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Supplement to «Distribution of Preferences and Measurement Errors in a Disaggregated Expenditure System»

Statistics Norway

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Supplement to
"Distribution of Preferences and Measurement Errors in a Disaggregated Expenditure System"

Abstract of supplement
This note includes supplementary results to Aasness, J., E. Biørn, and T. Skjerpen: "Distribution of preferences and measurement errors in a disaggregated expenditure system", to be published in the *Econometrics Journal*.

Abstract of paper
A complete system of consumer expenditure functions with 28 commodity groups is modeled and estimated by means of two-wave household panel data. Total consumption expenditure is treated as latent, with two income measures as observed indicators. The distribution of latent individual differences, interpreted as preference variation, is structured by a factor-analytic approach. Absence of measurement error in total expenditure is clearly rejected, as is also the standard assumption of uncorrelated measurement errors. The 2015 first- and second-order moments of the observed variables are modeled by means of 213 parameters in a reference model. Their maximum likelihood estimates have, with only a few exceptions, the expected sign and a reasonable magnitude. A notable finding is positive correlation between measurement errors of commodities belonging to major groups, e.g., foods, which may be explained by rational shopping behavior. The magnitude and ranking of the Engel elasticity estimates are not sensitive to whether the form of the Engel functions is linear or quadratic.

Keywords: Engel functions, panel data, preference distribution, measurement error, household expenditure surveys.

JEL classification: C33, C51, C52, D12, D31.

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Part A. Engel functions, preference variation, and two level Stone-Geary utility

The expenditure system

Assume that the I commodities in the household's budget are divided into G groups, and let I_g be the number of commodities in group $g\left(g = 1,\ldots,G,\ \Sigma_g I_g = I\right)$. The utility function U has the following Stone-Geary form in the group specific 'sub-utilities' $U_1,\ldots,U_G$

$$\text{(A.1)}\quad U = \prod_{g=1}^{G}\left(\frac{U_g - \gamma_g}{\beta_g}\right)^{\beta_g}, \quad \beta_g > 0, \quad U_g > \gamma_g, \quad g = 1,\ldots,G,$$

where β_g and γ_g are unknown parameters. Here we can assume, without loss of generality,

$$\text{(A.2)}\qquad \sum_g \beta_g = 1,$$

since $V = U^{1/\Sigma_g \beta_g}$ is an equally valid (ordinal) representation of the household's preferences as U. The 'sub-utility' functions U_g are also assumed to have the Stone-Geary form

$$\text{(A.3)}\quad U_g = \prod_{i=1}^{I_g}\left(\frac{\eta_{ig} - \gamma_{ig}}{\beta_{ig}}\right)^{\beta_{ig}}, \quad \beta_{ig} > 0, \quad \eta_{ig} > \gamma_{ig}, \quad i = 1,\ldots,I_g, \quad g = 1,\ldots,G,$$

where η_{ig} is the quantity consumed of commodity i in group g, denoted as commodity (i, g) for short, and β_{ig} and γ_{ig} are unknown parameters. We also assume that

$$\text{(A.4)}\quad \sum_i \beta_{ig} = 1, \qquad g = 1,\ldots,G,$$

which imply that all the 'sub-utilities' are homogeneous of degree one in the 'supernumerary consumption' $\eta_{ig} - \gamma_{ig}$ of all commodities. In contrast to (A.2), (A.4) implies restrictions on the demand functions, which will substantially facilitate the model formulation. [1]

When all prices are normalized to one, the budget constraint of the household can be written as

$$\text{(A.5)}\quad \xi_g = \sum_{i=1}^{I_g} \eta_{ig}, \qquad g = 1,\ldots,G,$$

[1] Note that this two level utility function is something very different from the standard Stone-Geary utility function, since we have G new parameters (γ_g) at the top level, which also play a crucial role in the specification of preference variation across households. This is different from the approach in Deaton (1975, ch.6) who uses a standard Stone-Geary model and rewrites it in a hierarchical form, before starting his econometric specification for time series analysis. However, there are some similarities in the hierarchical stochastic specification. Deaton, A. (1975): *Models and Projections of Demand in Post-war Britain*, London: Chapman and Hall.

(A.6) $\xi = \sum_{g=1}^{G} \xi_g ,$

where ξ is total consumption expenditure and ξ_g is the part allocated to group g. Necessary conditions for U to be maximized with respect to all η_{ig}, subject to (A.5) - (A.6) with ξ given, is that all U_g are maximized with respect to $\eta_{1g},\ldots,\eta_{I_g g}$, subject to (A.5), with ξ_g given. The solution to this sub-problem, paying regard to (A.4) and assuming an interior solution, is described by the (conditional) within group, linear expenditure functions

(A.7) $\eta_{ig} - \gamma_{ig} = \beta_{ig}\left(\xi_g - m_g\right), \quad i = 1,\ldots,I_g, \quad g = 1,\ldots,G,$

where m_g is 'aggregate minimum consumption' of group g,

(A.8) $m_g = \sum_i \gamma_{ig}, \qquad g = 1,\ldots,G.$

From this it follows that maximal utility of group g is its 'supernumerary expenditure', since (A.3), (A.4), and (A.7) imply

(A.9) $U_g = \xi_g - m_g, \qquad g = 1,...,G.$

Substituting (A.9) in (A.1), it follows that the overall utility conditional on group specific utility maximization, for given group expenditures $\xi_1,\ldots,\xi_G$, is equal to

(A.10) $U = \prod_{g=1}^{G} \left(\frac{\xi_g - m_g - \gamma_g}{\beta_g} \right)^{\beta_g} .$

The remarkable property of this 'partially maximized' utility function is that it has exactly the same Stone-Geary form as (A.1) and (A.3), with $m_g + \gamma_g = \sum_i \gamma_{ig} + \gamma_g$ now interpreted as the 'minimum consumption of group g'.

The upper (overall) utility maximization of the household is then obtained by maximizing (A.10) with respect to $\xi_1,\ldots,\xi_G$ subject to (A.6). The solution to this problem, using (A.4), is, in complete analogy to (A.7), given by the G group specific, linear expenditure functions

(A.11) $\xi_g - m_g - \gamma_g = \beta_g\left(\xi - m - M\right), \qquad g = 1,\ldots,G,$

where

(A.12) $m = \sum_g m_g = \sum_g \sum_i \gamma_{ig},$

(A.13) $M = \sum_g \gamma_g .$

Eqs. (A.11) imply that the overall 'supernumerary expenditure', defined as $\xi - m - M$, whose components are given by (A.6), (A.12), and (A.13), are allocated to the G groups according to the group specific marginal budget shares β_g. Note also that the overall unconditional maximal utility is equal to the 'supernumerary expenditure', since (A.4), (A.10), and (A.11) imply

$$\text{(A.14)} \quad U = \xi - m - M = \sum_g \xi_g - \sum_g m_g - \sum_g \gamma_g = \sum_g \sum_i \eta_{ig} - \sum_g \sum_i \gamma_{ig} - \sum_g \gamma_g .$$

Using (A.11) to eliminate $\xi_g - m_g$ in (A.7), we find that the commodity specific, linear expenditure functions can be written as $\eta_{ig} - \gamma_{ig} = \beta_{ig}\left[\beta_g(\xi - m - M) + \gamma_g\right]$, or

$$\text{(A.15)} \quad \eta_{ig} - \gamma_{ig} - \beta_{ig}\gamma_g = \beta_{ig}\beta_g(\xi - m - M), \; i = 1,\ldots,I_g, \quad g = 1,\ldots,G.$$

Here, minimum consumption of commodity (i,g) has two additive components, the first, γ_{ig}, representing commodity specific minimum consumption [cf. (A.3)], the second, $\beta_{ig}\gamma_g$, being the share β_{ig} of the group specific minimum consumption [cf. (A.1)]. Likewise, the marginal budget share of commodity (i,g) has two multiplicative components, the first, β_{ig}, being the within group commodity specific marginal budget share, the second, β_g, being the marginal budget share specific to group g.

Demographic specification

In the econometric specification of the model, the minimum consumption parameters γ_g and γ_{ig} are not constants, but specified as functions of household characteristics in the following way

$$\text{(A.16)} \quad \gamma_g = \beta_g\left(\overline{a}_g + \overline{c}_g z + \overline{\alpha}_g\right), \qquad g = 1,\ldots,G,$$

$$\text{(A.17)} \quad \gamma_{ig} = \underline{a}_{ig} + \underline{c}_{ig} z + \underline{\alpha}_{ig}, \qquad i = 1,\ldots,I_g; \quad g = 1,\ldots,G.$$

Here z is an $M \times 1-$ vector of demographic variables, $\beta_g \overline{c}_g$ and $\underline{c}_{ig}$ are $1 \times M-$ vectors representing their effect on minimum consumption of group g and of commodity (i,g), respectively, $\beta_g \overline{a}_g$ and $\underline{a}_{ig}$ are corresponding intercept terms, and $\beta_g \overline{\alpha}_g$ and $\underline{\alpha}_{ig}$ are stochastic variables representing (unmeasured) household specific variation in preferences affecting minimum consumption. (We use 'underscore' and 'overscore' to symbolize disaggregate commodities and aggregate groups, respectively.)

From (A.16) and (A.17) it follows that the composite minimum consumption parameters in (A.15) can be expressed in terms of the demographic effects and the preference variables as

$$\text{(A.18)} \quad \gamma_{ig} + \beta_{ig}\gamma_g = a^*_{ig} + c^*_{ig} z + \alpha_{ig}, \qquad i = 1,\ldots,I_g; \quad g = 1,\ldots,G,$$

and their aggregates as [cf. (A.12) and (A.13)]

$$\text{(A.19)} \quad m + M = \sum_g \sum_i \gamma_{ig} + \sum_g \sum_i \beta_{ig}\gamma_g = \sum_g \sum_i a^*_{ig} + \sum_g \sum_i c^*_{ig} z + \sum_g \sum_i \alpha_{ig},$$

where

(A.20) $a^*_{ig} = \underline{a}_{ig} + \beta_{ig}\beta_g\overline{a}_g$,

(A.21) $c^*_{ig} = \underline{c}_{ig} + \beta_{ig}\beta_g\overline{c}_g$,

(A.22) $\alpha_{ig} = \underline{\alpha}_{ig} + \beta_{ig}\beta_g\overline{\alpha}_g$, $\quad i = 1,\ldots,I_g; \quad g = 1,\ldots,G.$

Let now b_{ig} be the marginal budget share of commodity (i,g) relative to total expenditure, i.e.

(A.23) $b_{ig} = \beta_{ig}\beta_g$, $\quad i = 1,\ldots,I_g; \quad g = 1,\ldots,G,$

let a^*, b, α, and η denote the $I \times 1$ vectors of $a^*_{ig}, b_{ig}, \alpha_{ig}$, and η_{ig} ordered first by group, second by commodity, and let C^* denote the $I \times M$ matrix of c^*_{ig} similarly ordered. We can then write (A.15) as

(A.24) $\eta = a + b\xi + Cz + \mu,$

where

(A.25) $a = (I - b\iota')a^*, \quad C = (I - b\iota')C^*,$

ι_I denoting the $I \times 1$ vector of ones, and

(A.26) $\mu = (I - b\iota')\alpha.$

Eq. (A.24) is identical to (1) in the main text, when the time subscript t is added to η and ξ.

Part B. Detailed empirical results

Table B1. Mean of the observed variables. The y and w variables are measured in 1000 Norwegian 1974 kroner

	Variable	Mean in period 1	Variable	Mean in period 2
Commodity				
Flour and bread	$y_{1,1}$	0.9441	$y_{1,2}$	0.9022
Meat and eggs	$y_{2,1}$	2.4093	$y_{2,2}$	2.4258
Fish	y_{31}	0.6314	$y_{3,2}$	0.6552
Canned meat and fish	$y_{4,1}$	0.2281	$y_{4,2}$	0.2286
Dairy products	$y_{5,1}$	1.1714	$y_{5,2}$	1.2044
Butter and margarine	$y_{6,1}$	0.3632	$y_{6,2}$	0.3579
Potatoes and vegetables	$y_{7,1}$	1.7547	$y_{7,2}$	1.7400
Other food	$y_{8,1}$	1.4418	$y_{8,2}$	1.4214
Beverages	$y_{9,1}$	0.9749	$y_{9,2}$	1.0093
Tobacco	$y_{10,1}$	0.6356	$y_{10,2}$	0.6205
Clothing	$y_{11,1}$	3.5582	$y_{11,2}$	3.6852
Footwear	$y_{12,1}$	0.8207	$y_{12,2}$	0.7512
Housing	$y_{13,1}$	4.4736	$y_{13,2}$	4.8672
Fuel and power	$y_{14,1}$	1.4001	$y_{14,2}$	1.4328
Furniture	$y_{15,1}$	2.0944	$y_{15,2}$	2.1143
Household equipment	$y_{16,1}$	1.1186	$y_{16,2}$	1.2683
Misc. household good	$y_{17,1}$	0.7891	$y_{17,2}$	0.8962
Motorcars, bicycles	$y_{18,1}$	2.4094	$y_{18,2}$	3.6250
Running cost of vehicles	$y_{19,1}$	3.3682	$y_{19,2}$	3.6245
Public transport	$y_{20,1}$	0.9605	$y_{20,2}$	0.8733
PTT charges	$y_{21,1}$	0.4648	$y_{21,2}$	0.6707
Recreation	$y_{22,1}$	2.6391	$y_{22,2}$	2.9971
Public entertainment	$y_{23,1}$	1.3293	$y_{23,2}$	1.2683
Books and newspapers	$y_{24,1}$	0.7586	$y_{24,2}$	0.7607
Medical care	$y_{25,1}$	0.5648	$y_{25,2}$	0.5748
Personal care	$y_{26,1}$	0.7505	$y_{26,2}$	0.8115
Misc. goods and services	$y_{27,1}$	0.4592	$y_{27,2}$	0.6260
Restaurants, hotels etc.	$y_{28,1}$	1.1824	$y_{28,2}$	1.2708
Total expenditure	x_1	39.6960	x_2	48.6832
Income concept				
Income measure 1	$w_{1,1}$	37.8589	$w_{1,2}$	41.7440
Income measure 2	$w_{2,1}$	55.1871	$w_{2,2}$	58.5761
Demographic variable				
Number of children	z_1	0.8039		
Number of adults	z_2	2.2255		

Table B2. Covariance matrix of the 62 observed variables. The y and w variables are measured in 1000 Norwegian 1974 kroner

	y1,1	y1,2	y2,1	y2,2	y3,1	y3,2	y4,1	y4,2
y1,1	0.427136							
y1,2	0.215845	0.361314						
y2,1	0.447132	0.338967	6.195868					
y2,2	0.330587	0.382022	2.352503	5.926631				
y3,1	0.101367	0.074592	0.484935	0.360590	0.582443			
y3,2	0.079513	0.081344	0.359615	0.310967	0.262869	0.612832		
y4,1	0.052930	0.029663	0.153327	0.106201	0.019004	0.008113	0.064346	
y4,2	0.036874	0.051156	0.166520	0.101848	0.016381	0.038021	0.021663	0.094324
y5,1	0.234593	0.185987	0.502650	0.523719	0.094047	0.070603	0.048213	0.048528
y5,2	0.175702	0.212662	0.364057	0.565124	0.064085	0.098708	0.033098	0.047947
y6,1	0.079472	0.067788	0.135215	0.203106	0.032323	0.028702	0.015086	0.014121
y6,2	0.065395	0.080462	0.172476	0.152563	0.044667	0.051454	0.008144	0.018385
y7,1	0.353961	0.242747	1.227227	1.040988	0.258460	0.138616	0.089245	0.070465
y7,2	0.312377	0.363698	0.870247	0.972296	0.232592	0.196047	0.076412	0.097277
y8,1	0.331429	0.262179	0.913086	0.750342	0.115939	0.054115	0.073660	0.071229
y8,2	0.254850	0.297154	0.682845	0.907736	0.099227	0.146415	0.055003	0.080601
y9,1	0.141597	0.119491	0.634334	0.608018	0.136841	0.170550	0.069735	0.054495
y9,2	0.144207	0.176706	0.760337	0.682634	0.130838	0.266100	0.072587	0.100262
y10,1	0.072734	0.082545	0.357396	0.240192	0.025631	-0.004007	0.040129	0.028943
y10,2	0.075877	0.094914	0.283973	0.276192	0.012733	0.021640	0.038875	0.042145
y11,1	0.602012	0.675922	1.966112	1.751012	0.496198	0.279854	0.068939	0.128744
y11,2	0.720136	0.837372	1.704442	2.403319	0.332579	0.249114	0.177645	0.154668
y12,1	0.198212	0.146368	0.641767	0.247023	0.078971	0.137662	0.045076	0.086069
y12,2	0.150846	0.177070	0.510405	0.747004	0.077012	0.118241	0.058826	0.041654
y13,1	0.367729	0.475860	1.903638	2.142836	0.403809	0.314365	0.078118	0.150814
y13,2	0.636750	0.661392	1.453830	2.287562	0.370972	0.197202	0.146465	0.074140
y14,1	0.089388	0.089491	0.224935	0.336892	0.048242	0.038290	0.017807	0.012948
y14,2	0.056190	0.082186	0.153859	0.325295	0.036292	0.043498	0.013441	0.018260
y15,1	0.263425	0.183303	1.625456	1.650049	0.193804	-0.078395	0.084680	0.063567
y15,2	0.278470	0.288309	1.915438	1.572327	0.098452	0.112789	0.123753	0.165548
y16,1	0.123535	0.121456	0.454469	0.656889	0.152683	-0.035258	0.028269	0.007255
y16,2	0.301780	0.265868	0.895445	1.090358	0.158494	0.063753	0.077476	0.103981
y17,1	0.093733	0.107370	0.407849	0.387133	0.070725	0.067026	0.038174	0.031942
y17,2	0.096437	0.126591	0.359779	0.790302	0.105675	0.094437	0.019434	-0.000075
y18,1	0.310662	0.540626	1.764705	0.512761	0.345963	0.491577	0.120769	0.262373
y18,2	0.686913	0.798792	1.104584	-0.291651	-0.266759	0.048236	0.146225	0.268857
y19,1	0.745687	0.598268	1.255195	1.237074	0.315215	0.034619	0.257504	0.109229
y19,2	0.739687	0.953740	1.540203	2.870636	0.201596	0.254545	0.299851	0.197974
y20,1	0.058885	0.047236	0.614615	0.399873	0.162396	0.044791	0.014374	-0.004469
y20,2	0.175396	0.106720	0.365211	0.527568	0.259743	0.104033	0.058696	0.025904
y21,1	0.019656	-0.055066	0.119158	-0.215456	0.129133	0.034263	0.013684	-0.000886
y21,2	0.030866	0.079361	0.293628	0.395137	0.113913	0.169218	0.058854	0.025010
y22,1	0.401505	0.451754	0.698359	1.114989	0.532399	0.327307	0.086495	0.162542
y22,2	0.488684	0.546365	1.066446	2.176266	0.773085	0.552148	0.111655	0.193024
y23,1	0.199597	0.169699	0.399391	0.523325	0.183447	0.074765	0.051995	0.047499
y23,2	0.289698	0.229079	0.959015	1.052705	0.128810	0.153704	0.055651	0.056676
y24,1	0.075113	0.071795	0.386358	0.126712	0.102322	0.090446	0.016558	0.052296
y24,2	0.123679	0.117578	0.398678	0.435097	0.131140	0.129054	0.034996	0.048864
y25,1	0.134879	0.079410	0.131775	0.122186	0.159581	0.062275	0.032666	0.028516
y25,2	0.079830	0.067985	0.117905	0.232076	0.052698	0.076853	0.018278	-0.010110
y26,1	0.162022	0.137765	0.476244	0.479652	0.060101	-0.001384	0.036935	0.040558
y26,2	0.165238	0.166283	0.306243	0.560314	0.046019	0.038846	0.034788	0.072499
y27,1	0.129237	0.126306	0.166918	0.211764	0.051396	0.059325	0.014428	0.038283
y27,2	0.139223	0.150788	0.354242	0.344523	0.081742	0.123160	0.059582	0.057087
y28,1	0.197866	0.250193	0.531259	0.358140	0.078164	0.150699	0.054675	0.035084
y28,2	0.249809	0.297200	0.597371	0.642157	0.061511	0.137085	0.128271	0.081958
w1,1	3.604583	3.648542	14.307195	11.424504	3.601512	2.498421	0.942103	0.744641
w1,2	4.472059	4.679180	15.087812	13.654683	3.497230	2.518629	0.972359	0.848690
w2,1	8.290474	8.161755	29.708858	22.224018	5.276846	3.741779	2.168641	1.800650
w2,2	9.127865	9.299631	30.644186	24.747675	5.292720	3.650002	2.097247	1.994522
z1	0.324077	0.306573	0.642530	0.852789	0.037979	0.026310	0.062642	0.049138
z2	0.223900	0.205832	0.570417	0.531699	0.110106	0.105979	0.032476	0.052949

Table B2 (cont.)

	y5,1	y5,2	y6,1	y6,2	y7,1	y7,2	y8,1	y8,2
y5,1	0.484954							
y5,2	0.335040	0.528161						
y6,1	0.106057	0.075484	0.104105					
y6,2	0.072653	0.092716	0.035149	0.101121				
y7,1	0.364443	0.317306	0.099052	0.110936	1.809764			
y7,2	0.331181	0.393130	0.092387	0.142980	0.930900	1.736025		
y8,1	0.354440	0.295307	0.110412	0.082747	0.589954	0.571037	0.965470	
y8,2	0.296788	0.359653	0.089301	0.125707	0.406964	0.687808	0.530943	1.076546
y9,1	0.124534	0.083342	0.048788	0.019531	0.320584	0.326421	0.277546	0.206204
y9,2	0.082838	0.103052	0.042193	0.044627	0.508087	0.510122	0.306623	0.329680
y10,1	0.063970	0.043409	0.046557	0.021209	0.064211	0.103416	0.133585	0.134908
y10,2	0.069647	0.053835	0.056163	0.021354	0.046265	0.149588	0.146937	0.184646
y11,1	0.728322	0.674066	0.133879	0.209884	1.165055	1.250340	0.978609	1.170503
y11,2	0.757395	0.807879	0.290056	0.216236	1.275668	1.509832	1.325874	1.476556
y12,1	0.217655	0.205418	0.053381	0.094123	0.368636	0.407373	0.224308	0.337900
y12,2	0.238317	0.227556	0.086333	0.086816	0.188219	0.350961	0.236677	0.275545
y13,1	0.365885	0.493414	0.187954	0.106763	1.086847	1.297631	0.581094	0.512416
y13,2	0.478336	0.435509	0.241424	0.147881	1.341250	1.467292	0.575522	0.461948
y14,1	0.116513	0.128655	0.035929	0.036577	0.244887	0.231712	0.083741	0.146831
y14,2	0.097531	0.085607	0.031577	0.027386	0.180538	0.190753	0.047882	0.107697
y15,1	0.229036	0.225434	0.063095	0.039458	0.648857	0.567187	0.404973	0.423451
y15,2	0.187925	0.312478	0.132675	0.089791	0.763143	0.810254	0.592305	0.851553
y16,1	0.125257	0.058535	0.043718	0.033883	0.271186	0.254564	0.437795	0.298019
y16,2	0.263442	0.193268	0.107034	0.052870	0.627089	0.543818	0.344552	0.378584
y17,1	0.127928	0.108071	0.044102	0.021691	0.326346	0.255687	0.241845	0.193397
y17,2	0.152811	0.175571	0.052882	0.020914	0.357001	0.349445	0.222968	0.202988
y18,1	0.354515	0.484759	-0.047273	-0.027169	1.544742	1.154421	0.256074	0.394122
y18,2	0.815933	0.523890	0.145169	0.045878	0.438945	0.918296	0.606052	1.346081
y19,1	0.765881	0.626910	0.176933	0.075654	1.262196	1.537116	1.256258	1.054027
y19,2	0.776784	0.799447	0.267425	0.254425	1.527395	1.758877	1.132433	1.503112
y20,1	-0.010049	0.085136	0.027632	0.022533	0.149715	0.140380	0.119342	0.062917
y20,2	0.147642	0.174311	0.046835	-0.008102	0.300454	0.229586	0.173785	0.195420
y21,1	-0.049609	-0.035968	-0.021119	-0.028555	-0.119262	-0.086183	0.046299	-0.033715
y21,2	0.040039	0.007263	-0.007828	-0.001898	-0.005922	0.222767	0.040425	-0.042635
y22,1	0.498511	0.518620	0.194266	0.131124	0.492172	1.001870	0.391056	0.868532
y22,2	0.332570	0.283096	0.117526	0.170145	1.278881	1.316865	0.668039	0.844894
y23,1	0.115007	0.168627	0.067537	0.050844	0.359062	0.516310	0.240412	0.307572
y23,2	0.219983	0.256419	0.075404	0.083919	0.411732	0.478271	0.360208	0.476128
y24,1	0.117761	0.080896	0.024541	0.043587	0.160135	0.189681	0.121039	0.150371
y24,2	0.162806	0.144520	0.068897	0.051868	0.212806	0.259571	0.160715	0.201207
y25,1	0.132608	0.098577	0.045481	0.028814	0.259024	0.197265	0.223199	0.086636
y25,2	0.118235	0.071818	0.061495	0.032042	0.085535	0.202259	0.092252	0.038357
y26,1	0.153441	0.123283	0.046656	0.044358	0.295487	0.263973	0.222768	0.253732
y26,2	0.162000	0.162181	0.049600	0.037102	0.258627	0.281841	0.279300	0.265188
y27,1	0.056045	0.077907	0.043834	0.047299	0.237588	0.323824	0.220276	0.208771
y27,2	0.082203	0.127059	0.031841	0.048324	0.271876	0.243825	0.156682	0.289718
y28,1	0.145724	0.153209	0.028506	0.070668	0.376302	0.410498	0.365480	0.267437
y28,2	0.152291	0.158074	0.014422	0.041707	0.723554	0.733119	0.509300	0.418071
w1,1	4.130560	4.141326	1.013423	1.081838	9.334125	8.784599	4.475398	5.287295
w1,2	5.028165	4.821008	1.397820	1.191330	10.112784	11.284442	5.858323	6.417669
w2,1	9.547225	8.562001	2.380725	2.026720	20.454927	17.848324	10.758255	11.703224
w2,2	10.843215	9.902834	2.747412	2.305818	21.031675	20.812504	12.525773	13.375947
z1	0.448809	0.431142	0.116758	0.106907	0.635200	0.593470	0.417774	0.403947
z2	0.258218	0.270234	0.071444	0.080534	0.335901	0.379850	0.303321	0.364366

Table B2 (cont.)

	y9,1	y9,2	y10,1	y10,2	y11,1	y11,2	y12,1	y12,2
y9,1	1.812463							
y9,2	1.048725	2.227676						
y10,1	0.398784	0.338763	0.670170					
y10,2	0.343782	0.350653	0.543933	0.691208				
y11,1	1.322626	1.359470	0.282196	0.330245	15.826782			
y11,2	1.201850	1.728756	0.525344	0.450258	6.811828	16.067616		
y12,1	0.079274	0.277110	0.053443	0.069869	2.008507	0.870101	2.553363	
y12,2	0.312127	0.373273	0.187355	0.149672	1.571990	2.461255	0.234057	2.533371
y13,1	1.768395	1.919003	0.800556	1.005203	2.500729	3.995183	0.365756	0.815960
y13,2	1.496551	2.092349	0.453106	0.516048	1.778011	4.595732	0.260625	0.859877
y14,1	0.073141	0.105546	0.003875	0.037009	0.507378	0.481135	0.040732	-0.031063
y14,2	0.025744	0.070372	0.025996	0.068108	0.414266	0.260059	0.104692	-0.031191
y15,1	0.740233	0.969929	0.231009	0.238607	1.950133	2.786365	0.256830	0.745044
y15,2	0.607206	0.748947	0.037164	0.098837	1.699604	3.055022	0.285779	1.173183
y16,1	0.248369	0.458641	0.091243	0.054180	0.731549	1.501514	0.197611	0.356420
y16,2	0.548872	0.352138	0.119422	0.058990	1.418423	2.385704	0.028656	0.262305
y17,1	0.181658	0.220969	0.058075	0.040224	0.442870	0.835014	0.082259	0.132581
y17,2	0.243298	0.186730	-0.018298	0.036584	0.791614	1.001330	-0.019740	0.176534
y18,1	0.236733	0.404938	0.115841	0.154422	2.764149	2.316408	0.020046	-0.333030
y18,2	0.139232	0.689381	0.693622	0.506321	2.559162	7.090926	1.302235	0.829487
y19,1	0.444135	0.874227	0.489351	0.508532	4.287702	4.640522	0.689917	1.323514
y19,2	1.126975	1.677847	0.556628	0.715293	3.037211	5.837450	0.630643	1.406015
y20,1	0.340284	0.338778	0.102158	0.167184	0.972879	0.129856	0.049014	0.107437
y20,2	0.197673	0.186574	0.120228	0.152536	0.911365	1.168430	-0.026577	0.297776
y21,1	-0.021625	0.036383	0.112494	0.155086	-0.263608	-0.177793	-0.018857	-0.049727
y21,2	0.266782	0.298439	0.078432	0.103762	0.460005	0.083688	-0.032203	0.301680
y22,1	0.991697	0.990038	0.092264	0.177944	2.950260	3.625141	0.940679	1.757859
y22,2	1.107623	1.785227	-0.029100	0.033376	3.941600	5.126144	0.923941	1.418602
y23,1	0.193025	0.027792	0.205600	0.253489	1.114885	0.458086	0.229465	0.476598
y23,2	0.129763	0.508995	0.192820	0.225582	0.872593	1.268627	0.076915	0.437749
y24,1	0.143958	0.240610	0.075390	0.044408	0.493571	0.537713	0.287178	0.131811
y24,2	0.249383	0.409773	0.161463	0.179312	0.716614	0.829813	0.282009	0.289911
y25,1	-0.034928	0.219428	0.100324	0.043427	0.499579	0.321482	0.168781	0.017228
y25,2	0.150939	0.343874	0.039258	0.008986	0.451440	0.532908	0.030294	0.098177
y26,1	0.270671	0.256374	0.101860	0.081410	1.176898	0.916278	0.210209	0.132396
y26,2	0.283987	0.328194	0.128068	0.121732	1.105173	1.236384	0.196247	0.301877
y27,1	0.214292	0.352935	0.072465	0.068193	1.162350	1.177255	0.235147	0.364827
y27,2	0.212181	0.349200	0.077636	0.093716	0.744201	1.272245	0.300993	0.211779
y28,1	0.576822	0.603314	0.299696	0.379014	1.327964	1.302965	0.237965	0.632334
y28,2	0.637230	1.106493	0.333103	0.464224	1.243908	2.271039	0.216652	0.489027
w1,1	6.392618	7.486928	2.210887	2.174381	27.389803	25.413620	3.672475	6.213305
w1,2	6.611136	8.265311	3.058760	3.450768	30.594397	32.005119	3.307799	8.032613
w2,1	13.599019	15.665276	5.001468	5.225776	53.711353	54.377289	10.308606	12.719235
w2,2	13.164108	15.681645	6.336159	6.866270	58.686035	62.784725	10.460119	15.988892
z1	0.111256	0.150909	0.115522	0.107336	0.971057	1.024994	0.342344	0.264107
z2	0.185081	0.172617	0.104229	0.130044	1.118706	1.131239	0.204552	0.208609

Table B2 (cont.)

	y13,1	y13,2	y14,1	y14,2	y15,1	y15,2	y16,1	y16,2
y13,1	18.377975							
y13,2	10.970476	25.731113						
y14,1	0.462410	0.609248	0.561220					
y14,2	0.484263	0.496945	0.355142	0.522497				
y15,1	3.607696	2.531925	0.497939	0.525906	11.968079			
y15,2	2.607879	3.330039	0.316922	0.279521	2.665390	12.108100		
y16,1	1.303095	1.136986	0.062969	0.080166	1.626024	0.713235	2.892304	
y16,2	0.963827	0.689830	0.285469	0.261407	1.466584	1.487958	0.695273	5.657512
y17,1	1.030104	0.785380	0.106482	0.125018	0.627285	0.582224	0.379211	0.142306
y17,2	1.243411	0.868574	0.072518	0.061304	0.232704	0.323060	0.156473	0.355231
y18,1	2.346464	0.028890	0.635237	0.529392	0.871438	1.083455	0.159252	0.654640
y18,2	2.479087	2.395715	0.222404	0.104324	5.809729	2.414502	1.217068	0.975682
y19,1	3.796474	5.615843	0.535895	0.353072	2.189157	3.117536	1.551519	1.397521
y19,2	3.214742	5.867730	0.717488	0.577114	2.223134	2.850775	1.493058	1.981299
y20,1	1.287250	1.307591	0.070694	-0.035670	0.243426	0.311829	0.240898	0.120748
y20,2	1.184724	0.875135	0.108540	0.052046	0.594223	0.329628	0.025016	0.283030
y21,1	0.717672	0.688269	0.012337	0.019490	0.174296	0.077317	0.097543	-0.013755
y21,2	0.553404	0.171718	0.045046	0.015613	0.217354	-0.007356	-0.002645	-0.216141
y22,1	2.919122	1.722116	0.250760	0.446815	2.704724	1.198353	0.900068	0.847709
y22,2	4.687044	3.385348	0.231745	0.297265	3.122290	1.885654	1.153863	1.431844
y23,1	0.362329	0.050500	-0.002712	0.114845	0.311201	0.442643	0.145826	0.098976
y23,2	0.682792	0.781772	0.147908	0.111392	-0.099313	0.807304	0.176840	0.035720
y24,1	0.427249	0.550470	0.034071	-0.000290	0.348826	0.125240	0.112417	0.078442
y24,2	0.851633	0.762599	0.075300	0.025843	0.553094	0.284366	0.107480	0.438209
y25,1	0.462976	0.556905	-0.005517	0.020256	0.229424	0.083470	0.228910	0.367178
y25,2	0.805371	1.042563	0.016976	0.000636	0.104956	0.435439	-0.022171	-0.056200
y26,1	0.669399	0.683560	0.079289	0.066557	0.463385	0.473611	0.217408	0.277903
y26,2	0.899364	0.701640	0.103233	0.080433	0.258019	0.638077	0.183816	0.322863
y27,1	0.617654	0.592655	0.056205	0.024740	0.127075	0.397215	0.283404	0.845783
y27,2	0.833519	0.608423	0.079997	0.134959	0.630704	0.808929	0.307118	0.607137
y28,1	2.598123	1.736824	0.127657	0.149553	0.636899	0.742341	0.374913	0.347007
y28,2	2.564543	2.359977	0.272988	0.139253	1.146483	1.187190	0.301536	0.724400
w1,1	30.474464	31.944881	3.948847	3.132111	14.426525	13.262739	6.110340	8.349269
w1,2	30.418890	31.248163	4.607725	3.936088	17.618690	14.890628	6.469933	9.669741
w2,1	70.195587	73.589951	8.244598	6.516798	38.033180	28.454617	15.308734	18.458696
w2,2	69.328011	71.372505	8.656631	7.069178	39.869198	30.725561	14.684651	20.347328
z1	0.760778	1.205322	0.151191	0.113973	0.147769	0.274263	0.164621	0.345004
z2	0.543605	0.733228	0.161686	0.123757	0.415644	0.430485	0.181817	0.372113

Table B2 (cont.)

	y17,1	y17,2	y18,1	y18,2	y19,1	y19,2	y20,1	y20,2
y17,1	0.865053							
y17,2	0.367977	1.454572						
y18,1	-0.550310	0.185461	42.321239					
y18,2	0.768962	-0.013828	-3.549514	70.497459				
y19,1	0.673264	0.645247	7.909493	5.207490	20.608160			
y19,2	0.638115	1.030358	6.135601	6.658256	10.405229	29.357044		
y20,1	0.006267	0.147463	0.583952	0.466579	0.447017	0.285553	2.347898	
y20,2	0.168145	0.391481	-0.006623	0.363896	0.956475	0.977820	0.600306	2.261793
y21,1	0.106904	0.088494	-0.320131	0.824376	0.503758	-0.072700	0.302100	0.035395
y21,2	-0.004651	-0.045424	0.647226	-0.551095	0.672646	0.518657	0.098898	0.097567
y22,1	0.371134	0.121385	2.766212	6.025756	2.342477	3.401347	0.351726	0.447364
y22,2	0.792466	0.958760	1.278132	4.281792	3.241615	5.111523	0.659952	0.769316
y23,1	-0.089304	0.094600	2.030878	0.283302	1.916681	1.725580	0.160994	0.259271
y23,2	0.156745	0.283406	0.953390	0.767915	0.864121	1.228299	0.238857	0.569507
y24,1	0.057953	0.075814	0.180513	0.370818	0.541897	0.967247	0.168476	0.113242
y24,2	0.125906	0.122166	-0.388204	0.404634	0.503951	1.128340	0.310709	0.344492
y25,1	0.118537	0.084199	-0.172217	0.506833	0.830379	-0.020136	0.230651	0.231495
y25,2	0.081696	0.017467	0.247534	-0.639687	0.305685	0.267763	0.104302	0.026458
y26,1	0.148857	0.176590	0.508777	0.802064	0.740668	0.644328	0.228908	0.184960
y26,2	0.132706	0.188919	0.310640	0.847627	1.160203	0.934825	0.185623	0.245006
y27,1	0.151648	0.116893	0.208931	0.579227	0.800998	1.028843	0.229043	0.137688
y27,2	0.166882	0.106314	0.853926	-0.258753	0.591351	1.322533	0.070133	0.308471
y28,1	0.036595	0.249341	1.944940	1.375462	2.114430	1.948218	0.978442	0.630812
y28,2	0.234951	0.395950	1.616973	1.554461	1.950238	2.639444	0.651420	1.018450
w1,1	3.125437	3.376444	38.468849	32.968998	39.890095	30.623215	10.024041	9.244157
w1,2	3.734536	3.897270	36.854679	47.646912	45.191887	40.678036	11.173652	10.291575
w2,1	8.872904	6.607642	71.482468	64.223534	86.841690	72.276825	15.268535	14.209900
w2,2	8.428413	7.348486	59.695694	83.538300	90.558128	83.995216	17.065765	16.845295
z1	0.248429	0.243189	0.240443	0.710125	1.154150	1.482922	-0.124171	0.002141
z2	0.009856	0.092973	1.552026	1.355742	1.490224	1.352089	0.247417	0.316117

	y21,1	y21,2	y22,1	y22,2	y23,1	y23,2	y24,1	y24,2
y21,1	2.001215							
y21,2	0.558718	4.241985						
y22,1	0.418982	0.201070	17.019882					
y22,2	0.265667	0.122795	4.401606	17.339136				
y23,1	-0.028076	0.574177	0.584498	0.706125	3.485285			
y23,2	0.161273	0.339255	0.455652	0.611860	1.489238	3.566737		
y24,1	0.014316	0.156567	-0.010384	0.446875	0.335906	0.227502	1.165015	
y24,2	0.029348	0.148534	0.444439	0.817575	0.132399	0.372954	0.559146	1.189302
y25,1	0.202058	0.057698	0.243430	0.408966	0.115675	0.182618	-0.027870	0.037352
y25,2	0.060503	0.237440	0.600774	0.169528	-0.037270	0.172680	0.049625	0.218629
y26,1	-0.058248	0.013012	0.447052	0.732791	0.213112	0.188138	0.063144	0.117140
y26,2	-0.010104	0.128542	0.395346	0.841063	0.302821	0.259051	0.030181	0.179072
y27,1	0.004852	-0.018054	0.928812	1.179661	0.247036	0.248680	0.172538	0.241383
y27,2	-0.062922	0.043051	0.600667	1.111487	0.141625	0.144776	0.142657	0.085050
y28,1	0.247619	0.210708	1.284867	1.383910	0.857123	0.623515	0.218007	0.539719
y28,2	0.311983	0.241052	0.051692	1.877583	0.499322	0.652695	0.307361	0.578381
w1,1	0.605261	2.688444	22.983744	24.205875	9.226966	9.565433	3.392338	5.315474
w1,2	0.558613	3.785682	24.351259	28.301781	9.417617	10.671722	4.221370	6.428628
w2,1	-0.954287	4.335158	40.636337	50.339207	18.488815	17.331896	7.094429	10.721671
w2,2	-1.159410	6.007296	41.308605	56.367001	19.475693	19.108829	8.625416	12.162814
z1	-0.196621	0.016028	0.468997	0.595099	0.078153	0.243050	0.078209	0.108816
z2	0.008769	0.129021	0.659226	0.661151	0.424406	0.424699	0.143196	0.198987

Table B2 (cont.)

	y25,1	y25,2	y26,1	y26,2	y27,1	y27,2	y28,1	y28,2
y25,1	1.390735							
y25,2	-0.089581	1.840205						
y26,1	0.118171	0.041695	0.688810					
y26,2	0.196806	0.115061	0.306136	0.744907				
y27,1	0.181317	-0.005900	0.143546	0.199385	1.109198			
y27,2	-0.035739	0.026626	0.171231	0.245634	0.293097	1.775229		
y28,1	0.252655	0.067678	0.226463	0.375308	0.336117	0.226703	3.521796	
y28,2	0.556137	0.078226	0.420033	0.457922	0.338905	0.345069	2.147486	4.718562
w1,1	4.770749	2.736684	5.878923	5.849747	3.758516	3.421099	14.356845	15.662035
w1,2	5.003687	3.220475	5.928851	6.538258	4.604678	3.540328	15.664503	17.344334
w2,1	7.784428	4.309711	11.859710	12.804666	8.329100	6.687543	29.022100	26.856989
w2,2	8.517956	4.458968	12.098310	14.043112	9.382539	6.748914	32.054962	30.116575
z1	0.096989	0.251938	0.225201	0.213226	0.082403	0.196258	0.128466	0.076684
z2	0.118844	0.140508	0.238436	0.243887	0.152594	0.179226	0.317542	0.426256

	w1,1	w1,2	w2,1	w2,2	z1	z2
w1,1	462.676819					
w1,2	444.539032	544.669678				
w2,1	744.513428	757.631042	1626.370850			
w2,2	731.354187	869.879517	1624.143677	1851.204956		
z1	2.397596	4.392388	9.495282	12.433169	1.579200	
z2	12.255118	13.281254	20.156355	21.558226	0.078527	0.826605

Table B3. Overview of fitted models with characteristics[a]

	D_U	D_S	D_R	D_N
P_UM_U	p=950	p=926	p=924	p=923
	DF=1065	DF=1089	DF=1091	DF=1092
	CHI=1475.90	CHI=1496.64	CHI=1497.29	CHI=1502.61
	AIC=3375.90	AIC=3348.64	AIC=3345.29	AIC=3348.61
	CAIC=8136.60	CAIC=7989.08	CAIC=7975.70	CAIC=7974.01
	CAICF=8963.24	CAICF=8800.25	CAICF=8789.64	CAICF=8791.49
P_UM_B	p=655	p=631	p=629	p=628
	DF=1360	DF=1384	DF=1386	DF=1387
	CHI=1876.65	CHI=1893.73	CHI=1894.29	CHI=1897.15
	AIC=3186.65	AIC=3155.73	AIC=3152.29	AIC=3153.15
	CAIC=6469.03	CAIC= 6317.84	CAIC=6304.38	CAIC=6300.23
	CAICF=7162.59	CAICF=6997.89	CAICF=7021.38	CAICF= 6987.06
P_BM_U	p=683	p=659	p=657	p=656
	DF=1332	DF=1356	DF=358	DF=1359
	CHI=1837.47	CHI=1859.17	CHI=1859.43	CHI=1864.35
.	AIC=3203.47	AIC=3177.17	AIC=3173.43	AIC=3176.35
	CAIC=6626.17	CAIC=6479.60	CAIC=6465.84	CAIC=6463.74
	CAICF=7202.17	CAICF=7040.74	CAICF=7029.80	CAICF= 7031.18
P_BM_B	p=388	p=364	P=362	p=361
	DF=1627	DF=1651	DF=1653	DF=1654
	CHI=2293.97	CHI=2310.94	CHI=2311.45	CHI=2313.89
	AIC=3069.97	AIC=3038.94	AIC=3035.45	AIC=3035.89
	CAIC=5014.34	CAIC=4863.04	CAIC=4849.53	CAIC=4844.95
	CAICF=5370.53	CAICF=5205.62	CAICF=5195.02	CAICF=5194.19
P_BM_R	p=315	p=291	p=289	p=288
	DF=1700	DF=1724	DF=1726	DF=1727
	CHI=2387.19	CHI=2405.22	CHI=2405.74	CHI=2406.64
	AIC=3017.19	AIC=2987.22	AIC=2983.74	AIC=2982.64
	CAIC=4595.74	CAIC=4445.50	CAIC=4432.00	CAIC=4425.89
	CAICF=4852.55	CAICF=4689.21	CAICF=4678.65	CAICF=4676.36
P_RM_B	p=312	p=288	p=286	p=285
	DF=1703	DF=1726	DF=1729	DF=1730
	CHI=2459.47	CHI=2476.12	CHI=2476.82	CHI=2477.93
	AIC=3083.47	AIC=3052.12	AIC=3048.82	AIC=3047.93
	CAIC=4646.98	CAIC=4495.36	CAIC=4482.04	CAIC=4476.14
	CAICF=4875.73	CAICF=4710.73	CAICF=4700.34	CAICF=4698.24

Table B3 (cont.)

	D_U	D_S	D_R	D_N
P_RM_R	p=239 DF=1776 CHI=2537.95 AIC=3015.95 CAIC=4213.65 CAICF=4327.66	p=215 DF=1800 CHI=2556.40 AIC=2986.40 CAIC=4063.82 CAICF=4164.80	p=213 DF=1802 CHI=2556.96 AIC=2982.96 CAIC=4050.36 CAICF=4154.29	p=212 DF=1803 CHI=2557.71 AIC=2981.71 CAIC=4044.09 CAICF=4151.86
P_RM_D	p=229 DF=1786 CHI=2768.12 AIC=3226.12 CAIC=4373.70 CAICF=4476.17	p=205 DF=1810 CHI=2785.76 AIC=3195.76 CAIC=4223.07 CAICF=4312.78	p=203 DF=1812 CHI=2786.39 AIC=3192.39 CAIC=4209.67 CAICF=4302.34	p=202 DF=1813 CHI=2787.28 AIC=3191.28 CAIC=4203.55 CAICF=4300.04
P_DM_R	p=232 DF=1783 CHI=2599.17 AIC=3063.17 CAIC=4225.79 CAICF=4371.67	p=208 DF=1807 CHI=2617.49 AIC=3033.49 CAIC=4075.83 CAICF=4208.89	p=206 DF=1809 CHI=2618.06 AIC=3030.06 CAIC=4062.38 CAICF=4198.38	p=205 DF=1810 CHI=2618.91 AIC=3028.91 CAIC=4056.22 CAICF=4196.15
P_DM_D	p=222 DF=1793 CHI=3037.58 AIC=3481.58 CAIC=4594.08 CAICF=4721.13	p=198 DF=1817 CHI=3055.61 AIC=3451.61 CAIC=4443.84 CAICF=4558.15	p=196 DF=1819 CHI=3056.28 AIC=3448.28 CAIC=4430.49 CAICF=4547.72	p=195 DF=1820 CHI=3057.28 AIC=3447.28 CAIC=4424.48 CAICF=4545.68
$P_RM_RA_N$	p=236 DF=1779 CHI=2554.79 AIC=3026.79 CAIC=4209.45 CAICF=4347.80	p=212 DF=1803 CHI=2573.42 AIC=2997.42 CAIC=4059.81 CAICF=4183.12	p=210 DF=1805 CHI=2574.00 AIC=2994.00 CAIC=4046.36 CAICF=4172.61	p=209 DF=1806 CHI=2575.42 AIC=2993.42 CAIC=4040.77 CAICF=4170.78
P_RM_N	p=579 DF=1436 CHI=2184.06 AIC=3342.06 CAIC=6243.58 CAICF=6823.04			p=552 DF=1463 CHI=2208.90 AIC=3312.90 CAIC=6079.12 CAICF=6649.84

[a] The models are generated from combinations of assumptions in the dimensions P, M, A and D; see table 1 for definitions. For each model are presented the number of estimated parameters (p), the number of degrees of freedom (DF), the chi square statistics (CHI), the Akaike information criterion (AIC), the Consistent Akaike information criterion (CAIC) and the Consistent Akaike information criterion with Fisher information (CAICF); cf. Bozdogan (1987) for definitions.

Table B4. Engel functions. Marginal budget shares (b), effect of an additional child (c_1), effect of an additional adult (c_2), and intercept term (a_A).[a] Standard errors in parentheses

Commodity		b (‰)		c_1		c_2		a_A	
01	Flour and bread	8.33	(1.23)	144.04	(17.47)	140.57	(27.00)	156.02	(55.92)
02	Meat and eggs	44.24	(5.40)	211.24	(74.11)	85.31	(115.34)	260.67	(236.41)
03	Fish	10.23	(1.84)	-39.61	(26.52)	4.75	(40.84)	249.06	(85.02)
04	Canned meat and fish	3.71	(0.62)	13.57	(8.85)	3.39	(13.66)	59.35	(28.34)
05	Dairy products	5.44	(1.32)	235.52	(19.25)	228.21	(29.59)	269.54	(61.74)
06	Butter and margarine	2.38	(0.66)	54.14	(9.50)	56.61	(14.63)	94.43	(30.44)
07	Potatoes and vegetables	26.50	(2.85)	230.54	(38.97)	75.04	(60.71)	318.70	(124.30)
08	Other food	18.29	(2.08)	145.52	(28.65)	158.10	(44.54)	219.82	(91.45)
09	Beverages	41.66	(3.47)	-145.69	(45.44)	-297.97	(71.42)	80.12	(144.46)
10	Tobacco	12.34	(2.26)	-0.87	(31.72)	-14.64	(49.13)	160.09	(101.39)
11	Clothing	100.64	(8.55)	41.37	(110.30)	80.20	(174.04)	-678.18	(349.66)
12	Footwear	22.39	(3.47)	63.76	(45.67)	-40.28	(71.75)	-85.03	(144.83)
13	Housing	128.24	(11.15)	-83.31	(142.76)	-846.68	(225.60)	1411.98	(452.13)
14	Fuel and power	7.88	(1.95)	34.45	(26.94)	69.49	(41.87)	914.05	(85.91)
15	Furniture	69.54	(7.71)	-253.76	(100.37)	-346.72	(158.05)	255.13	(318.15)
16	Household equipment	31.98	(4.64)	-21.40	(61.17)	-68.79	(96.02)	64.58	(194.11)
17	Misc. household goods	20.70	(2.57)	44.90	(34.01)	-204.55	(53.34)	420.92	(108.03)
18	Motorcars, bicycles	55.96	(26.45)	-49.09	(225.64)	1039.31	(404.87)	-2096.03	(697.25)
19	Running cost of vehicles	114.21	(11.25)	157.14	(141.67)	255,04	(224.80)	-1836.94	(447.39)
20	Public transport	24.14	(3.70)	-182.06	(47.69)	52.02	(75.27)	-32.98	(150.87)
21	PTT charges	11.74	(4.26)	-122.59	(57.08)	-54.09	(89.31)	309.87	(181.33)
22	Recreation	91.79	(9.15)	-180.02	(118.63)	-349.22	(186.94)	11.19	(376.01)
23	Public entertainment	23.71	(4.68)	-47.40	(62.81)	217.28	(98.20)	-109.96	(199.68)
24	Books and newspapers	18.69	(2.77)	-48.73	(37.29)	-25.37	(58.30)	96.09	(118.63)
25	Medical care	7.97	(2.70)	61.74	(35.98)	49.78	(56.34)	85.59	(114.26)
26	Personal care	18.49	(1.92)	28.03	(25.38)	54.69	(39.83)	-114.23	(80.64)
27	Misc. goods and services	22.11	(2.72)	-37.07	(35.98)	-76.15	(56.42)	-156.21	(114.28)
28	Restaurants, hotels etc.	56.73	(4.95)	-254.35	(64.89)	-245.33	(102.00)	-327.63	(206.17)
	Sum	1000.00		0.00		0.00		0.00	

[a] The estimated parameters have been multiplied by 1000. Thus c_1, c_2, and a_A are measured in kroner and b in per thousand. (Since the input data are measured in 1 000 NOK so are the estimated parameters, but in this table, they are rescaled by 1 000 for convenience.)

Table B5. Income-consumption relations.[a] Standard errors in parentheses

	Parameters				
Income concept	e	f_1	f_2	d_1	d_2
Income measure 1	0.509	-1.280	9.118	-1.698	1.436
	(0.050)	(0.643)	(1.038)	(2.055)	(2.072)
Income measure 2	1.095	-0.027	11.356	-13.731	-11.959
	(0.094)	(1.242)	(1.948)	(3.966)	(3.997)

[a] Confer eq. (8) in the main paper. d_1 and d_2 are intercept terms in period 1 and 2, respectively.

Table B6. Parameters of the distribution of preference variables and measurement errors. Standard errors in parentheses [a]

Commodities and groups			
Ia Food	**var($\underline{\alpha}$)**	**var($\underline{\nu}$)**	**h**
01 Flour and bread	0.062	0.140	0.218
	(0.012)	(0.012)	(0.024)
02 Meat and eggs	0.922	3.579	0.235
	(0.250)	(0.254)	(0.109)
03 Fish	0.206	0.321	0.112
	(0.029)	(0.023)	(0.033)
04 Canned meat and fish	0.012	0.055	0.052
	(0.004)	(0.004)	(0.013)
05 Dairy products	0.111	0.123	0.244
	(0.014)	(0.012)	(0.025)
06 Butter and margarine	0.013	0.058	0.119
	(0.004)	(0.005)	(0.015)
07 Potatoes and vegetables	0.281	0.736	0.283
	(0.062)	(0.055)	(0.052)
08 Other foods	0.128	0.379	0.361
	(0.032)	(0.033)	(0.040)
	var($\bar{\alpha}$)		
Group specific preference variable	211.010		
	(57.298)		
Ib Beverages and tobacco	**var(α)**	**var(ν)**	
09 Beverages	0.563	0.938	
	(0.088)	(0.067)	
10 Tobacco	0.490	0.135	
	(0.040)	(0.010)	
Beverages vs Tobacco	0.203		
	(0.042)		
II Clothing and footwear	**var (α)**	**var (ν)**	
11 Clothing	2.563	8.839	
	(0.626)	(0.627)	
12 Footwear	0.007	2.294	
	(0.115)	(0.161)	
Clothing vs Footwear	0.259	0.935	
	(0.194)	(0.229)	
III Housing, fuel and furniture	**var($\underline{\alpha}$)**	**var(ν)**	
13 Housing	5.974	10.850	
	(1.059)	(0.774)	
14 Fuel and power	0.301	0.188	
	(0.029)	(0.013)	
15 Furniture	0.800	9.418	
	(0.526)	(0.659)	
16 Household equipment	0.223	3.588	
	(0.191)	(0.251)	
17 Misc. household goods	0.192	0.789	
	(0.053)	(0.056)	
Furniture vs Household equipment		0.627	
		(0.231)	
	var($\bar{\alpha}$)		
Group specific preference variable	81.892		
	(34.233)		

Table B6 (cont.)

IVa Travel	**var(α)**	**var(ν)**
18 Motorcars, bicycles	15.461	37.687
	(6.557)	(6.723)
19 Running cost of vehicles	5.951	13.881
	(1.116)	(0.982)
20 Public transport	0.343	1.675
	(0.104)	(0.118)
Motorcars, bicycles vs	3.386	
Running cost of vehicles	(0.946)	
Motorcars, bicycles vs	-0.332	
Public transport	(0.271)	
Running cost of vehicles vs	-0.306	
Public transport	(0.207)	
IVb Recreation	**var(α)**	**var(ν)**
21 PTT charges	0.499	2.589
	(0.155)	(0.181)
22 Recreation	1.927	12.424
	(0.748)	(0.874)
23 Public entertainment	1.179	2.012
	(0.171)	(0.141)
24 Books and newspapers	0.442	0.608
	(0.058)	(0.043)

V Other goods and services	**var(α)**	**var(ν)**
25 Medical care	-0.146	1.702
	(0.077)	(0.119)
26 Personal care	0.123	0.402
	(0.028)	(0.028)
27 Misc. goods and services	0.095	1.165
	(0.065)	(0.082)
28 Restaurants, hotels etc.	1.228	1.891
	(0.183)	(0.135)

Income concepts	**var(λ)**	**var(ε)**
Income measure 1	182.279	53.624
	(15.490)	(4.065)
Income measure 2	726.229	94.599
	(57.666)	(8.415)
Income measure 1 vs	268.711	52.117
Income measure 2	(26.363)	(5.146)

[a] Note that **var(x)** includes also the covariances between the elements in any vector x, and that only (co)variances that are free parameters under estimation are included.

Table B7. Parameters related to the distribution of latent total expenditure.
Standard errors in parentheses

Parameter	Symbol	Estimate
Variance of the permanent component of latent total expenditure	$\sigma_{\chi\chi}$	362.056 (33.021)
Variance of the volatile component of latent total expenditure	σ_{uu}	14.793 (3.691)
Covariance between latent total expenditure and the number of children	$\sigma_{\chi z1}$	8.668 (1.373)
Covariance between latent total expenditure and the number of adults	$\sigma_{\chi z2}$	9.863 (1.070)
Expected value of the permanent component of latent total expenditure	$\Phi_{\chi} = \Phi_{\xi 1}$	39.885 (1.126)
Expected value of latent total expenditure in the second period	$\Phi_{\xi 2}$	41.362 (1.212)
Growth in expected latent total expenditure from the first to the second period	$\Phi_{\xi 2} - \Phi_{\xi 1}$	1.477 (0.649)
Intercept term for period 2 in the latent total expenditure process	q_{02}	-3.620 (1.359)
Growth factor of latent total expenditure	q_2	1.128 (0.029)
Expected value of the purchase residual for motorcars in period 2	$a_{B18,2}$	1.133 (0.541)
Covariance between the volatile component of latent total expenditure and the residual for motorcar purchases in the same period	$cov(\nu_{18,t},u_t)$	14.467 (3.466)
Cov. between the volatile comp. of latent total expenditure in the first period and the residual for motorcar purchases in the second period	$cov(\nu_{18,2},u_1)$	13.131 (4.524)
Autocovariance of purchase residuals for motorcars	$cov(\nu_{18,1},\nu_{18,2})$	-21.388 (6.397)

Table B8. Distributional measures of the preference variables α. Relative covariation of preferences in the lower triangle (relative variation along the main diagonal) and correlation coefficients in the upper triangle (excluding the main diagonal)

	α01	α02	α03	α04	α05	α06	α07	α08	α09	α10	α11	α12	α13	α14	α15	α16	α17	α18	α19	α20	α21	α22	α23	α24	α25	α26	α27	α28
α01	0.089	0.244	0.136	0.196	0.101	0.126	0.258	0.262	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α02	0.035	0.228	0.173	0.249	0.128	0.159	0.327	0.332	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α03	0.030	0.061	0.551	0.139	0.072	0.089	0.183	0.186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α04	0.031	0.063	0.054	0.277	0.103	0.128	0.263	0.267	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α05	0.009	0.018	0.015	0.016	0.083	0.066	0.136	0.138	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α06	0.013	0.025	0.022	0.023	0.006	0.112	0.168	0.171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α07	0.029	0.059	0.051	0.052	0.015	0.021	0.140	0.351	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α08	0.024	0.049	0.043	0.044	0.012	0.018	0.041	0.097	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α09	0	0	0	0	0	0	0	0	0.572	0.387	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α10	0	0	0	0	0	0	0	0	0.326	1.242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α11	0	0	0	0	0	0	0	0	0	0	0.195	1.933	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α12	0	0	0	0	0	0	0	0	0	0	0.091	0.011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
α13	0	0	0	0	0	0	0	0	0	0	0	0	0.336	0.055	0.247	0.224	0.169	0	0	0	0	0	0	0	0	0	0	0
α14	0	0	0	0	0	0	0	0	0	0	0	0	0.013	0.153	0.074	0.067	0.051	0	0	0	0	0	0	0	0	0	0	0
α15	0	0	0	0	0	0	0	0	0	0	0	0	0.074	0.015	0.270	0.300	0.226	0	0	0	0	0	0	0	0	0	0	0
α16	0	0	0	0	0	0	0	0	0	0	0	0	0.060	0.012	0.073	0.216	0.205	0	0	0	0	0	0	0	0	0	0	0
α17	0	0	0	0	0	0	0	0	0	0	0	0	0.055	0.011	0.066	0.054	0.320	0	0	0	0	0	0	0	0	0	0	0
α18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.698	0.353	-0.144	0	0	0	0	0	0	0	0
α19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.321	0.487	-0.214	0	0	0	0	0	0	0	0
α20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.120	-0.095	0.408	0	0	0	0	0	0	0	0
α21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.549	0	0	0	0	0	0	0
α22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.243	0	0	0	0	0	0
α23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.699	0	0	0	0	0
α24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.767	0	0	0	0
α25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.449*	0	0	0
α26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.201	0	0
α27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.321	0
α28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.816

*) The estimated variance is negative.

Table B9. Distributional measures of the preference variables μ. Relative covariation of preferences in the lower triangle (relative variation along the main diagonal) and correlation coefficients in the upper triangle (excluding the main diagonal)

	μ01	μ02	μ03	μ04	μ05	μ06	μ07	μ08	μ09	μ10	μ11	μ12	μ13	μ14	μ15	μ16	μ17	μ18	μ19	μ20	μ21	μ22	μ23	μ24	μ25	μ26	μ27	μ28
μ01	0.089	0.225	0.124	0.193	0.091	0.122	0.247	0.254	0.008	-0.018	-0.009	0.052	-0.070	-0.016	-0.018	-0.008	-0.009	-0.142	-0.090	0.042	-0.010	0.005	-0.018	0.000	*)	0.025	0.037	0.003
μ02	0.031	0.216	0.149	0.234	0.110	0.148	0.299	0.307	-0.018	-0.032	-0.045	-0.011	-0.119	-0.028	-0.058	-0.041	-0.035	-0.192	-0.144	0.034	-0.021	-0.028	-0.034	-0.015	*)	0.007	0.015	-0.023
μ03	0.027	0.051	0.542	0.129	0.061	0.081	0.165	0.169	-0.009	-0.017	-0.024	-0.004	-0.064	-0.015	-0.031	-0.022	-0.019	-0.105	-0.078	0.019	-0.011	-0.014	-0.019	-0.008	*)	0.004	0.009	-0.012
μ04	0.030	0.057	0.050	0.277	0.095	0.127	0.257	0.263	0.016	-0.016	-0.001	0.072	-0.065	-0.014	-0.010	-0.001	-0.004	-0.142	-0.084	0.048	-0.008	0.013	-0.015	0.004	*)	0.032	0.047	0.009
μ05	0.008	0.015	0.013	0.014	0.082	0.060	0.122	0.125	-0.007	-0.013	-0.018	-0.003	-0.048	-0.011	-0.023	-0.016	-0.014	-0.078	-0.058	0.014	-0.009	-0.011	-0.014	-0.006	*)	0.003	0.006	-0.009
μ06	0.012	0.023	0.020	0.022	0.006	0.111	0.162	0.167	0.007	-0.011	-0.003	0.039	-0.044	-0.010	-0.010	-0.003	-0.004	-0.092	-0.057	0.029	-0.006	0.005	-0.011	0.001	*)	0.018	0.027	0.004
μ07	0.027	0.051	0.045	0.050	0.013	0.020	0.137	0.337	0.004	-0.026	-0.020	0.050	-0.102	-0.023	-0.033	-0.019	-0.018	-0.193	-0.128	0.051	-0.015	-0.002	-0.027	-0.004	*)	0.028	0.042	-0.003
μ08	0.023	0.044	0.038	0.043	0.011	0.017	0.038	0.095	0.012	-0.024	-0.011	0.073	-0.095	-0.021	-0.024	-0.010	-0.012	-0.193	-0.121	0.058	-0.013	0.008	-0.024	0.000	*)	0.036	0.052	0.005
μ09	0.001	-0.007	-0.006	0.006	-0.002	0.002	0.000	0.002	0.604	0.362	0.032	0.204	-0.085	-0.017	0.017	0.029	0.017	-0.240	-0.119	0.104	-0.004	0.057	-0.014	0.021	*)	0.083	0.116	0.043
μ10	-0.006	-0.017	-0.015	-0.009	-0.004	-0.004	-0.011	-0.008	0.310	1.220	-0.032	-0.032	-0.063	-0.015	-0.038	-0.029	-0.024	-0.089	-0.075	0.008	-0.013	-0.024	-0.020	-0.012	*)	-0.006	-0.005	-0.020
μ11	-0.001	-0.010	-0.008	-0.001	-0.002	-0.001	-0.004	-0.002	0.010	-0.016	0.194	1.212	-0.131	-0.028	-0.019	-0.001	-0.007	-0.289	-0.171	0.098	-0.015	0.028	-0.030	0.008	*)	0.067	0.096	0.020
μ12	0.003	-0.002	-0.001	0.007	0.000	0.002	0.003	0.004	0.029	-0.007	0.103	0.037	-0.182	-0.032	0.109	0.135	0.088	-0.641	-0.274	0.321	0.004	0.218	-0.018	0.084	*)	0.275	0.377	0.166
μ13	-0.011	-0.030	-0.025	-0.018	-0.007	-0.008	-0.020	-0.016	-0.036	-0.037	-0.031	-0.019	0.275	0.008	0.127	0.127	0.091	-0.272	-0.252	0.001	-0.047	-0.110	-0.071	-0.052	*)	-0.048	-0.054	-0.088
μ14	-0.002	-0.005	-0.004	-0.003	-0.001	-0.001	-0.003	-0.003	-0.005	-0.007	-0.005	-0.003	0.001	0.151	0.043	0.042	0.030	-0.073	-0.063	0.005	-0.011	-0.022	-0.017	-0.011	*)	-0.007	-0.007	-0.018
μ15	-0.003	-0.014	-0.012	-0.003	-0.004	-0.002	-0.007	-0.004	0.005	-0.022	-0.005	0.010	0.033	0.008	0.259	0.288	0.211	-0.303	-0.192	0.089	-0.021	0.010	-0.038	-0.001	*)	0.054	0.079	0.005
μ16	-0.001	-0.009	-0.008	-0.001	-0.002	-0.001	-0.004	-0.002	0.009	-0.016	-0.001	0.011	0.030	0.007	0.067	0.215	0.200	-0.266	-0.157	0.089	-0.014	0.025	-0.028	0.007	*)	0.061	0.088	0.018
μ17	-0.002	-0.010	-0.008	-0.002	-0.002	-0.001	-0.004	-0.002	0.006	-0.015	-0.002	0.009	0.026	0.006	0.060	0.051	0.316	-0.202	-0.124	0.064	-0.012	0.013	-0.023	0.002	*)	0.041	0.060	0.009
μ18	-0.052	-0.109	-0.095	-0.092	-0.027	-0.038	-0.088	-0.073	-0.229	-0.121	-0.157	-0.152	-0.175	-0.035	-0.189	-0.151	-0.140	1.490	0.142	-0.299	-0.080	-0.289	-0.109	-0.127	*)	-0.214	-0.273	-0.227
μ19	-0.017	-0.042	-0.036	-0.028	-0.010	-0.012	-0.030	-0.024	-0.058	-0.052	-0.047	-0.034	-0.083	-0.015	-0.061	-0.046	-0.044	0.106	0.377	-0.250	-0.058	-0.150	-0.085	-0.070	*)	-0.079	-0.094	-0.120
μ20	0.008	0.010	0.009	0.017	0.003	0.006	0.013	0.012	0.054	0.006	0.029	0.041	0.000	0.001	0.030	0.027	0.024	-0.249	-0.106	0.462	0.017	0.117	0.016	0.048	*)	0.119	0.159	0.091
μ21	-0.004	-0.013	-0.011	-0.005	-0.003	-0.003	-0.007	-0.005	-0.005	-0.018	-0.009	0.000	-0.031	-0.005	-0.014	-0.009	-0.009	-0.122	-0.045	0.013	1.536	-0.008	-0.013	-0.005	*)	0.006	0.010	-0.007
μ22	0.000	-0.007	-0.006	0.003	-0.002	0.001	-0.001	0.001	0.021	-0.014	0.005	0.020	-0.030	-0.005	0.001	0.005	0.003	-0.179	-0.048	0.040	-0.006	0.256	-0.021	0.020	*)	0.091	0.127	0.043
μ23	-0.005	-0.014	-0.012	-0.007	-0.003	-0.003	-0.008	-0.006	-0.010	-0.018	-0.012	-0.004	-0.031	-0.006	-0.017	-0.011	-0.011	-0.110	-0.044	0.008	-0.014	-0.009	0.684	-0.011	*)	0.000	0.003	-0.017
μ24	0.000	-0.007	-0.006	0.001	-0.002	0.000	-0.002	0.000	0.013	-0.012	0.002	0.014	-0.025	-0.004	-0.001	0.002	0.000	-0.137	-0.039	0.028	-0.006	0.008	-0.008	0.771	*)	0.036	0.051	0.015
μ25	0.005	0.007	0.006	0.010	0.002	0.004	0.008	0.007	0.032	0.005	0.018	0.024	0.002	0.001	0.019	0.017	0.015	-0.067	-0.003	0.031	0.009	0.024	0.006	0.017	-0.431	*)	*)	*)
μ26	0.003	0.001	0.001	0.008	0.000	0.003	0.004	0.005	0.030	-0.004	0.013	0.024	-0.013	-0.001	0.012	0.013	0.010	-0.124	-0.024	0.038	0.003	0.021	-0.001	0.014	0.022	0.224	0.145	0.070
μ27	0.007	0.003	0.003	0.015	0.001	0.005	0.009	0.010	0.055	-0.005	0.025	0.045	-0.019	-0.002	0.024	0.024	0.020	-0.212	-0.038	0.067	0.007	0.039	0.001	0.027	0.039	0.042	0.398	0.097
μ28	0.000	-0.011	-0.009	0.004	-0.003	0.001	-0.002	0.001	0.029	-0.021	0.007	0.028	-0.044	-0.007	0.001	0.006	0.003	-0.255	-0.069	0.055	-0.009	0.018	-0.014	0.011	0.033	0.029	0.054	0.841

*) The estimated variance is negative, and hence the correlation coefficients can not be calculated.

Table B10. Distributional measures of the measurement errors ν. Relative covariation of measurement errors in the lower triangle (relative variation along the main diagonal) and correlation coefficients in the upper triangle (excluding the main diagonal)

	v01	v02	v03	v04	v05	v06	v07	v08	v09	v10	v11	v12	v13	v14	v15	v16	v17	v18	v19	v20	v21	v22	v23	v24	v25	v26	v27	v28
v01	0.220	0.062	0.098	0.110	0.288	0.224	0.158	0.255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v02	0.023	0.622	0.024	0.027	0.070	0.055	0.039	0.062	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v03	0.041	0.017	0.805	0.042	0.111	0.086	0.061	0.098	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v04	0.054	0.022	0.040	1.104	0.125	0.097	0.068	0.111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v05	0.049	0.020	0.036	0.047	0.130	0.254	0.179	0.289	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v06	0.078	0.032	0.058	0.076	0.068	0.553	0.139	0.225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v07	0.038	0.016	0.028	0.037	0.033	0.054	0.267	0.158	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v08	0.060	0.024	0.044	0.058	0.052	0.084	0.041	0.249	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v09	0	0	0	0	0	0	0	0	0.953	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v10	0	0	0	0	0	0	0	0	0	0.342	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v11	0	0	0	0	0	0	0	0	0	0	0.674	0.208	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v12	0	0	0	0	0	0	0	0	0	0	0.329	3.713	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v13	0	0	0	0	0	0	0	0	0	0	0	0	0.497	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v14	0	0	0	0	0	0	0	0	0	0	0	0	0	0.094	0	0	0	0	0	0	0	0	0	0	0	0	0	0
v15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.127	0.108	0	0	0	0	0	0	0	0	0	0	0	0
v16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.250	2.519	0	0	0	0	0	0	0	0	0	0	0	0
v17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.112	0	0	0	0	0	0	0	0	0	0	0
v18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.140	0	0	0	0	0	0	0	0	0	0
v19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.136	0	0	0	0	0	0	0	0	0
v20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.992	0	0	0	0	0	0	0	0
v21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8.032	0	0	0	0	0	0	0
v22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.564	0	0	0	0	0	0
v23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.193	0	0	0	0	0
v24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.053	0	0	0	0
v25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.243	0	0	0
v26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.659	0	0
v27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.958	0
v28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.257

Part C. Decomposition of the mean of variances of expenditures

Using scalar notation we may write equation (5) in the main paper as:

$$\text{(C1)}\ y_{it} = a_{i,A} + a_{i,B} + b_i\xi_t + c_{i1}z_1 + c_{i2}z_2 + \mu_i + \nu_{it}; i = 1,...,I;\ t = 1,...,T.$$

Taking the variance in (C1) we can for each commodity deduce the following formula

$$\begin{aligned}\text{(C2)}\ \bar{\sigma}^{ii}_{yy} = \frac{1}{T}\sum_{t=1}^{T}\sigma^{ii}_{y_t y_t} &= \frac{1}{T}\sum_{t=1}^{T}[b_i^2\sigma_{\xi_t\xi_t} + c_{i1}^2\sigma^{11}_{zz} + c_{i2}^2\sigma^{22}_{zz} + 2c_{i1}c_{i2}\sigma^{12}_{zz} + 2b_i c_{i1}\sigma_{\xi_t z_1} + \\ &\quad 2b_i c_{i2}\sigma_{\xi_t z_2} + 2b_i\sigma^{i}_{\xi_t \nu_t} + \sigma^{ii}_{\mu\mu} + \sigma^{ii}_{\nu\nu}] \\ &= b_i^2\bar{\bar{q}}(\sigma_{\chi\chi} + \sigma_{uu}) + c_{i1}^2\sigma^{11}_{zz} + c_{i2}^2\sigma^{22}_{zz} + 2c_{i1}c_{i2}\sigma^{12}_{zz} + \\ &\quad 2b_i c_{i1}\bar{q}\sigma_{\chi z_1} + 2b_i c_{i2}\bar{q}\sigma_{\chi z_2} + 2b_i\bar{q}\sigma^{i}_{u\nu} + \sigma^{ii}_{\mu\mu} + \sigma^{ii}_{\nu\nu},\end{aligned}$$

where $\bar{q} = \frac{1}{T}\sum_{t=1}^{T} q_t$ and $\bar{\bar{q}} = \frac{1}{T}\sum_{t=1}^{T} q_t^2$.

In our empirical application we have T=2 and q_1=1. Furthermore we have assumed that $\sigma^{i}_{u_t \nu_t}$ is zero for all commodities with exception of 18 Motorcars, bicycles. To measure the importance of different factors for the magnitude of $\bar{\sigma}^{ii}_{yy}$ we introduce the following ratios

$$\text{(C3)}\ \tau^{i}_{\xi} = \frac{b_i^2\bar{\bar{q}}(\sigma_{\chi\chi} + \sigma_{uu})}{\bar{\sigma}^{ii}_{yy}},$$

$$\text{(C4)}\ \tau^{i}_{D} = \frac{c_{i1}^2\sigma^{11}_{zz} + c_{i2}^2\sigma^{22}_{zz} + 2c_{i1}c_{i2}\sigma^{12}_{zz}}{\bar{\sigma}^{ii}_{yy}},$$

$$\text{(C5)}\ \tau^{i}_{\xi D} = \frac{2b_i c_{i1}\bar{q}\sigma_{\chi z_1} + 2b_i c_{i2}\bar{q}\sigma_{\chi z_2}}{\bar{\sigma}^{ii}_{yy}},$$

$$\text{(C6)}\ \tau^{i}_{\mu} = \frac{\sigma^{ii}_{\mu\mu}}{\bar{\sigma}^{ii}_{yy}},$$

$$\text{(C7)}\ \tau^{i}_{\nu} = \frac{\sigma^{ii}_{\nu\nu}}{\bar{\sigma}^{ii}_{yy}} \text{ and}$$

$$\text{(C8)}\ \tau^{i}_{u\nu} = \frac{2b_i\bar{q}\sigma^{i}_{u\nu}}{\bar{\sigma}^{ii}_{yy}}.$$

It now follows that

$$\text{(C9)}\ \tau^{i}_{\xi} + \tau^{i}_{D} + \tau^{i}_{\xi D} + \tau^{i}_{\mu} + \tau^{i}_{\nu} + \tau^{i}_{u\nu} = 1.$$

One should note that the two (interaction) terms $\tau^{i}_{\xi D}$ and $\tau^{i}_{u\nu}$, a priori, may take on both signs. In Table 3 in the main paper we refer to τ^{i}_{ξ} as "the contribution from total expenditure (1)", to τ^{i}_{D} as "the contribution from demographic variables (2)", to $\tau^{i}_{\xi D}$ as "the contribution from the interaction between total expenditure (1) and demographic variables (2)", to τ^{i}_{μ} as "the contribution from preference variables" and to $(\tau^{i}_{\nu} + \tau^{i}_{u\nu})$ as "the contribution from measurement errors".

Part D. Robust calculation of standard errors. Relative biases of standard errors

Table D1. Results for marginal budget shares, demographic derivatives and the intercepts

		Marginal budget share		Child derivative		Adult derivative		Intercept terms	
Com. num.	Commodity	Sandwich	Bootstrapping	Sandwich	Bootstrapping	Sandwich	Bootstrapping	Sandwich	Bootstrapping
01	Flour and bread	1.049	1.211	1.106	1.179	1.243	1.298	1.070	1.018
02	Meat and eggs	1.141	1.298	1.199	1.224	1.191	1.213	1.107	0.928
03	Fish	0.957	1.109	0.921	0.998	0.959	0.998	0.908	0.800
04	Canned meat and fish	1.177	1.306	1.185	1.233	1.012	0.997	1.077	0.969
05	Dairy products	1.333	1.470	1.764	1.812	1.458	1.516	1.186	1.061
06	Butter and margarine	1.182	1.348	1.604	1.706	1.280	1.349	1.129	1.005
07	Potatoes and vegetables	1.095	1.263	1.283	1.345	1.033	1.076	0.968	0.889
08	Other food	1.120	1.293	1.288	1.354	1.040	1.099	1.024	0.952
09	Beverages	1.104	1.331	1.026	1.132	1.121	1.219	1.024	0.924
10	Tobacco	1.221	1.593	1.101	1.139	1.117	1.229	1.076	1.000
11	Clothing	1.030	1.234	1.080	1.149	1.083	1.145	1.103	1.034
12	Footwear	1.104	1.222	1.263	1.344	1.050	1.085	1.071	0.919
13	Housing	1.206	1.538	1.151	1.326	1.112	1.238	1.143	0.942
14	Fuel and power	1.077	1.190	1.041	1.045	1.045	1.127	1.036	0.946
15	Furniture	1.285	1.438	0.990	1.043	1.005	1.058	1.012	0.906
16	Household equipment	1.569	1.772	1.058	1.134	1.289	1.367	0.968	0.812
17	Misc. household good	1.195	1.253	1.045	1.105	1.068	1.064	0.973	0.870
18	Motorcars, bicycles	0.968	1.924	1.074	1.546	1.098	1.719	1.102	1.139
19	Running cost of vehicles	1.134	1.292	1.249	1.283	0.952	1.026	1.145	0.973
20	Public transport	1.246	1.408	0.911	0.967	1.112	1.192	0.955	0.829
21	PTT charges	1.052	1.200	1.188	1.290	0.987	1.042	1.002	0.940
22	Recreation	1.125	1.340	1.030	1.070	1.009	1.076	1.176	1.011
23	Public entertainment	1.045	1.186	1.091	1.163	1.129	1.149	1.212	1.083
24	Books and newspapers	1.220	1.379	0.908	0.946	1.024	1.079	1.002	0.851
25	Medical care	1.026	1.156	1.183	1.213	1.043	1.106	1.120	1.060
26	Personal care	1.151	1.292	1.144	1.203	1.187	1.242	1.079	0.944
27	Misc. goods and services	1.419	1.577	1.167	1.226	1.147	1.204	1.002	0.891
28	Restaurants, hotels etc.	1.329	1.566	1.039	1.107	1.076	1.193	0.971	0.935
Unweighted mean		1.163	1.364	1.146	1.224	1.103	1.182	1.058	0.951

Table D2. Results for first order parameters in the income-consumption relations

Income concepts	Parameters									
	e		f_1		f_2		d_1		d_2	
	Sandwich	Boot-strapping	Sandwich	Boot-strapping	Sandwich	Boot-strapping	Sandwich	Boot-strapping	Sandwich	Boot-strapping
Income measure 1	1.218	1.740	0.978	1.177	1.086	1.298	0.934	0.967	1.048	0.984
Income measure 2	1.331	2.191	1.209	1.455	1.182	1.562	1.020	1.019	1.005	1.038

Table D3. Parameters of the distribution of preference variables and measurement errors

	Sandwich	Bootstrapping	Sandwich	Bootstrapping	Sandwich	Bootstrapping
Commodity and groups						
Ia Food	**var($\underline{\alpha}$)**		**var($\underline{\nu}$)**		**h**	
01 Flour and bread	1.071	1.083	1.396	1.417	1.153	1.375
02 Meat and eggs	1.399	1.424	2.081	2.142	1.167	1.413
03 Fish	1.874	1.897	1.838	1.826	0.996	1.182
04 Canned meat and fish	0.897	1.000	1.465	1.500	1.011	1.154
05 Dairy products	1.276	1.357	1.464	1.500	1.028	1.240
06 Butter and margarine	1.198	1.250	1.310	1.400	1.069	1.200
07 Potatoes and vegetables	1.456	1.403	1.761	1.818	1.133	1.385
08 Other foods	1.106	1.094	1.310	1.303	1.148	1.500
	var($\overline{\alpha}$)					
Group specific preference variable	1.117	1.517				
Ib Beverages and tobacco	**var(α)**		**var(ν)**			
09 Beverages	1.154	1.136	1.948	1.970		
10 Tobacco	1.314	1.275	1.745	1.800		
Beverages vs Tobacco	1.287	1.286				
II Clothing and footwear	**var (α)**		**var (ν)**			
11 Clothing	1.169	1.211	1.341	1.332		
12 Footwear	1.327	1.322	1.512	1.590		
Clothing vs Footwear	1.192	1.227	1.176	1.210		

Table D3. (Continued)

III Housing, fuel and furniture	**var(α)**		**var(ν)**	
13 Housing	1.278	1.313	1.910	1.889
14 Fuel and power	1.186	1.172	1.562	1.615
15 Furniture	1.236	1.295	1.614	1.672
16 Household equipment	1.097	1.110	1.994	2.008
17 Misc. household goods	1.422	1.472	2.269	2.304
Furniture vs Household equipment			1.447	1.498
	var($\bar{\alpha}$)			
Group specific preference variable	1.045	1.304		
IVa Travel	**var(α)**		**var(ν)**	
18 Motorcars, bicycles	1.036	3.728	1.111	2.572
19 Running cost of vehicles	1.276	1.254	1.838	1.711
20 Public transport	1.363	1.375	1.883	1.847
Motorcars, bicycles vs Running cost of vehicles	1.104	1.189		
Motorcars, bicycles vs Public transport	0.919	0.985		
Running cost of vehicles vs Public transport	1.086	1.068		
IVb Recreation	**var(α)**		**var(ν)**	
21 PTT charges	1.501	1.574	2.343	2.359
22 Recreation	1.500	1.571	1.731	1.770
23 Public entertainment	1.264	1.281	1.583	1.574
24 Books and newspapers	1.743	1.810	2.046	2.116
V Other goods and services	**var(α)**		**var(ν)**	
25 Medical care	0.666	0.662	1.984	1.899
26 Personal care	1.267	1.250	1.557	1.536
27 Misc. goods and services	1.229	1.138	2.027	2.122
28 Restaurants, hotels etc.	1.460	1.503	2.154	2.141
Income concepts	**var(λ)**		**var(ε)**	
Income measure 1	1.049	1.142	2.043	2.071
Income measure 2	1.097	1.278	1.796	1.749
Income measure 1 vs Income measure 2	1.055	1.250	1.954	1.948

Table D4. Parameters related to the distribution of latent total expenditure

Parameter	Symbol	Sandwich	Bootstrapping
Variance of the permanent component of latent total expenditure	$\sigma_{\chi\chi}$	0.974	1.064
Variance of the volatile component of latent total expenditure	σ_{uu}	1.120	2.599
Covariance between latent total expenditure and the number of children	$\sigma_{\chi z1}$	1.007	0.997
Covariance between latent total expenditure and the number of adults	$\sigma_{\chi z2}$	1.032	1.050
Expected value of the permanent component of latent total expenditure	$\Phi_{\chi} = \Phi_{\xi 1}$	0.974	1.005
Expected value of latent total expenditure in the second period	$\Phi_{\xi 2}$	1.010	1.064
Growth in expected latent total expenditure from the first to the second period	$\Phi_{\xi 2} - \Phi_{\xi 1}$	1.088	1.196
Intercept term for period 2 in the latent total expenditure process	q_{02}	1.010	1.166
Growth factor of latent total expenditure	q_2	1.126	1.621
Expected value of the purchase residual for motorcars in period 2	$a_{B18,2}$	1.005	1.015
Covariance between the volatile component of latent total expenditure and the residual for motorcar purchases in the same period	$cov(\nu_{18,t},u_t)$	0.988	1.376
Cov. between the volatile comp. of latent total expenditure in the first period and the residual for motorcar purchases in the second period	$cov(\nu_{18,2},u_1)$	1.238	1.576
Autocovariance of purchase residuals for motorcars	$cov(\nu_{18,1},\nu_{18,2})$	1.060	2.321

Part E. LISREL program of the reference model

The following program has been used to run the reference model ($P_MM_RA_RD_R$) on LISREL 8.30. The other models in the paper can be run using the same program after some minor changes. To read the program one should know the basic LISREL syntax and have read the paper. If a line starts with /* it means it contains a comment only. We have included 6 numbered comments.

TITLE REFERENCE MODEL:$P_RM_RA_RD_R$
DA NI=62 NO=408
/* Comment 1: Labels of observed variables. Confer Table B1.
LA
*
'Y1.1' 'Y1.2' 'Y2.1' 'Y2.2' 'Y3.1' 'Y3.2' 'Y4.1' 'Y4.2' 'Y5.1' 'Y5.2' 'Y6.1' 'Y6.2' 'Y7.1' 'Y7.2' 'Y8.1' 'Y8.2'
'Y9.1' 'Y9.2' 'Y10.1' 'Y10.2' 'Y11.1' 'Y11.2' 'Y12.1' 'Y12.2' 'Y13.1' 'Y13.2' 'Y14.1' 'Y14.2' 'Y15.1' 'Y15.2'
'Y16.1' 'Y16.2' 'Y17.1' 'Y17.2' 'Y18.1' 'Y18.2' 'Y19.1' 'Y19.2' 'Y20.1' 'Y20.2' 'Y21.1' 'Y21.2' 'Y22.1'
'Y22.2' 'Y23.1' 'Y23.2' 'Y24.1' 'Y24.2' 'Y25.1' 'Y25.2' 'Y26.1' 'Y26.2' 'Y27.1' 'Y27.2' 'Y28.1' 'Y28.2'
'W1.1' 'W1.2' 'W2.1' 'W2.2' 'Z1' 'Z2'
/* Comment 2: Reading of empirical covariance matrix and empirical means. Confer tables B2 and B1,
/* respectively. Note that file assignments depend on operating system. The programme
/* has been run on an Alpha Digital Unix machine.
CM FU FI=/ssb/frisch/h1/tes/lisrel/data/nivlim FO
(16F12.6,/,16F12.6,/,15F12.6,/,15F12.6)
ME FI=snitt.asc FO
(2F8.4)
MO NY=62 NE=192 LY=FU BE=FU PS=SY,FI TE=ZE AL=FR TY=FR
FI TY(1)-TY(35) TY(37)-TY(62) AL(55) AL(56) AL(61) AL(63)-AL(93) AL(97)-AL(192)
/* Comment 3: The element TY(36) corresponds to the parameter $a_{B18,2}$ in the paper, cf. Table B7.
/* The vector AL contains the parameters in $a_{A,1}$=$a_{A,2}$, d_1, d_2, q_{02}, Φ_χ , Ez_1 and Ez_2, cf. tables
/* B4, B5 and B7. The matrix BE contains the parameters in b, C, e, F, q_2 and h_{Ia}, cf. tables
/* B4-B7. The matrix PS contains the second order parameters, that is the 'deep' second order
/* parameters in $\Sigma_{\alpha\alpha}$ and Σ_{vv},, alongside with $\sigma_{\chi\chi}$, $\Sigma_{\chi z}$, Σ_{zz}, σ_{uu} , $\Sigma_{\lambda\lambda}$, $\Sigma_{\varepsilon\varepsilon}$, cov($\nu_{18,1}$, $\nu_{18,2}$),
/* cov($\nu_{18,1}$, u_1) = cov($\nu_{18,2}$, u_2) and cov($\nu_{18,2}$, u_1), cf. tables B6 and B7.
FR BE(1,63) BE(3,63) BE(5,63) BE(7,63) BE(9,63) BE(11,63)
FR BE(13,63) BE(15,63) BE(17,63) BE(19,63) BE(21,63) BE(23,63) BE(25,63)
FR BE(27,63) BE(29,63) BE(31,63) BE(33,63) BE(35,63) BE(37,63) BE(39,63)
FR BE(41,63) BE(43,63) BE(45,63) BE(47,63) BE(49,63) BE(51,63) BE(53,63)
FR BE(57,61) BE(59,61) BE(1,95) BE(3,95) BE(5,95) BE(7,95) BE(9,95) BE(11,95)
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FR BE(41,96) BE(43,96) BE(45,96) BE(47,96) BE(49,96) BE(51,96) BE(53,96)
FR BE(57,96) BE(59,96) BE(62,94) BE(1,131) BE(3,131) BE(5,131) BE(7,131)
FR BE(9,131) BE(11,131) BE(13,131) BE(15,131) PS(94,94) PS(95,94) PS(96,94)
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FR PS(161,161) PS(163,163) PS(165,165) PS(163,161) PS(167,167) PS(169,169)

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FR PS(183,183) PS(185,185) PS(187,187) PS(189,189) PS(191,191) PS(191,189)
FR PS(167,127) PS(168,128) PS(168,127) PS(168,167) PS(129,129) PS(130,130)
/* Comment 4:   Imposition of different equality restrictions.
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EQ PS(191,189) PS(192,190)
EQ PS(191,191) PS(192,192)
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EQ BE(21,63) BE(22,64)
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EQ BE(59,95) BE(60,95)
EQ BE(59,96) BE(60,96)
EQ BE(62,94) BE(62,128)
EQ AL(1) AL(2)
EQ AL(3) AL(4)
EQ AL(5) AL(6)
EQ AL(7) AL(8)
EQ AL(9) AL(10)
EQ AL(11) AL(12)
EQ AL(13) AL(14)
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EQ AL(45) AL(46)
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EQ AL(51) AL(52)
EQ AL(53) AL(54)
/* Comment 5: Imposition of fixed values.
VA -1 BE(55,1) BE(55,3) BE(55,5) BE(55,7) BE(55,9) BE(55,11) BE(55,13)
VA -1 BE(55,15) BE(55,17) BE(55,19) BE(55,21) BE(55,23) BE(55,25) BE(55,27)
VA -1 BE(55,29) BE(55,31) BE(55,33) BE(55,35) BE(55,37) BE(55,39) BE(55,41)
VA -1 BE(55,43) BE(55,45) BE(55,47) BE(55,49) BE(55,51) BE(55,53) BE(56,2)
VA -1 BE(56,4) BE(56,6) BE(56,8) BE(56,10) BE(56,12) BE(56,14) BE(56,16)
VA -1 BE(56,18) BE(56,20) BE(56,22) BE(56,24) BE(56,26) BE(56,28) BE(56,30)
VA -1 BE(56,32) BE(56,34) BE(56,36) BE(56,38) BE(56,40) BE(56,42) BE(56,44)
VA -1 BE(56,46) BE(56,48) BE(56,50) BE(56,52) BE(56,54)
VA 1 BE(55,61) BE(56,62) LY(1,1) LY(2,2) LY(3,3) LY(4,4) LY(5,5) LY(6,6)
VA 1 LY(7,7) LY(8,8) LY(9,9) LY(10,10) LY(11,11) LY(12,12) LY(13,13)
VA 1 LY(14,14) LY(15,15) LY(16,16) LY(17,17) LY(18,18) LY(19,19)

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