

Distribution of Total expenditure (SEK)	$TE^{tot} = TE^{prod} + TE^{nonprod}$	TE^{prod} stands for those expenditures that go to intermediary goods and services and $TE^{nonprod}$ stands for the expenditure on goods and services for final consumption.

Linking activities and expenditures

The process of actually allocating the expenditures according to whether they are to be seen as an intermediaries or for final consumption usually is a mix of calculations as there are no questions in an expenditure survey that focus on what the goods and services purchased are used for - even though this would be an interesting development.

There are basically two general approaches to choose from and one will probably need both of them:

- Allocate according to assumed distribution, e.g all food expenditure except ready made meals can be assumed to go into the cooking activity of the household. It is seen as intermediary consumption.

- Allocate on equal basis over all activities. This could be an allocation of expenditure for heating. This means that activities that have a longer duration gets more of the expenditures. It also means that the classification into productive and non productive time use also decides the classification into intermediate or final consumption.

Given this kind of allocation we can now link the *n* expenditures with the *q* activities. In a sense this can be seen as the equivalent of the goods*bransch-matrix in the input/output tables of the national accounts

Expenditure categories allocated on all activities

$$\begin{Bmatrix} a_{11}E_1 & . & . & . & a_{1m}E_1 \\ . & . & & & . \\ . & & . & & . \\ . & & & . & . \\ a_{n1}E_n & . & . & . & a_{nm}E_n \end{Bmatrix}$$

Where, e.g. $a_{11} = E_1 / A_1$, i.e. the proportion of good/service 1 that is used in activity 1. $a_{11}E_1$ represents the expenditure on good/service 1 that is linked to activity 1

$$TE^{tot} = \sum_{e=1}^{n}\sum_{a=1}^{q} a_{ea}E_e$$

$$E_e^{tot} = \sum_{a=1}^{q} a_{ea}E_e = E_e$$

Expenditure categories on productive activities

$$TE^{prod} = \sum_{e=1}^{n}\sum_{a=1}^{m} a_{ea}E_e$$

$$E_e^{prod} = \sum_{a=1}^{m} a_{ea}E_e$$

where $m<q$

Expenditure categories on non-productive activities

$$TE^{nonprod} = \sum_{e=1}^{n}\sum_{a=m+1}^{q} a_{ea}E_e$$

$$E_e^{nonprod} = \sum_{a=m+1}^{q} a_{ea}E_e$$

Value added in household production

It is now possible to formulate the value added in household production in a similar way to how it is defined in the national accounts. The major difference between household production and market production is of course the lack of market wages for the time input as well as a lack of a market price for the produce of the household.

In principle, the value added in the household should be valued according to the amount of labour and capital inputs.

Total "Value added" over all productive household activities

$$VA0 = \sum_{a=1}^{m} wA_a + r K_a$$

Where r is the interest or return on the capital used in the process and K_α represent the capital stock used in activity α.

It is possible to estimate K_a by inventorying the capital stock of the household and then make depreciation assumptions as well as linking the use of specific capital goods to different activities.[9] The capital/labour ratio in household production is primarily of interest for analysing household production functions. The use of capital in household production is often evaluated using a so called perpeptual inventory model, and although this is a major task in compiling satellite accounts for the household sector we will not go in to it here. We will just assume a simple short term labour value added formulation like this.

Labour based value added

$$VA1 = \sum_{a=1}^{m} wA_a$$

w is an imputed wage. Value added then becomes this imputed wage times the time spent in the activity in question. Summing over all productive activities and households would then give the Gross Household Product.

The imputed wages has been the subject of much controversy in the discussion on valuation of household work - for instance in the form of Satellite Accounts. Much of the analytical underpinning of the various household production models comes from Beckers Time Allocation model where the concept of a shadow wage is important for reaching an efficient allocation of time on household production. In equilibrium the time spent producing something in the household would produce a marginal product which value would equal the market wage for the same time spent working on the market. This is usually translated to using some market wage as a basis for the imputed wage in household production.

This reproduces the income distribution of the market, i.e. the imputed wage of women in general will be lower than that of men. Many see this as a direct route to depreciating the value of household work. It also leads to absurd results in terms of the valuation of household production as such. As long as the output of household production is not valued on the market there is little scope for taking the issue of the shadow wage further. Most recent household production account have converged on using the wage for a non specialist domestic (so called polyvalent) worker to get around the problem - i.e. by using a replacement cost instead of an opportunity cost approach.

But given an imputed wage it is possible to calculate an imputed total cost for the different activities, by adding the imputed wage and the cost for the intermediary goods that enter as inputs into the activity.

Activity or production cost

$$TC_a = wA_a + \sum_{e=1}^{n} a_{ea} E_e$$

The total cost of household production TC_{tot} is the sum of the cost for the different activities TC_a.

9) This approach is found in Fitzgerald J, M Swenson & J Wicks “Valuation of household production at market prices and estimation of productions function”, *Review of Income and Wealth*, Ser 42, No 2, 1996.

$\alpha = 1 \ldots\ldots m$

$$TC_{tot} = \sum_{a=1}^{m} TC_a$$

Household production - an example

As one example of what the above can look like in figures, the following table is from Statistics Sweden where a simple Household Satellite Account was calculated using the 1990/91 time use survey and the 1988 Household Budget Survey [10].

10 Statistics Sweden, *A Statistical System on Household Production and Consumption* paper prepared for the joint ECE/INSTRAW Work Session on Statistics of Women, Geneva, March 1995. The table is constructed as an fictitious input-output matrix. Thsi approach has been used in several studies and the inspiration for this approach is Duncan Ironmonger, Cf *National Time Accounts: A Focus for International Comparison, Modelling and Methodology* paper presented at the 14th Annual Meeting of the International Association for Time Use Research, Rome, June 1992 eller Ironmonger D (ed), *Households Work*, Sydney 1989.

There are many similar accounts Cf Jackson C *Trends in the Value of Household Work in Canada, 1961-1986* paper presented at the annual meeting of the Canadian Economics Association, Carleton University, Ottawa, June 1993; Australian Bureau of Statistics, *Unpaid Work and the Australian Economy*, Occasional Paper, Cat. No.5240.0, September 1994; Bureau of Economic Analysis, *Measuring Nonmarket Economic Activity*, BEA Working Papers, U.S. Department of Commerce, 1982; Chadeau A, *What is Households' Non-Market Production Worth?* OECD Economic Studies, No.18, Spring 1992; Chadeau A & C Roy "Relating Households' Final Consumption to Household Activities: Substitutability or Complementarity Between Market and Non-Market Production," *Review of Income and Wealth*, Series 32, No.4, December 1986.

Table 3 Input-Output household production measure for Sweden

Mill SEK	Cooking	Cleaning/ Washing	Mainte-nance	Shopping	Child care	Gardening	Other	Transport		Inputs	Con-sumption	Tot exp	Input % of Tot
Food	93700	0	0	0	0	0	0	0		93700	0	93700	100%
Kitchen equip	4770	490	130	0	0	130	0	0		5520	0	5520	100%
Cleaning/Wash equip	0	1500	0	0	0	0	0	0		1500	0	1500	100%
Energy	850	600	190	0	470	0	430	0		2540	12350	14890	17%
Transport	0	0	40	0	0	0	0	26610		26650	51210	77860	34%
Clothing/Shoes	2020	1430	450	890	1100	270	1030	940		8130	26570	34700	23%
Furniture	660	460	150	0	490	0	330	0		2090	12260	14350	15%
Household articles	5870	4170	10120	180	3210	770	2990	190		27500	85840	113340	24%
Personal equipm	80	2790	20	30	660	10	40	40		3670	21490	25160	15%
Services	320	320	320	320	3230	320	320	320		5470	4080	9550	57%
Misc	580	430	540	300	2330	940	310	3840		9270	78330	87600	11%
Sum inputs	108850	12190	11960	1720	11490	2440	5450	31940		186040	292130	478170	39%
Value added	119630	84910	26600	52990	65310	15750	60970	55510		481670			
Production cost	228480	97100	38560	54710	76800	18190	66420	87450		667710			
Labour input/Productio	52%	87%	69%	97%	85%	87%	92%	63%		72%			
Labour cost	119630	84910	26600	52990	65310	15750	60970	55510					
(Wage = 70 SEK/Hour)													
Time input (Mill Hours)	1709	1213	380	757	933	225	871	793					
Men	505	298	325	324	271	127	409	383					
Women	1204	915	55	433	662	98	462	410					

The larger grey area shows the allocation of expenditure over activities– i.e. $a_{ea}E_e$ above. On the right we have a sum for the expenditures on inputs - E_e^{prod} -as well as the total expenditure for this category, "Tot exp" - E_e above[11]. The difference between them is the consumption part of the total expenditures - $E_e^{nonprod}$. Summing over all expenditure categories we see that 39% of what we usually refer to as private consumption can be seen as inputs into the value adding process in the household - TE^{prod}. It is the result of this value adding process that should be added to the 61% of total expenditure to give a more correct picture of total private consumption.

The lower grey area displays the allocation of time for men and women over the productive activities -A_a.

The row "Production cost" equals TC_a from above and the row "Value Added" is wA_a. The relationship between wA_a and TC_a can be seen as a measure of labour intensity. This ratio is in the row below the production cost.

The imputed wage is of course essential in the calculations. The wage used in the example above is that of a municipal house-keeper or aid that perform all sorts of tasks in the household - mainly for the elderly. For the years in question this wage was appr 70 SEK per hour.[12] This

11 It is worth noting that this total expenditure is not equal to the Total Private Consumption in the national accounts. For different reasons the two do not match. The Household Budget Surveys are, on average, 30% lower than the national accounts figures for the same expenditure groups. Cf EUROSTAT *Task force on the use of household budget surveys for national accounts*, Final report, September 1996

12 For a further discussion on the relevant wage Cf Goldschmidt-Clermont L "Monetary Valuation of Non-market Productive Time: Methodological Considerations," *Review of Income and Wealth*, Series 39, No.4, December 1993; Gronau R, "The Intrafamily Allocation of Time: The Value of Housewives Time," *American Economic Review*, Vol.63, No.4, September 1973; Heckman J, "Shadow Prices, Market Wages and Labor Supply," *Econometrica*, Vol.42, No.4, July 1974.,

wage has then simply been multiplied with the number of hours that men and women spend cooking, cleaning etc.

Summing up the value added we arrive at a figure of 480 Billion SEK that represents the contribution of the household sector to Swedish economy around 1990. As a comparison, GDP was 1300 Billion SEK in 1990, which means that the household sector produced a value of 37% of that of the formal economy. Comparing single activities, the active child care produced in the household accounted for 2/3 of the value spent in Sweden on, mostly municipal, day-care.

Activities and outputs

The picture given above of the household and its productive activities suffers from one serious drawback in terms of getting it comparable to the national accounts and to environmental indicators that are linked to economic activities and processes. We do not have market valuations of neither the input nor the output of household production. So although we can impute values on the input side, we can not really say anything about what comes out of the process. In fact, apart from maybe a few exceptions, the activities we describe above are not unique in ways that makes it possible to find market equivalents and use these for imputing values to the output. Activities such as cooking, cleaning, repairing, gardening etc are really sets of activities. Cooking for instance can be one of several types of breakfasts, dinners etc for varying number of eaters.

It is worth noting that there are few examples of data on the amout of goods and services produced by the households. The data that does exist come from single projects with limited sampled and based on various techniques. It is apparently possible to get this kind of data. It is however not apparent that it is possible to do this within the framework of an existing time use survey or a couples time use/expenditure survey.

Let us assume that it is possible to specify the different goods and services– g - that comes out of the activities A_a. Every activity can produce several market equivalent goods and services - $g^1 ..... g^r$. A certain good/service can be produced in different activities - as a coffee and a sandwich at home (cooking) or at the gas station when filling up the car (maintenance) or on the way to work (transportation). The number of goods/services we attach to a certain activity would depend on the level of disaggregation in the number of activities. The fewer the activities the more goods/services this activity produces.

There are r different goods/services categories indexed by γ. Ideally these categories should translate into the expenditure categories from the Household Budget Surveys or the private consumption by purpose categories of the national accounts. This would make it possible to produce an output matrix that is akin to the sector*commodity output matrix of the national accounts, but now with activities instead of sectors.

Waring M, *Counting for Nothing: What Men Value and What Women are Worth*, Wellington, New Zealand, 1988.

One examples of a study with this kind of output mapping is by Fitzgerald & Wicks who defined 54 goods/services, measured the amount of these produced in different households and then attributed market prices to these 54 goods/services.[13] In this study there was no direct link between the time use of the household in the over all sense, i.e. mapping the full 24 hours of the day, and the production of the 54 goods/services. This would however be possible.

So this gives us:

Number (G) and value (VG) of the market equivalent goods/services produced in the household.

$$G^{g} = \sum_{a=1}^{m} g_a^g \qquad \gamma = 1....r$$

G^g represents the total amount of the good produced in all activities

$$VG^{g} = p_g \sum_{a=1}^{m} g_a^g \qquad \gamma = 1.....r$$

VG^g represents the total market value of the production of good/service γ in all activities.

Then we can sum the production of goods/services over the activities to obtain a market value of the activities that produce these goods/services. This valuation is based on the market value of the goods/services that the activity produces in contrast to the earlier valuation of the activities that used an input approach based on an imputed average wage.

Market value of activity a

$$AG^{a} = \sum_{g=1}^{r} p_g g_a^g \quad a = 1 .... m$$

The total turnover of the household will then be:

Production value of all activities - market valuation of equivalent goods/services

$$HHP2 = \sum_{g=1}^{r} \sum_{a=1}^{m} p_g g_a^g$$

Summing over all goods/services and the activities that produces them

We can then use this to calculate a value added or income from household production.

Value added based on market equivalents.

$$VA3=HHINK2= \sum_{g=1}^{r} \sum_{a=1}^{m} p_g g_a^g - E^{prod}$$

The value added in household production calculated as turnover minus expenditure on intermediary goods/services. VA3 could then be compared to the value of the time used

13 Fitgerald J & J Wicks “Measuring the value of household output: a comparison of direct and indirect approaches”, *Review of Income and Wealth*, Ser 36, No 2, 1990

in the activities as it is the income from household production.

Where $E^{prod} = \sum_{a=1}^{m} \sum_{e=1}^{n} a_{ea} E_e$

Even if VA3 > 0 we can not conclude that household production is efficient. To be able to say something about this we would have to compare the marginal market wage rate with the marginal income earned in household production. One way of analysing this would be to use the imputed wage rate w and the total cost - TC_{tot} - used above, and contrast this with the market value of household production here.

Profitability of household production

$$HPEFF = \left(\sum_{g=1}^{r} \sum_{a=1}^{m} p_g g_a^g \right) - TC_{tot}$$

where $TC_{tot} = \left(\sum_{a=1}^{m} wA_a + \sum_{a=1}^{m} \sum_{e=1}^{n} a_{ea} E_e \right)$

If w reflects a real alternative cost for the time used in household production and HPEFF < 0 then time is used inefficiently over all.

Even if total profitability is negative it probably varies considerably between different goods/services/activities.

We first allocate the hours worked in the household over the goods/services produced - by assuming a linear relationship.

Hours worked per produced unit of a certain good/service

$$\mu_g = \frac{\sum_{j=1}^{m} \left(p_g g_a^g / AG^a \right) A_a}{G^g} \qquad \gamma = 1.....r$$

μ_g shows the time used to produce good/service g.

Number of units per hour input

$$\lambda_g = \frac{G^g}{\sum_{a=1}^{m} \left(p_g g_a^g / AG^a \right) A_j} \qquad g = 1.....r$$

λ_g shows the number of units of g produced by every hour.

The hours used on a certain good/service in an activity is based on the proportion of the market value of that good/services in the specific activity in relation to the total market value of the activity

The we do the same in monetary units, i.e. the number of hours per SEK turnover or the number of SEK per hour worked.

Number of hours worked per produced SEK of a certain good/service

$$p\eta_i = \frac{\sum_{j=1}^{m} \left(p_i g_j^i / AG^j \right) A_j}{p_i G^i} \quad i=1.....r$$

$p\eta_g$ - the time use per produced SEK

Number of produced SEK per hour worked

$$p\lambda_g = \frac{p_g G^g}{\sum_{j=1}^{m} \left(p_g g_a^g / AG^a \right) A_a} \quad g = 1.....r$$

$p\lambda_g$ - the value an hour produces in household production of good/service g

Using this we can then formulate the average value per hour household work - *ARH*.

Average production value per hour worked

$$ARH = \sum_{g=1}^{r} p\lambda_g \left(VG^g / HHP2 \right)$$

The value is weighted by the proportion of the value of the different goods/services produced in relation to total turnover.

where

$$VG^g = p_g \sum_{a=1}^{m} g_a^g \qquad \gamma = 1 \ldots.r$$

$$HHP2 = \sum_{g=1}^{r} \sum_{a=1}^{m} p_g g_a^g$$

A last step is to distribute the expenditure on the goods/services used as inputs on the produced goods/services in order to establish a value added and a market based wage for household work. This is done by formulating the input cost per SEK produced on the one hand and the value produced per input SEK

Input cost per produced SEK - ps_g

$$ps_g = \frac{\sum_{e=1}^{n} \sum_{a=1}^{m} \left(p_g g_a^g / AG^a \right) a_{ea} E_e}{p_g G^g}$$

Once again weighted by the different goods/services part of total turnover

$g = 1.....r$

Produced SEK per input SEK - pq_g

$$pq_g = \frac{p_g G^g}{\sum_{e=1}^{n} \sum_{a=1}^{m} \left(p_g g_a^g / AG^a \right) a_{ea} E_e}$$

$g = 1.....r$

This give us the following value added

Value added from labour in production of g

$$VA_g = p_g G_g - \sum_{e=1}^{n}\sum_{a=1}^{m}\left(p_g g_a^g / AG^a\right) a_{ea} E_e$$

$g = 1.....r$

We subtract the input costs for producing g from the production value of g. In principle this is the income of the household from producing g on their own

Finally we divide this value added by the number of hours worked in producing it.

Wage per hour in the production of g

$$\$_g = \frac{VA_g}{\sum_{a=1}^{m}\left(p_g g_a^g / AG^a\right) A_a}$$

$g = 1.....r$

If w is the real alternative cost for the time used - for instance a market wage - $w > \$_g$ means that time is used less efficient in the household production of good/service g, while $w < \$_g$ implies that time is used efficiently.

Many see $\$$ as the only solution to calculating a reasonable value added and hence a production value of household production. Used in this way the hourly wage rate $\$$ has to be applied to the activities of the household instead of the different goods and services these activities produce.

Wage per hour of activity *j*

$$\tilde{w}_a = \sum_{g=1}^{r}\left(p_g g_a^g / AG^a\right) \$_g$$

$a = 1.....m$

This wage is calculated by weighting the wages in producing the different goods/services produced in activity a. They are weighted by the share of the good/service in the total value of activity a. $\tilde{w}_a$ can be < 0

An activity based calculation of the value of household production would then use $\sum_{a=1}^{m} \tilde{w}_a A_a$

Household activities and the environment

With these links between resource use and activities in and output from household production we can now turn to the environmental aspects of the activities of the household, i.e how emissions can be linked to the activities of the household. We can identify two kinds of emissions:

1 Emissions through the level and composition of the consumption/expenditure of the household with regards to what has occurred in the production process. We can call this the **indirect** emissions of the household.

2 Emission through the use of resources in different household activities, whether productive or not. These are the **direct** emissions.

The household also generates waste. Here there are also a direct component as well as an indirect component. With the **indirect** component going via the expenditures and the waste these goods and services generate in the production process and the **direct** component being the waste the household generates as a result of its own activities. These can be directly influenced by garbage sorting and recycling.

Starting with the direct emissions from purchased goods/services - EmC_u^e - these can be formulated as a coefficient relating emission of type u to the use of good/service *TE*e, for instance the emission of CO_2 per litre of leaded petrol. The purchase of petrol assumes the subsequent use of petrol which leads to emission.

Direct emission per SEK expenditure on good/service E_ε

$$EmC_u^e = \frac{EmC_u}{E_e}$$

u = 1 ....*u* different emissions
e = 1 .....*n* different expenditures

The emissions are assumed to be proportional to the quantity of the good/service purchased. The calculation of the coefficient in itself can, for instance, be based on average carbon content.

In the so called green tax (or tax swap) commission many calculations were made on the effects on emissions from changes in carbon taxes,. etc. Among other sources they used the following relationships between different fuels and CO_2-emissions. This is an example of the coefficient EmC_u^e above

Table 4 Emissions for some fuels

Fuel (ε)	Emissions in Kg CO_2 per unit fuel
Oil 1, m^3	2744
Oil 5, m^3	2966
Coal, ton	2484

Natural gas, 1000 m^3	2138
LP gas, ton	2993
Petrol, m^3	2323
Peat, ton	1355

We can go about specifying the indirect emissions in the same way. Here we are interested in the emissions caused by the production process before we purchase the good/service in question. We formulate this as EmP_u^e.

Indirect emissions in the production of good/service E_ε

$$EmP_u^e = \frac{EmP_u}{E_e}$$

u = 1 ....*u* - emissions
e = 1 .....*n* - expenditures

Once again we assume a linear relationship between the quantity (real value) of the purchased good/service and the emission this causes

In terms of environmental accounts these emissions would probably be seen as marginal emissions, i.e. the increase in emissions due to a 1 SEK increase in final demand. In the Swedish environmental accounts they calculate that a 1 million SEK increase in the demand for agricultural products would increase the CO_2 emissions by 39 ton or that a 1 million SEK increase in the demand for electricity, gas or heating would increase the CO_2 emissions by 166 ton.

These emission coefficients are established on aggregate sector/commodity data, One of the major points in the discussion on the household and the environment in recent years has been the idea that a comprehensive environmetal labelling system would fascilitate for consumers to choose the better alternative of a given good/service and that this would lead to a steady substitution towards a more environmentally sound production process and content in all sectors. In terms of the emission coefficents - these would decrease over time.

From an analytical as well as a policy perspective it would be interesting to capture this substitution process for single goods and for different household types, regions etc. instead of observing the changes in the gross average. This means disaggregating the Ee into two categories according to whether the good in question is labelled as environmentally sounder or not.

If we break out the environmentally labelled part we assume that $EmP_u^{e^{envir}} < EmP_u^e$. The market share of the environmentall friendlier products will then determine the average emissions from the sector and different households will have different mixes between the more an less environmentally friendly product.

It would be very interesting to introduce the environmental dimension in the expenditure surveys. This would give us the data to analyse in what ways, which households contribute to a more sustainable consumption.

It is possible to formulate the direct and indirect waste coefficients the same way and we will not present them here. According to the Swedish environmental accounts the mining sector produces 13.5 ton waste per 1000 SEK value added while the food industry produces 44 Kg waste per 1000 SEK value added.

Using these coefficients we can now formulate the following relationships for the environmental impact of the household.

Total emissions u for a certain expenditure e belonging to activity a

$$TEm_u^e =$$
$$a_{ea} E_e * EmP_u^e + a_{ea} E_e * EmC_u^e =$$
$$a_{ea} E_e (EmP_u^e + EmC_u^e) =$$
$$a_{ea} E_e * EmT_u^e$$

u = 1....*u* emissions
a = 1....*q* activities
e = 1....*n* expenditures

This can be broken down into the **indirect** emissions *IE* and **direct** emissions *DE*.

$$IEm_u^e = a_{ea} E_e * EmP_u^e \quad \text{and} \quad DEm_u^e = a_{ea} E_e * EmC_u^e$$

u = 1....*u;* a = 1....*q;*e = 1....*n*

With this we can then sum up the emissions from the different activities - a -via the direct and indirect emissions caused by the expenditures on different goods/services

Total emissions of u in activity a

$$TEmA_u^a = \sum_{e=1}^{n} TEm_u^e$$

u = 1....*u*
a = 1....*q*
e = 1....*n*

Indirect emissions of u in activity a

$$IEmA_u^a = \sum_{e=1}^{n} IEm_u^e$$

Direct emissions of u in activity a

$$DEmA_u^a = \sum_{e=1}^{n} DEm_u^e$$

This will allow us to calculate emissions per hour in different activities.

Total emissions per hour in activity a

$$TEmTAH_u^a = \sum_{e=1}^{n} TEm_u^e \Big/ A_a$$

For the productive activities:
$TEmPAH_u^a$ with a = 1 .... *m*

For the non-productive activities
$TEmNPAH_u^a$ with a = m+1 ... *q*

Indirect emissions per hour in activity a

$$IEmTAH_u^a = \sum_{e=1}^{n} IEm_u^e \Big/ A_a$$

The same applies to IEmPAH, IEmNPAH, DemPAH and DEmNPAH

Direct emissions per hour in activity a

$$DEmTAH_u^a = \sum_{e=1}^{n} DEm_u^e \Big/ A_a$$

u = 1....*u*; a = 1....*q*; e = 1....*n*

Using an imputed wage w in household production, **the emissions per SEK value added in the productive activities** a = 1 ... *m*, could then be calculated.

Total emissions

$$TEmPAVA_u^a = \sum_{e=1}^{n} TEm_u^e \Big/ wA_a$$

where $TEm_u^e = a_{ea} E_e * EmT_e$

Indirect emissions

$$IEmPAVA_u^a = \sum_{e=1}^{n} IEm_u^e \Big/ wA_a$$

where $IEm_u^e = a_{ea} E_e * EmP_u^e$

Direct emissions

$$DEmPAVA_u^a = \sum_{e=1}^{n} DEm_u^e \Big/ wA_a$$

where $DEm_u^e = a_{ea} E_e * EmC_u^e$

u = 1....*u*; a = 1....*m* ; e = 1....*n*

This provides a link between the emissions caused by the household through its purchases via the activities they perform - productive as well as non productive. This could be used to calculate different indicators and measures that would be of interest when analysing sustainable household behaviour. For instance:

- The share of the indirect emissions to total emissions of u i.e.:

$$\sum_{a=1}^{q} DEmA_u^a \Big/ \sum_{a=1}^{q} TEmA_u^a \quad \text{where } u = 1....u$$

- or the emissions of u per productive hour compared to the emissions per non productive hour

$$\sum_{a=1}^{m} TEmPAH_u^a \left(\frac{A_a}{TA_{prod}} \right) \Big/ \sum_{a=m+1}^{q} TEmNAH_u^a \left(\frac{A_a}{TA_{nonprod}} \right) \quad \text{where } u = 1....u$$

Thus, it is possible to link the households contribution to environmental problems to the actual activity pattern of the household. The organisation of everyday life and the goods/services we purchase will determine the environmental impact of the household. It is important to remember that this impact is the sum of many decisions taken. Different household organise their lives in different ways. It is difficult a priori to judge whether a household has a more sustainable way of life than another, for instance just by observing that its total expenditure is higher. There is so much more involved.

One aspect of the sustainability question that has emerged from time to time over the last couple of decades, is the environmental aspect of the reallocation of activities from the formal to the informal economy and vice versa. Many contributions from the environmental movement have stated or implied that there is a “Small is beautiful”-factor to consider in environmental terms also, i.e. that small scale informal production should be more environmentally sound than large scale formal production of the same items. Part of it is argued along the lines that small scale (household based) informal production means that the producer and the consumer is the same person or at least that the producer and the consumer meet. When production-distribution-consumption becomes personal and not anonymous - greater care is taken.

Be that as it may, the relevant question from a statistical/analytical point of view is to try to establish whether small scale household production produces more or less emissions per unit or value than formal production.

We can formulate this in the following way, where we look at the emission from the household in the production of 1 SEK worth of good/service γ.

$$TEmG_u^g = \frac{\sum_{e=1}^{n} \sum_{a=1}^{m} \left(p_g g_a^g \Big/ AG^a \right) TEm_u^e}{p_g G^g}$$

$$g = 1....r;\ u = 1....u;\ a = 1....m;\ e = 1....n$$

Given this, it would be possible to compare the emissions from the household producing a unit of the good/service with the emissions caused by a market produced unit of the same good/service. So, for $e = g$, $TEmG_u^g > TEm_u^e$ implies that household production causes larger emissions u per SEK turnover than market production does. If $TEmG_u^g < TEm_u^e$ then the reverse is true.

VI The household and the environment - concluding remarks on the micro approach

The discussion so far has been almost entirely from a household perspective where we have included data as we have gone along. Some of it is clearly is unrealistic in terms of expecting the major surveys to deliver this kind of data, for instance the output measures of household production, while others are possible with marginally efforsts within the framework of the Household Budget or Time Use survey in question, for instance the inventory of capital equipment or simple indicators of the activity allocation of expenditures or proportions of eco-labelled goods etc..

The crucial step in the analysis above is no doubt to link expenditure with time use, and preferably within the context of the regular surveys in these areas. In most countries these are run completely separate and both surveys are problematic in that they expect a lot from the respondent. Combining them may therefore seem an unsurmountable task. There are however ways around this, and one that has proven fruitful in Sweden is to combine a light version of a diary for measuring time use with the ordinary expenditure survey. This means fewer details in the time allocation pattern as it is built on 30 pre defined activities. This makes it less likely as a candidate for comparative analysis as these 30 activities will have to be defined according to the socio-economic and cultural framework of the country in question.

It is also possible to go through this data on a higher level, i.e combine different surveys and work with the group averages. This will not give the level of detail and the possibilities of estimating the relationships between the different data set in the way a microbased household survey gathering all, or most of, the data for the same sample of households.

VII A macro approach to the household sector and the environment

If the task of gathering the data from the bottom up seems daunting, one could instead approach this from another view. One that starts off in existing macro and micro surveys and then tries to link these together so that a better view of the environmental effects of households can emerge.

The data on emissions and emission coefficients presented above come from the so called environmental accounts. A statistical system that is becoming more common. The idea behind these environmental accounts is often to establish a environmental data as a satellite account to

the national accounts, whereby one can relate economic activity in the national accounts to their environmental consequences in terms of emission, resource use, waste recycling, etc.

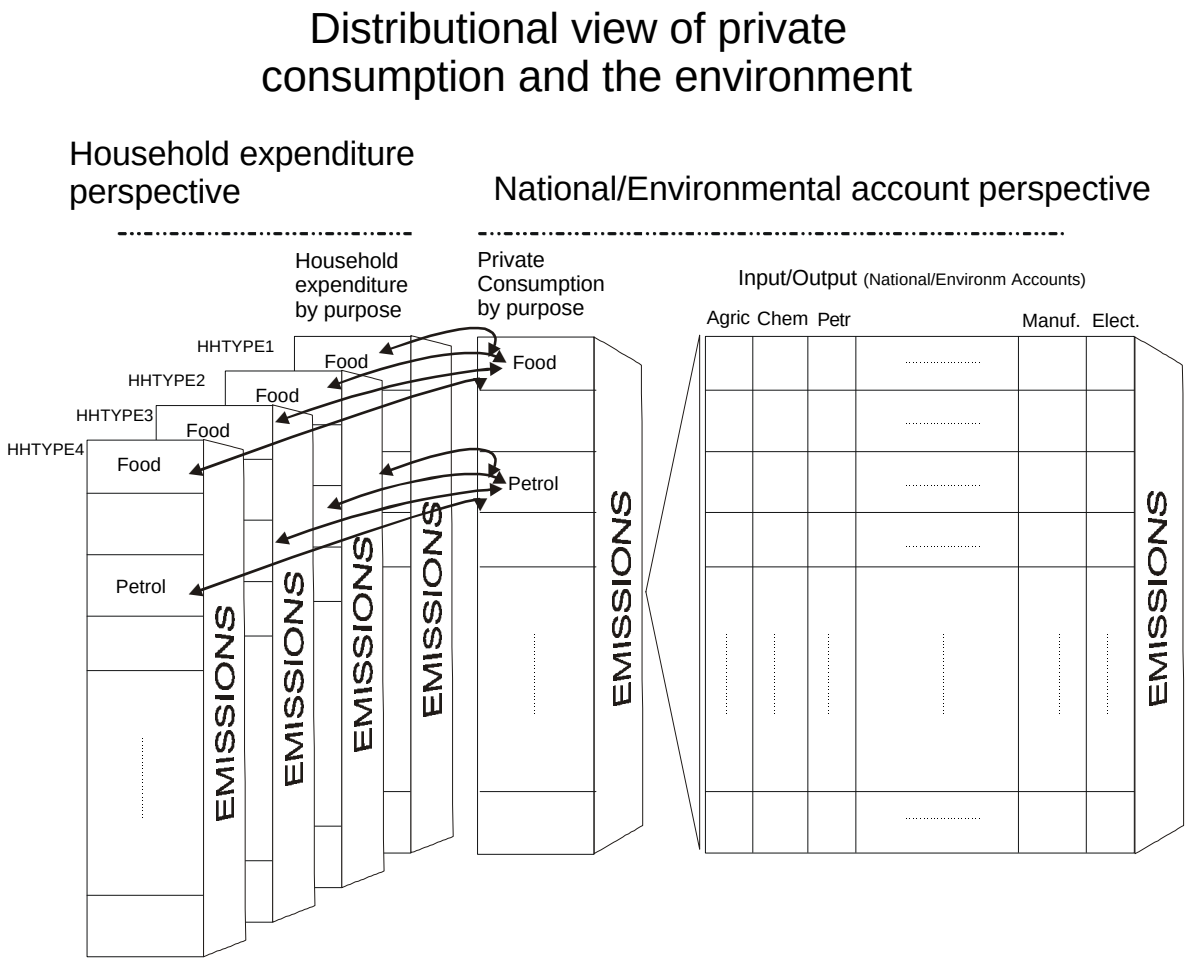
This is usually done by using the input/outputtables of the national accounts and combining these withe the energy accounts to be able to calculate and allocate emission over all sectors of the economy - including that of private consumption.

As they stand today, the environmental accounts produce statitstics on over all emissions etc by sector and uses this to produce a set of indicators such as emission per SEK value added in the different sectors. This is interesting in itself, but the environmental accounts could become more interesting from a consumption/household point of view if these emissions could be allocated over different household types, region or other distributions. It would also be more interesting if they could relate the emissions to household activities instead of, in a sense, passive consumption as this would open up for policy relevant questions on changes in life styles etc.

Given that the environmental accounts are based on the national accounts and the sectoral calassification of these, it would be possible to convert the emissions from private consumptions to the COICOP categories that classify according to purpose. With this classification it would then be possible to link the accounts data to the expenditure survey (HBS) where expenditure/consumption is, or at least will be, classified according to the COICOP-HBS. With this link between the private consumption of the accounts and the expenditures of the HBS - it would then be possible to allocate the emission from consumption over the different household types that can be constructed through the HBS. We would then introduce a distributional aspect of the environmental accounts.

This can be illustrated as in the following picture.

Diagram 2 Linking environmental accounts and household budget surveys



Running this the other way, this is the kind of link we assumed when introducing the environment in the discussion above - i.e linkning the environmental effects through average emission coefficients provided by the environmental accounts and reclassified according to the COICOP categories.

This is, in general, the approach taken in the Fiscal Reforms projects as well as many partial studies of the distributional effetcs of fiscal measures for consumption. A macro economic model including the environment assumes these linkages - mainly by using the coefficients of what we have called the indirect emissions, i.e the emissions caused in the value adding process of production.

As the linkages depicted in the picture above would not require changes in any existing survey or data collecting process, but is merely a translation and analysis task, it could be fairly easily. The results would probably be more interesting than the aggregate measures produced today and could lead to another interest in the consumption/household side of sustainable development.

This would of course be made even more interesting if it could include some reference to differences in the environmental effects within product categories, i.e the classification according to some eco labelling system or similar. This would then make it possible to develop the household and environmental accounts by disaggregating the production sectors along the same lines, thereby making it possible to follow the substitution towards more environmentally sounder production in general.

This would probably mean changes to existing surveys, mainly the HBS. This would probably be regarded as a risk considering the low respons rates in general in these surveys. It is also possible that the inclusion of environmental questions/tasks in the HBS would give it another urgency and thus contribute to the response rates. We do not know.

There are initiatives at using the expenditure surveys to address environmentally related questions. One such initiative, although not a high priority one, comes from Eurostat where they are looking at ways of revealing the expenditures/investments by households for environmental protection measures.[14] This is a much narrower task than what we have discussed earlier.

In the discussion on the COICOP-HBS, i.e the classification system for the household budgetr surveys by purpose they have singles out the following categories as environmental protection expenditures by households.

In the COICOP-HBS
04.4.1 Refuse collection
04.4.2 Sewerage services
04.4.3 Water supply
04.4.4 Other services relating to the dwelling n.e.c.

In addition to this one would have to look for products/services like:

Maintenace service and other products for septic tanks
Catalytic converters for vehicles
Lead free gasoline
Desulphurised fuels
Other costs of compliance with environmental regulation in domestic vehicles
Trash bags and bins
Rubbish and compost containers
Measurement services of exhaust gases of heating systems
Measurement services of exhaust gases from ehicles
Installation of anti-noise windows
Installation of septic tank (which is gross fixed capital formation)

In the same paper they aslo mention the costs for environmental protection that comes from spending time on activities that can be seen as environmental protection. There is no discussion on the tasks, but time spent on waste sorting and recycling would probably be one of them.

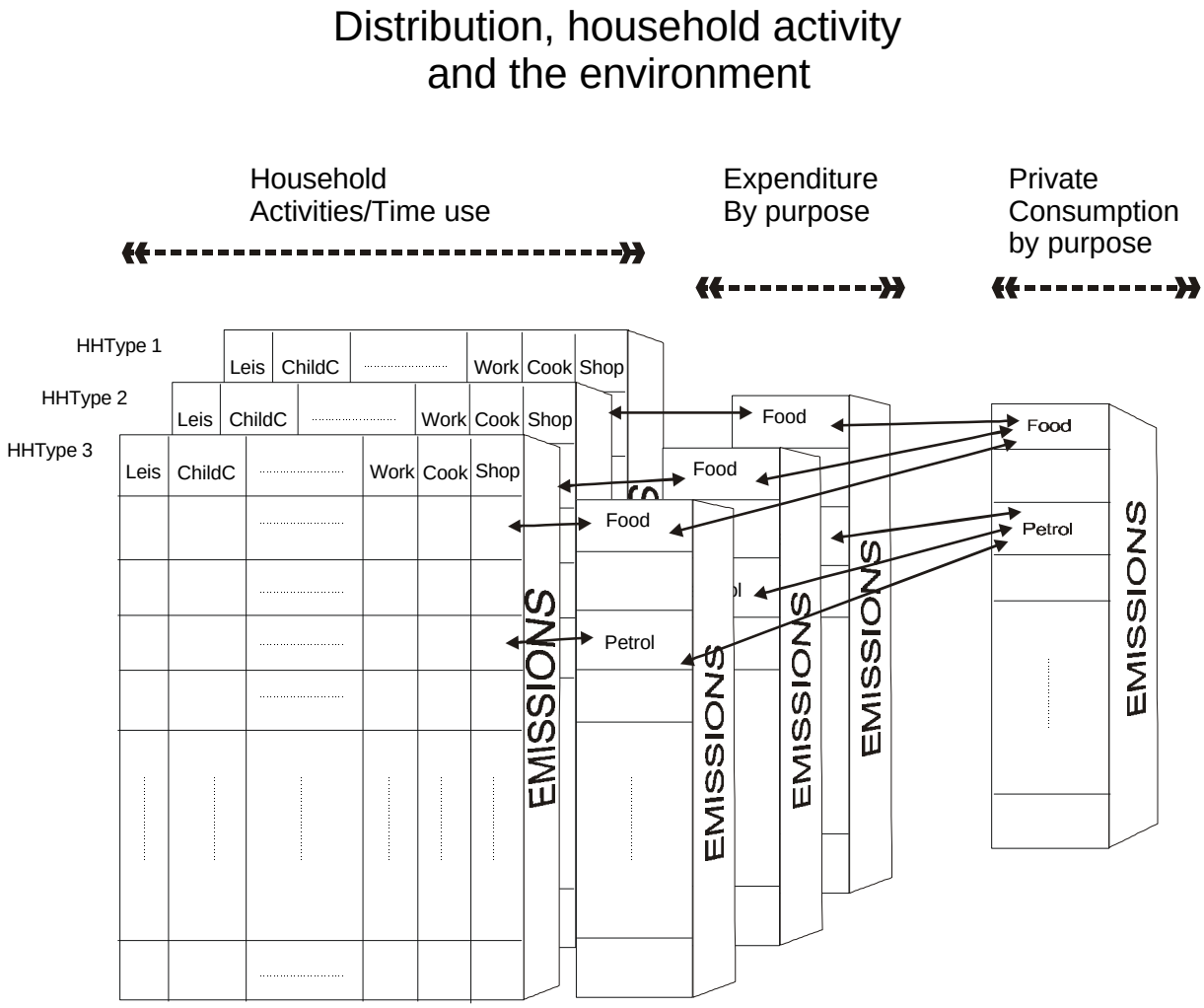
14) "Implementation of a regular data collection system concerning environmental protection expenditure by households", Eurostat F3/R.Reis, Luxembourg, September 1997

The activities performed by households are relevant to the environmental problems, whether we are interested in the protection costs or in the environmental problems they contribute to.

One way of introducing this into our national accounts-environmental accounts- private consumption by purpose- HBS chain above is to use existing time use survey data to link expenditures to activities - in ways described earlier. The idea is simply to match the household types in the HBS and the time use survey on a group level. It is the aggregated version of this that is presented in the table of Swedish Satellite Account earlier.

This would expand the left hand part of the earlier picture in the following way.

Diagram 3 Household activities and environmental accounts



With this kind of information it would be possible to see how the different activities undertaken by households in their everyday life, contribute to the environmental problems, although the links now are on a group level and not the microdata we discussed earlier. This would invite more thourough discussions on changes in life styles etc.Much of this discussion has so far been based on hypothetical examples and fragments of what constitutes every day life.

VIII Conclusions

In order to make the role of the household in a more sustainable development more visible, existing data sources need to be linked and new data added. In this paper we have discussed a set of relationships that would be of interest to follow in order to give a broader view of the environmental aspects of the household sector.

We have chosen an economic perspective when looking at the environmental impact of households. This is mainly due to the fact that most environmental effects caused by households stems from the goods and services they purchase and consume, whether indirect through the production process of the goods/services they buy or more direct through their use of and value adding to the goods/services they buy.

In this sense the linkages between the household and the environment can be seen as an extension to the efforts being made in measuring the activities of the households in the framework of household production accounts. The information needed for a micro based household production account is identical to the one needed to make the environmental analysis. It has to be augmented with data on environmental consequences in terms of emissions coefficients etc.

If combined in the way we have described above, it would be possible to arrive at an interesting picture of the role of the household in the economy and the environmental problems we face.

As this is uncharted territory in some of the parts and especially in the combination of these data sets, the macro approach discussed above would be a way forward. This would make it possible to try the relevance of the combination of emissions data with expenditure and time use data. All member states have expenditure surveys. Some have emissions data that are linked to the national accounts or other multisector (input output based) accounts. The same applies to time use surveys. The efforts made at Eurostat in recent years to initiate a harmonised time use survey would certainly help in this respect. In addition to these data sources there are a host of other data sources for energy consumption, travel, etc that can be used and added.

The important thing is to build this information from a household perspective, i.e. by focusing on the household as the actor.