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Household commodity demand and demographics in the Netherlands: A microeconometric analysis

Adriaan Kalwij,* Rob Alessie, Peter Fontein

CentER for Economic Research and Economics Institute Tilburg, Tilburg University, P.O. Box 90153, 5000LE Tilburg, The Netherlands
(e-mail: kalwij@kub.nl; alessie@kub.nl; fontein@kub.nl)

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Abstract. We investigate the effects of demographics, household expenditure and female employment on the allocation of household expenditure to consumer goods. For this purpose we estimate an Almost Ideal Demand System based on Dutch micro data. We find that interactions between household expenditure and demographics are of significant importance in explaining the allocation to consumer goods. As a consequence, consumer goods such as *housing* and *clothing* change with demographic characteristics from luxuries to necessities. Furthermore, this implies that budget and price-elasticities cannot be consistently estimated from aggregated data and that equivalence scales are not identified from budget survey data alone. We reject weak separability of consumer goods from female employment. A couple with an employed spouse has a smaller budget share for *housing* and *personal care* and a larger budget share for *education, recreation and transport* and *clothing* compared to a couple with a non-employed spouse.

JEL classification: C30, D12

Key words: Demand systems, consumption, demographics

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1. Introduction

In this paper we investigate the effects of demographics, household expenditure and female employment on the allocation of household expenditure to consumer goods. We address issues like aggregation over households, the Independence of Base Utility assumption and weak separability of consumer goods from female employment. For this purpose we estimate a complete consumer demand system based on a time series of cross-sections of Dutch budget survey data.

Most empirical work on demand systems using Dutch data has been carried out on either aggregated time series (see for instance Barten 1969), or on a combination of one cross-section data set and aggregated time series (see for instance Van Imhoff 1984). However, using British microeconomic data, Blundell et al. (1993) have clearly shown that because of aggregation biases, it is not suitable to estimate price and budget elasticities on the basis of aggregated data. The biases, introduced by the use of aggregated data, depend on the way household characteristics interact with total household expenditure and price effects. In this paper, we will assess whether or not the aggregation bias is an important issue in the Dutch case.

The Almost Ideal Demand (AID) System of Deaton and Muellbauer is taken as the starting point of the analysis (see Deaton and Muellbauer 1980a). Consumer demand patterns vary considerably across households with different demographic characteristics and different levels of household expenditure. We model this variability by allowing almost all parameters of the AI cost function to depend on household characteristics. Due to this specification we allow for the fact that budget and (un)compensated price elasticities may vary across households with different observable characteristics. In principle, a policy maker would be interested in the question whether or not we can construct equivalence scales from these models. From economic behavior, as observed in budget surveys, we can identify the parameters of the demand functions, but it is not possible to identify e.g. the "joy of having children". This is a fundamental identification problem as discussed by Pollak and Wales (1979). Several studies (see for instance Blundell and Lewbel 1991), have investigated under which conditions one can identify equivalence scales from budget survey data alone. In order to identify equivalence scales many empirical studies impose the Independence of Base Utility (IB) condition[1] on the model. We will investigate whether or not the IB condition holds.

We do not only investigate the effects of demographics (e.g. the number of children) but also the effects of the employment state of the woman in the household on the allocation of household expenditure to consumer goods. There are two important reasons for doing so. Firstly, female employment is known to be highly correlated with the presence of young children (see e.g. Mroz 1987). If there are children in the household the woman is less likely to be employed. Therefore, by ignoring female employment we can mistakenly impute employment effects for child presence effects on the allocation of household expenditure to consumer goods. For instance, there is a reduction in transport costs if a woman decides to stop working and to have a child. Browning and Meghir (1991) provide empirical evidence to support this theory. Secondly, it is possible that the preferences over goods differ with the employment state of the women, once controlled for child presence. For instance, the share of household expenditure on housing may be lower for a household where both the man and the woman are employed compared to a household where only the man is employed. Possible reasons for this are economies of scale and the fact that in the Netherlands mortgages are based on the income of the man or the woman and not on household income[2]. This implies that female employment may not only have an expenditure effect but also an effect on the allocation of household expenditure to consumer goods. For this reason, ignoring female employment may lead to biased estimates of the parameters of the demand equations. Assuming that the allocation of household expenditure is independent of female employment is equivalent to the assumption of weak separability of consumer goods from female employment. We allow for non-separability by including a female employment variable in the demand system mentioned above with appropriate allowance for the fact that this employment variable is potentially endogenous. This conditional approach has become popular due to the work of Browning and Meghir (1991).

The organization of this paper is as follows. Section 2 discusses the theoretical framework. The Almost Ideal parameterisation of the cost function is employed and Marshallian demand functions are derived. This demand system allows us to investigate the issues of aggregation, identification of the equivalence scales, and weak separability of consumer goods from female employment. Section 3 discusses the econometric issues concerning the estimation procedure. Section 4 describes the Dutch budget surveys used for the empirical analysis. The empirical results are discussed in Sect. 5. We pay special attention to the allocation of household expenditure to consumer goods for different types of households. Section 6 concludes.

2. Theoretical framework

Preferences over all available consumer goods are represented by the household utility function $U(q,z)$, where q is a vector of quantities of the different consumer goods consumed by the household and z is a vector of demographic variables (i.e. household composition).[3] Household composition may affect preferences, hence the allocation of household expenditure to consumer goods. The household is assumed to maximize household utility with respect to q, subject to a budget constraint:

$$\begin{aligned} &\max_q \; U(q,z) \\ &s.t. \quad x = p^T q, \end{aligned} \tag{2.1}$$

where p is a price vector and x is household expenditure on all consumer goods. The solution of this optimization problem can be described by a complete demand system. At first glance, it appears that in optimization problem (2.1) the saving behavior of the household is not considered. Saving behavior can be modeled by making use of the life-cycle framework. The standard life-cycle model assumes that the household maximizes an intertemporal additive utility function under a lifetime budget constraint. One can show that the intertemporal additivity of the utility function allows for two-stage budgeting (see e.g. Blundell and Walker 1986). In the first stage of the budgeting process, the household derives total (non-durable) consumption at time t by allocating lifetime income to different periods. In the second stage of the two-stage budgeting process, the household allocates household expenditure within a period to the different consumer goods (e.g. food, clothing and other non-durable goods). This stage can be described by optimization problem (2.1). In other words, model (2.1) can be justified by calling upon the life-cycle hypothesis and a two-stage budgeting argument.

As discussed in the introduction we do not only allow demographics (denoted by z) but also allow the female employment state to affect the allocation of household expenditure to consumer goods. This refers to the issue of weak separability of consumer goods from female employment. Female employment is denoted by h and is defined to be equal to 1 if the spouse in the household is employed and is equal to 0 otherwise.[4] If we allow for non-separability, female employment (h) enters the indirect utility function of consumption, $U(q,h,z)$.[5] In this case h could be treated as a good and labor market restrictions should be explicitly modeled. An alternative approach is the conditional approach as proposed by Browning and Meghir (1991). In this conditional approach, the female employment state enters the Marshallian demand functions in the same way as the household composition variables. This conditional approach does not require the modeling of labor market restrictions. Furthermore, data limitations prevent us from estimating an unconditional demand system.[6] For these reasons this alternative approach seems most fruitful. Browning and Meghir also show the importance of conditioning both on the employment state and the hours of work. We, however, do not observe the hours of work (see Sect. 4). The employment state will pick up the fixed cost of working but not the variable cost of working. Furthermore, data limitations prevent us from conditioning on the employment state of the man in the household. Therefore we have to assume weak separability of consumer goods and female employment from male employment.

We derive the Marshallian demand equations by solving the dual problem of cost minimization.[7] This approach does not require a full specification of the utility function and the resulting demand equations are consistent with the maximization problem (2.1). We choose the functional form of the Almost Ideal Demand (AID) cost function as proposed by Deaton and Muellbauer (1980a, p.75):

$$\ln c(u,p,z,h) = \ln a(p,z,h) + ub(p,z,h) \tag{2.2}$$

where u is the level of utility and $a(p,z,h)$ and $b(p,z,h)$ are functions of prices (p) demographics (z) and female employment (h). This cost function gives rise to Engel curves that are linear in the logarithm of household expenditure. The parameterisation of the functions $a(p,z,h)$ and $b(p,z,h)$ is as follows:

$$\ln a(p,z,h) = \alpha_0 + \zeta^T(z,h)^T + (\ln p)^T(\alpha + \Delta(z,h)^T) + 1/2(\ln p)^T\Gamma(\ln p) \tag{2.3.a}$$

$$b(p,z,h) = \exp\{(\ln p)^T(\beta + \eta(z,h)^T)\} \tag{2.3.b}$$

where $ln p$ is the logarithm of prices (p). Female employment (h) enters the demand system in exactly the same way as the demographic variables (z). The first part of equation (2.3.a), $\alpha_0 + \zeta^T (z, h)^T$, is the price and utility independent term of the cost function. If the prices are normalized to 1 in the first period, one expects that this "fixed" cost term is an increasing function in variables like family size or the number of children and concave in such variables because of possible economies of scale in consumption. The parameters β and η of the $b(p, z, h)$ function are often assumed to be constant over time. The fact that we have a series of cross sections enables us to test whether or not this assumption is supported by the data. For identification of all other parameters of the model, i.e. the preference parameters of the $a(p, z, h)$ function, it is not necessary to assume that the parameters of the $b(p, z, h)$ function are constant over time. We discuss this in more detail in the next section.

Household expenditure is denoted by x. The system of Marshallian demand equations corresponding to (2.2) is given as follows:

$$w(x, p, z, h) = \alpha + \Delta(z, h)^T + \Gamma \ln p + (\beta + \eta(z, h)^T)(\ln x - \ln a(p, z, h)). \tag{2.4}$$

where $w(x, p, z, h)$ is a vector of budget shares of the consumer goods. From this demand system all structural parameters of the functions $a(p, z, h)$ and $b(p, z, h)$ are identified. These are used to construct the budget and the compensated price elasticities. The Slutsky equation is used to construct the uncompensated price elasticities.

Recent research has focused on the importance of the so called rank three demand systems (see e.g. Banks et al. (1997)). Such a system would allow budget shares not only to depend on $\ln(x)$, i.e. a rank two demand system, but also to depend on $(\ln(x))^2$. We restrict our analysis to a rank two demand system because data limitations prevent us from relaxing the IB assumption in a rank 3 demand system.[8] Furthermore, estimation results of Nicol (1995) show that a rank 2 demand system (without imposing IB) is not rejected against a rank system once sufficiently controlled for heterogeneity. In particular, conditioning on labor market states is shown to be of crucial importance.

As discussed in the introduction, aggregation biases depend on the way in which household characteristics interact with household expenditure and price effects.[9] Therefore a test on whether or not an aggregation bias will occur is equivalent to testing the null-hypothesis that $b(p, z, h)$ is independent of household characteristics (i.e. testing $H_0 \colon \eta = 0$, see Blundell et al. (1993)). A rejection of the null-hypothesis is an indication that the use of aggregate data results in biased estimates of the budget and price elasticities.

Identifying all parameters of the $a(p, z, h)$ function seems a crucial step towards estimating equivalence scales. Yet, most studies that are concerned with the identification of equivalence scales do not explicitly mention this and use some restrictive functional form. The "intercept parameter" of this function (denoted by α_0 in equation 2.3.a) is assumed to be equal to the minimum level of household expenditure in the sample[10] and is made independent of household characteristics (i.e. setting ζ in equation 2.3.a equal to 0), see for instance Banks et al. (1997), or is not modeled at all (i.e. $\alpha_0 = 0$ and $\zeta = 0$), see for instance Browning and Meghir (1991). Blundell and Lewbel (1991) acknowledge the importance of estimating α_0 and ζ but do not report whether or not they estimate α_0.

Their main empirical results are based on the assumption $\zeta = 0$. We follow Ray (1983) in modeling household characteristics in the $a(p, z, h)$ function and estimate all parameters of interest.[11] In contrast with Ray, Blundell and Lewbel state that once the IB property (see footnote 2) is imposed on the model the parameter ζ is no longer identified. This is based on a discussion in Pashardes (1989, p.14). However, the identification problem in Pashardes results from the fact that he uses a Stone price index approximation for equation (2.3.a) and this absorbs the interaction terms between characteristics and prices.[12] We do not use this approximation. Ray (1983) and Alessie et al. (1994) find significant values of the estimates of ζ and there seems to be no identification problem whatsoever. Whether or not one can interpret these estimates as equivalence scales is another issue.

A discussion on the identification of equivalence scales can be found in, for instance, Pollak and Wales (1979) and Blundell and Lewbel (1991). The bottom line in the literature on the identification of equivalence scales can be summarized as follows. Firstly, on the basis of budget survey data alone one is only capable of identifying preferences over consumer goods conditional on household characteristics, and one is not capable of identifying completely preferences over consumer goods and household characteristics. Therefore, based on budget survey data alone nothing can be inferred concerning welfare comparisons between households of different composition. This is the fundamental identification problem as discussed by Pollak and Wales (1979). Secondly, if one assumes that one can compare expenditures on consumer goods across households of different composition we are still not able to identify equivalence scales without making some arbitrary assumption concerning the utility or cost function (see e.g. Blundell and Lewbel 1991). A frequently used assumption in order to identify equivalence scales is the Independence of Base Utility assumption (IB). IB implies restrictions on the parameters of the cost function, some which can be tested[13] and some which can not be tested due to the identification problem as discussed by Pollak and Wales. We note that usually, IB is rejected by budget survey data. Instead of imposing a structure on the model that is not supported by the data, as will be shown in Sect. 5, we acknowledge the fact that we cannot identify the equivalence scales nor the cost of children from expenditure data alone. The only results we report in this paper are the effects of demographics on the allocation of household expenditure to consumer goods.

3. Econometric issues: a two-step estimation procedure

Equation (2.3.a) is substituted in equation (2.4) and this forms the basis for estimation. The time period is denoted by t and the household by i and $z^*_{it} = (z_{it}, h_{it})^T$. To control for optimization errors and measurement errors we add a vector of error terms (denoted by ε_{it}) to the system of Marshallian demand equations. The results of these operations leads to the following reduced form demand equations:

$$w_{it} = B_{0t} + B_{1t} z^*_{it} + B_{2t} \ln x_{it} + B_{3t} z^*_{it} \ln x_{it} + B_{4t}\, VEC(z^*_{it} z^{*T}_{it}) + \varepsilon_{it} \tag{3.1}$$

where the relationship between the reduced form parameters of equation (3.1) and the structural parameters of the equations (2.3.a) and (2.4) is given by:

$$\begin{aligned} B_{0t} &= \alpha + \Gamma(\ln p_t) - \beta_t \ln a^*(p_t); \\ B_{1t} &= \Delta - \eta_t \ln a^*(p_t) - \beta_t(\zeta + (\ln p_t)^T \Delta)^T; \\ B_{2t} &= \beta_t; \\ B_{3t} &= \eta_t; \\ B_{4t} &= (\zeta + (\ln p_t)^T \Delta)^T \otimes \ -\eta_t. \end{aligned} \tag{3.2}$$

with

$$\ln a^*(p_t) = \alpha_0 + \alpha^T \ln(p_t) + 1/2 \ln(p_t)^T \Gamma \ln(p_t).$$

Prices within a year are assumed to be the same across households and to be exogenous. The error terms in equation (3.1) are assumed to have expectation zero and are assumed to be independently distributed across time and across households but are allowed to correlate between the budget share equations (i.e. $E(\varepsilon_{it}) = 0$ and $E(\varepsilon_{it}\varepsilon_{it}^T) = \Sigma_t$). This implies that we do not allow for unobserved individual heterogeneity.[14] We have T time periods, I goods, K-1 household characteristics and one conditional good. B_{0t} and B_{2t} are $(I \times 1)$-vectors, B_{1t} and B_{3t} are $(I \times K)$-matrices, B_{4t} a $(I \times K^2)$-matrix and Σ_t is a $(I \times I)$-matrix. We follow a two-step estimation procedure to obtain all parameters of interest. In the first step we estimate equation (3.1) and obtain estimates of the reduced form parameter vector $(B_{0t}, \ldots, B_{4t})^T$ for each period separately. In the second step we obtain estimates of the preference parameters by applying Asymptotic Least Squares to the system of equations (3.2). In the following we discuss both steps in more detail.

In the first step we estimate the parameter vector $(B_{0t}, \ldots, B_{4t})^T$ which appears in model (3.1). We do this for each of the T periods separately. We follow Barten (1969) and leave out one good from the system of demand equations.[15] Barten has shown that the adding up restrictions ($\Sigma_k \alpha_k = 1$, $\Sigma_k \Delta_{k1} = 0, \Sigma_k \beta_k = 0, \Sigma_k \eta_{k1} = 0, \Sigma_k \gamma_{k1} = 0$) that are imposed by demand theory on the structural parameters of the demand equations, are automatically satisfied by leaving out one good from the reduced form equation (3.1). The model offers the opportunity to test the homogeneity ($\Sigma_1 \gamma_{k1} = 0$) and symmetry ($\gamma_{k1} = \gamma_{1k}$) conditions. Furthermore, we are able to check the negativity condition. Leaving out one good has no consequences for the estimates of reduced form equations of the remaining (I-1) goods. The potentially endogenous variables are household expenditure, female employment and all interaction terms with household expenditure and female employment. To solve this problem we employ an IV estimator. In theory this solves the endogeneity problem. In practice, however, it is very difficult to find suitable instruments for all potential endogenous variables, especially for the interaction terms between household expenditure, female employment and the variables reflecting household composition. For this reason we follow Banks et al. (1997) and use a two-step estimation procedure. In the first step we regress both household expenditure and female employment on the set of instruments. The set of instruments includes all demographic variables, educational attainment, age and age squared of both the head of household and the partner in the household, a dummy variable indicating whether or not a household is a single parent family, and marital status. In the second step we take the residuals from the first-step equations and include them in the budget share equations (equation (3.1)). In case we do not have interaction terms between the potential endogenous and exogenous variables this estimation procedure is the two-stage estimation procedure as described in Hausman (1978). In this case, a test on exogeneity is testing the null-hypothesis of the coefficient corresponding to the residual of the first regression in the second regression being equal to zero.

We estimate the preference parameters by making use of the Asymptotic Least Squares (ALS) procedure, see e.g. Gourieroux and Montfort (1995). The relationship between the reduced form parameter vector $(B_{0t}, \ldots, B_{4t})^T$ and the preference parameters of interest displayed in (3.2) has been estimated. This relationship is non-linear in the parameters of interest and for this reason we broke up this second step into a sequence of relatively easy estimation problems. In the appendix this sequence of steps is explained in more detail. System (3.2) shows that we assume the parameters α_0, α, Γ, ζ and Δ to be constant over time. However, the β and η parameters are allowed to vary over time. The reason for doing so is that the estimation results (see Sect. 5) suggested that constancy over time of the β and η parameters is not a valid assumption. All preference parameters appearing on the right hand side of (3.2) are identified.

4. Data: the Dutch budget surveys from 1980 to 1991

The data used in this study are taken from the Dutch budget survey which is held by Statistics Netherlands at an annual basis. The survey consists of a rotating panel among two to three thousand households. Only in the year 1991, the budget survey has been conducted among about a thousand households. These households keep a daily record of all expenses over 25 guilders (per item) during one year. For a limited time period all expenses are recorded, from which yearly expenses on goods with a price below 25 guilders are deduced. Furthermore, the survey contains information on income, family composition and background information on all members of the household (age, education etc.). The survey started in 1978, but in order to avoid any start-up related problems of the survey, we only use data from 1980 to 1991 (the last wave available at the moment of our study). A household may participate up to three years in the survey. The reason for this is that participation may influence spending behavior in the long run. The rotating panel character is not exploited in our study because the key variable necessary to merge the different waves of the budget survey was not available to us.

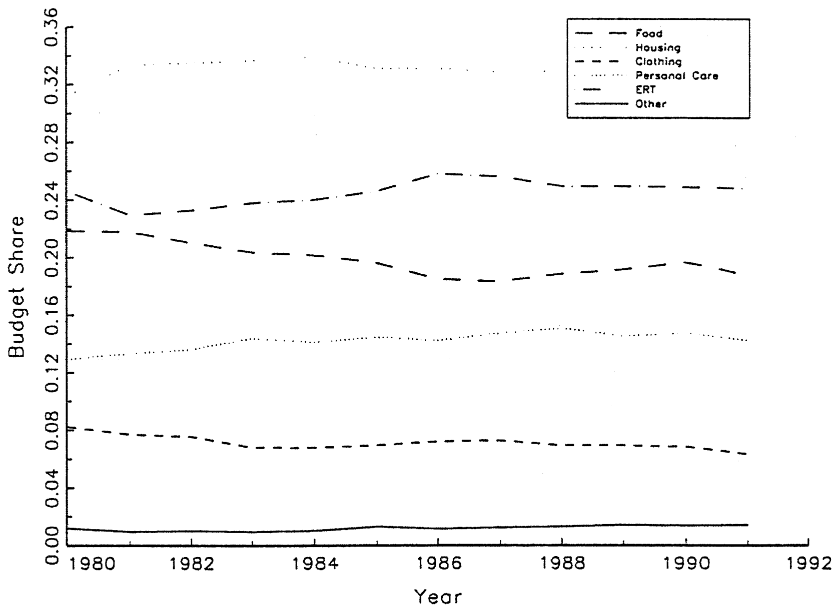
Some sample selections have been applied. Firstly, we have not included the self-employed in any of our calculations because it is impossible to distinguish between expenditures for the firm and expenditures for the household. Secondly, we have excluded households with negative income and 'non family households'.[16]

Every 5 years Statistics Netherlands constructs a weighting scheme from the budget survey which is used for price index calculations of the employed. To this end households where the head of the household is employed are over represented in 1980, 1985 and 1990. In 1981 the non-employed and in 1982 the self-employed are over represented for specific research purposes. Furthermore, since 1985 the method of optimal allocation is used in sampling the households (see CBS 1992). This means that households with a well-defined spending behavior are underrepresented compared to those with a larger variability in their spending behavior. The data that are available for this study do not contain information to correct for this overrepresentation of certain groups of households. Therefore, the tables reported in this section are not representative of the Dutch population. The stratification of the sample is based on exogenous variables, hence has no consequences for the consistency of the parameter estimates.

For the choice of consumer goods we follow the 1-digit classification of Statistics Netherlands and disaggregate household expenditure into the following six main categories:

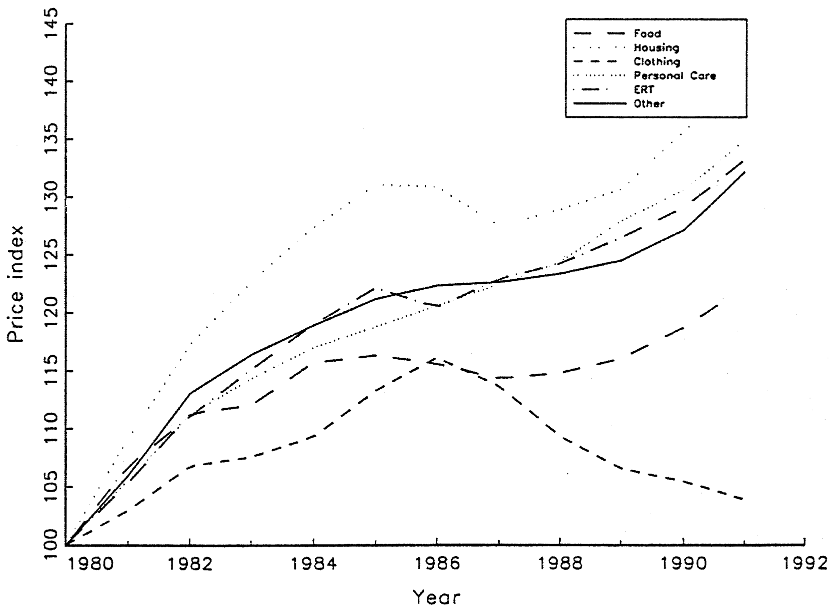
- *Food* (including outdoor meals),
- *Housing* (including (imputed) rent[17], maintenance, appliances, tools, heating and electricity),
- *Clothing* and footwear,
- *Personal care* and medical expenditures (including payments for domestic services),
- *Education, recreation and transport* (including holidays, smoking, stationery, subscriptions, public transportation, bicycles and cars),
- *Other* consumption (including insurance premiums).

We refer to these six categories of goods as the consumer goods. Figure 1 shows the average budget shares of these consumer goods in the sample per



*ERT = Education, recreation and transport

Fig 1. The budget shares for the six consumer goods over the period 1980–1991.



[a]*ERT = Education, recreation and transport*

Fig 2. The price indices for the six consumer goods over the period 1980–1991.

year. In all years the budget share for *housing* is the largest (about 32%), followed by *education, recreation and transport* (about 25%), *food* (about 20%), *personal care* (about 14%), *clothing* (about 7%) and *other* (about 2%). Statistics Netherlands provided two series of Laspeyres price indices (1980–1985 and 1985–1991) for the six consumer goods and we merged the two series into one for the entire period 1980–1991. These price indices are shown in Fig. 2. We see that there is a large price variation over time. The price index of *housing* shows the largest increase, and the price index of *clothing* increased in the first half of the eighties but decreased during the second half.

For privacy reasons Statistics Netherlands did not provide us with the most detailed data of the budget surveys (i.e. data at the household level). Instead, we obtained moment matrices containing all the relevant variables involved in the estimation process.[18] We define a couple as a household of which the head is either married or living together with a partner. In case of couples, the man is by definition the head of the household. As already defined in Sect. 2, the variable *female employment* takes on the value 1 if the spouse in the household is employed and the value 0 otherwise. This means that for an employed single woman *female employment* is equal to 0. The number of children is known per age category. The age categories are: under 6, from 6 to 12, from 12 to 18, and 18 years and over.

Table 1 reports the means and standard errors of the logarithm of household income, household expenditure, age of the head of household, the percentage of single-parent households and couples, the percentage of employed spouses and the number of children living at home. While studying table 4.1, one has to keep in mind that in some years some groups are over represented (e.g. the number of children living at home is relatively high in 1980, 1985 and

Table 1. Means and standard deviations of the logarithm of household income (ln(income)), the logarithm of household expenditure (ln(expenditure)) and the age of the head of household (age), the means of the percentage of single-parent households and couples, the percentage of employed spouses and the number of children living at home

Year	Number of observations	ln(income)		ln(expenditure)		Age		% one-person households	% couples	% employed spouses	Number of children at home
		mean	std	mean	std	mean	std	mean	mean	mean	mean
1980	2527	10.4	0.43	10.3	0.46	45	16	4.1	80.4	16.3	0.79
1981	2612	10.3	0.47	10.2	0.48	50	17	7.9	67.0	11.0	0.60
1982	1927	10.4	0.50	10.4	0.48	45	16	3.8	74.7	15.2	0.72
1983	2685	10.4	0.46	10.4	0.47	46	17	3.8	71.7	16.4	0.63
1984	2923	10.5	0.43	10.5	0.44	45	16	3.3	79.8	21.2	0.67
1985	2592	10.6	0.39	10.5	0.39	42	14	2.3	87.9	26.4	0.85
1986	2797	10.7	0.43	10.6	0.42	45	15	2.8	80.4	32.5	0.69
1987	2330	10.7	0.46	10.6	0.44	46	15	3.2	80.0	30.3	0.65
1988	1790	10.7	0.46	10.6	0.45	47	16	4.2	77.3	25.9	0.59
1989	1753	10.6	0.47	10.6	0.46	46	16	4.3	75.5	29.2	0.58
1990	2544	10.6	0.40	10.6	0.39	43	15	3.3	82.4	26.5	0.76
1991	923	10.6	0.47	10.5	0.45	46	17	4.7	73.1	27.5	0.56

Table 2. The average number of children per age category for couples where the woman is not employed and for coupes where the woman is employed

Children	Employment state of the woman	
Age category	Non-employed	Employed
0–5	0.28	0.15
6–11	0.22	0.19
12–17	0.18	0.20
18–>	0.11	0.09
All	0.79	0.63

Table 3. Budget shares for a single-person household, a couple with a non-employed spouse (FE = 0), and a couple without an employed spouse (FE = 1)

Budget shares	Single	Couple	
		FE = 0	FE = 1
Food	0.18	0.21	0.19
Housing	0.37	0.33	0.31
Clothing	0.06	0.07	0.08
Personal care	0.14	0.14	0.14
ERT[a]	0.24	0.24	0.28
Other	0.01	0.01	0.00

[a] *ERT = Education, recreation and transport*

1990, when households where the head of the household is employed are over represented). In Table 2 we report the average number of children for couples where the spouse is non-employed and couples where the spouse is employed. It can be seen that the number of children under 6 is considerably lower when the spouse is employed. Table 3 reports the budget shares for single-person households and for couples. The average budget share for *housing* is higher for single persons than for couples. Couples with an employed spouse spend relatively more on *education, recreation and transport* than other couples.

5. Empirical results

We now turn to the estimation results of the model as described in Sect. 3. Firstly, we discuss the results of the reduced form regressions. Secondly, we report the estimation results of the second stage where we obtain all parameters of interest. Once we have estimated the structural parameters we can compute the budget and (un)compensated price elasticities. Finally, we discuss the effects of demographics, female employment and household expenditure on the budget shares.

5.1 Reduced form regressions

In the empirical application we assume that the preference parameters depend on the following characteristics: *couple (CPL), number of children younger*

Table 4. Sargan test statistics for testing the orthogonality conditions of the instruments and the Hausman test statistics for testing the exogeneity of total expenditure and female employment (FE) per good. All test-statistics are the sum over the test-statistics per year

	Sargan[a]	Hausman[b]	
		ln(exp)	pp
Food	240.1	146.6	24.04
Housing	819.7	174.4	712.9
Clothing	216.7	61.9	17.9
Personal care	333.1	84.8	159.2
ERT[c]	742.2	70.2	1031.9

[a] 72 degrees of freedom per cell, $X^2_{0.95}(72) = 92.8$.
[b] 12 degrees of freedom per cell, $X^2_{0.95}(12) = 21.0$.
[c] *ERT = Education, recreation and transport*

than 6 (NCU6), and number of children aged 6 years and over (NCO6). In order to take into account economies of scale we have reefined the 'children' variables in the following way:

$$LNCO6 = LN\left(\frac{NADULTS + NCO6}{NADULTS}\right),$$

$$LNCU6 = LN\left(\frac{NADULTS + NCO6 + NCU6}{NADULTS + NCO6}\right).$$

Where *NADULTS* is the number of adults in the household. The conditioning variable is *female employment* (FE). In the first stage we estimate equation (3.1) using the extended IV regression approach as discussed in Sect. 3.[19] Based on both the partial R^2 's and the partial F-statistics the excluding instruments were considered to have sufficient explanatory power.[20] The estimation results of these reduced form regressions per year are not presented but are available from the authors upon request. In Table 4 we present some specification tests of these regressions. The Sargan statistics are considered to be large and we reject the null-hypothesis of orthogonality between the error term of the regression equation and the set of instruments for every budget share equation. Similar results are reported in other studies, see for instance Browning and Meghir (1991) and Blundell et al. (1993). One way to interpret this finding is that some variables in the instrument set are incorrectly excluded from the structural part of the model. We included age and age squared in the regression equation and this resulted in a considerably lower Sargan statistic. However, the null-hypothesis of the Sargan test was still rejected for each equation and it had no significant effect on the main estimation results.[21] The exogeneity tests (Table 5) clearly show the importance of instrumenting household expenditure and female employment, especially in the budget share equations for *housing* and *education, recreation and transport*. However, given the fact we reject the null-hypothesis of the Sargan test for each equation the results of the exogeneity tests should be interpreted with caution.[22]

Table 5. Estimates of the α_0, α, Δ and ζ parameters. Standard errors are given in parentheses

α_0	10.2 (0.03)			
α				
Food	0.15 (0.004)			
Housing	0.36 (0.004)			
Clothing	0.07 (0.001)			
Personal care	0.13 (0.002)			
ERT[a]	0.29 (0.005)			
Δ	FE	CPL	LNCU6	LNCO6
Food	−0.02 (0.005)	0.03 (0.004)	0.02 (0.006)	0.04 (0.004)
Housing	−0.09 (0.004)	−0.004 (0.003)	−0.02 (0.005)	−0.06 (0.003)
Clothing	0.01 (0.002)	0.007 (0.001)	0.01 (0.002)	0.02 (0.001)
Personal care	−0.02 (0.003)	0.006 (0.002)	0.01 (0.002)	−0.01 (0.002)
ERT[a]	0.13 (0.006)	−0.04 (0.005)	−0.03 (0.007)	0.01 (0.005)
ζ	0.20 (0.04)	0.30 (0.04)	−0.04 (0.05)	0.26 (0.03)

[a] *ERT = Education, recreation and transport*

Table 6. Estimates of the Γ-matrix and symmetry and homogeneity tests. Standard errors are given in parentheses

	Food	Housing	Clothing	Personal care	ERT[a]
Food	−0.09 (0.04)				
Housing	0.01 (0.03)	0.25 (0.05)			
Clothing	−0.02 (0.02)	−0.06 (0.02)	0.06 (0.01)		
Personal care	−0.22 (0.03)	0.08 (0.03)	0.06 (0.02)	−0.04 (0.07)	
ERT*	0.40 (0.05)	−0.32 (0.06)	−0.05 (0.03)	0.01 (0.09)	0.03 (0.15)
Homogeneity[b]	0.04	0.18	0.69	0.01	1.76
Symmetry[c]	65.3				

[a] *ERT = Education, recreation and transport*
[b] 1 degree of freedom per cell, $X^2_{0.95}(1) = 3.84$.
[c] 10 degrees of freedom per cell, $X^2_{0.95}(10) = 18.3$.

5.2 Second-stage estimation results

In the second stage of the estimation procedure we obtain all parameters of interest. In Table 5 we report the estimates of the α_0, α, Δ and ζ parameters. In Table 6 we report the estimates of the parameters of the gamma matrix. All these parameters are assumed to be constant over time (see the system of equations (3.2)). An interesting result is that the α_0 parameter is very precisely estimated. It is common practice to set α_0 equal to the minimum level of household expenditure in the sample, see for instance Nelson (1993) and Banks et al. (1997), or one does not include this parameter in the model, see for instance Browning and Meghir (1991).[23] Nelson (1993) and others claim that "the α_0 parameter is rarely identified by the data". Nelson (1993) has estimated a similar model to ours but contrary to us she assumes that IB holds (i.e. $\eta_t = 0$ for all t). By making this assumption one has less identifying information to estimate the parameter α_0. This can be seen from the system of equations (3.2). The α_0, α and Γ parameters appear in the first two equations of (3.2). However, if IB is assumed these parameters can be retrieved only from the constant term B_{0t} of equation (3.1). In other words, by making the IB assumption, one might end up with the "identification" problem observed by Nelson (1993). Banks et al. (1997) have considered the Integrable Quadratic Almost Ideal Demand (IQUAID) system. When using the IQUAID system one has more identifying information to estimate α_0 compared to an AID system in which IB is imposed. However, despite this extra identifying information Banks et al. do not estimate the α_0 parameter and report that the estimates of the price and other elasticities are not sensitive to the choice of α_0.

The estimates of the β_t and η_t parameters for each period are not reported but are available from the authors upon request. We allowed the β and η parameters to vary over time because the hypothesis that β and/or η is constant over time is rejected. The test statistic corresponding to testing the null-hypothesis $H_0\colon \beta_t = \beta$ for all t, is equal to 345 and the critical value is $\chi^2_{0.95}(55) = 73.3$. The test statistic corresponding to testing the null-hypothesis $H_0\colon \eta_t = \eta$ for all t, is equal to 3139 and the critical value is $\chi^2_{0.95}(220) = 255.6$. Furthermore, identification of all other parameters of interest is not affected by allowing β and η to vary over time.

Weak separability between consumer goods and female employment. An important advantage of the conditional approach to model female employment is that one is able to test for weak separability in a relatively easy way. Testing for weak separability between the consumer goods and female employment (the conditioning good) is testing the null-hypothesis that all coefficients belonging to female employment and the cross-products with female employment and household characteristics are equal to zero. In this case the Marshallian demand functions are independent of the conditioning good h. The test statistic per good is reported in the first column of Table 7. We reject the null-hypothesis for all consumer goods. The rejection is strongest for *housing* and *education, recreation and transport*. This means that female employment not only has an expenditure effect but also has an effect on the allocation of household expenditure to consumer goods. In Sect. 5.3 we investigate in more detail the effects of female employment and demographics on the allocation of household expenditure to consumer goods.

Table 7. Tests on weak separability between female employment and consumer goods, and testing the Independence of Base Utility assumption

	Weak separability[b]	Independence of base utility[c]
Food	92.5	482
Housing	751	411
Clothing	108	454
Personal care	113	1260
ERT[a]	813	904

[a] *ERT = Education, recreation and transport*
[b] 14 degrees of freedom per cell, $X^2_{0.95}(14) = 23.7$.
[c] 40 degrees of freedom per cell, $X^2_{0.95}(40) = 55.8$.

Table 8. Budget elasticities (evaluated in the means) in the years 1980, 1985 and 1990. Standard errors are given in parentheses

Year	1980	1985	1990
Food	0.50 (0.02)	0.46 (0.02)	0.52 (0.02)
Housing	1.10 (0.02)	1.13 (0.01)	1.01 (0.03)
Clothing	0.77 (0.03)	0.98 (0.03)	1.16 (0.05)
Personal care	0.93 (0.02)	0.84 (0.02)	0.89 (0.02)
ERT[a]	1.43 (0.03)	1.35 (0.02)	1.35 (0.04)
Other	0.91 (0.22)	1.35 (0.25)	1.49 (0.33)

[a]*ERT = Education, recreation and transport*

Independence of Base Utility (IB) and the aggregation bias. In the empirical literature IB is often imposed on the cost function in order to identify the equivalence scales, see for instance Nelson (1993) and Ray (1983). However, there are studies in which the IB is tested (see for instance Blundell and Lewbel 1991). Invariably, these studies indicate that the 'IB null-hypothesis' $\eta_t = 0$ for all t should be rejected. In the second column in Table 5, we report the test on the validity of the IB hypothesis. Like Blundell and Lewbel (1991) we also strongly reject this hypothesis for all consumer goods. Given these test results we do not impose IB on the model. This implies that we are not able to identify the equivalence scales.

As shown in Blundell et al. (1993), testing whether or not there will be an aggregation bias when using aggregated instead of micro data, boils down to testing the null-hypothesis $\eta_t = 0$ for all t. So in fact, this test coincides with testing the IB assumption. As we said before, this null-hypothesis is rejected. This result implies that one should use micro-level data instead of aggregate data when estimating demand equations.

Budget and price elasticities. In Table 8 we report the budget elasticities for the years 1980, 1985 and 1990 evaluated at the sample means of household expenditure, budget shares and demographics. It should be stressed that the budget elasticities presented in Table 8, are conditional on the conditioning good (in our case female employment). Unconditional elasticities can only be obtained when female employment is modeled explicitly. Keeping this caveat in mind, it can be concluded that on average *food* and *personal care* are necessary goods in all years. *Clothing* changes from being a necessity good in 1980 and 1985 to a luxury in 1990. *Housing* and *education, recreation and transport* are luxuries in all 3 years, although it should be noted that in 1990 the average budget elasticity of *housing* does not differ significantly from 1. Except for *clothing* and *other*, the average budget elasticities appear to be fairly constant over time.

Up to now, we have only presented the sample averages of the budget elasticities. However, since the IB restriction is not imposed on our model, the budget elasticities are not constant across households but depend on the demographic characteristics of the household. Whether or not a good is a luxury, depends solely on the value (sign) of $\beta_t + \eta_t(z_t, h_t)^T$. For the year 1990, we have computed this statistic for six different types of households: 1) singles, 2) couples without children, spouse not employed, 3) couples without children, spouse employed, 4) couples with 1 child under 6, spouse not em-

Table 9. Predicted budget shares for the different types of households (as defined below Table 10) Budget shares are computed with the sample mean of household expenditure. The budget shares for different levels of household expenditure are shown in Figs. 3 to 8

Type	1	2	3	4	5	6
Food	0.13	0.19	0.18	0.2	0.21	0.22
Housing	0.37	0.38	0.28	0.37	0.36	0.35
Clothing	0.05	0.06	0.07	0.07	0.07	0.07
Personal care	0.15	0.15	0.13	0.15	0.14	0.15
ERT[a]	0.28	0.21	0.32	0.2	0.2	0.2

[a] *ERT = Devlopment, recreation and transport*

Table 10. Budget elasticities for different types of households in 1990

Type	1	2	3	4	5	6
Food	0.33 (0.03)	0.49 (0.03)	0.52 (0.05)	0.56 (0.04)	0.52 (0.03)	0.56 (0.03)
Housing	0.90 (0.02)	1.03 (0.03)	1.09 (0.05)	1.02 (0.03)	1.02 (0.03)	1.01 (0.03)
Clothing	0.83 (0.06)	1.02 (0.07)	0.91 (0.09)	1.30 (0.08)	1.17 (0.07)	1.35 (0.07)
Personal care	1.24 (0.02)	1.11 (0.03)	1.01 (0.05)	0.76 (0.03)	0.98 (0.03)	0.72 (0.03)
ERT[a]	1.31 (0.03)	1.28 (0.06)	1.21 (0.05)	1.42 (0.07)	1.39 (0.06)	1.50 (0.06)

[a] *ERT = Education, recreation and transport*
1: Single-person household
2: Couple, no children, spouse is not employed
3: Couple, no children, spouse is employed
4: Couple, 1 child under 6, spouse is not employed
5: Couple, 1 child over 5, spouse is not employed
6: Couple, 1 child under 6 and 1 child over 5, spouse is not employed

ployed, 5) couples with 1 child over 5, spouse not employed, 6) couples with 1 child under 6 and 1 child over 5, spouse not employed. In Table 10 we report the budget elasticities for each type of household. It appears that *food* is a necessary good and *education, recreation and transport* is a luxury good for all types of households defined above. However, *housing* is a necessary good for singles but a luxury for all other types of households. *Clothing* (*personal care*) is a luxury (necessity) for those households where children are present and a necessity (luxury) for singles and couples with an employed spouse without children. The fact that the value of the budget elasticities varies so much across household types, underlines the importance of not imposing IB on the Almost Ideal Demand (AID) system.

In Table 11 we report the average compensated and uncompensated price elasticities for, respectively, 1980, 1985 and 1990. Price elasticities crucially depend on the matrix Γ. It is well-known that in the AID system the homogeneity and symmetry restrictions are effectively restrictions on the Γ matrix. We have tested whether these conditions hold. The results of these tests are presented in table 5.3. From this table it can be seen that the homogeneity condition can not be rejected for every good. In studies using macroeconomic data, homogeneity is often rejected (see for instance Barten 1969). However, our results of the homogeneity tests are more in line with other empirical studies based on micro-level data. In these studies the homogeneity condition

Table 11. Compensated and uncompensated price elasticities for the years 1980, 1985 and 1990. Standard errors are given in parentheses

Compensated price elasticities, 1980	Food	Housing	Clothing	Personal care	ERT[a]	Other
Food	−1.16 (0.18)	0.32 (0.13)	−0.03 (0.08)	−0.87 (0.16)	2.09 (0.24)	−0.35 (0.08)
Housing	0.22 (0.09)	0.12 (0.17)	−0.10 (0.05)	0.39 (0.10)	−0.79 (0.19)	0.16 (0.09)
Clothing	−0.07 (0.22)	−0.37 (0.20)	−0.23 (0.14)	0.87 (0.21)	−0.40 (0.34)	0.20 (0.16)
Personal care	−1.46 (0.26)	0.94 (0.25)	0.56 (0.14)	−1.17 (0.54)	0.25 (0.70)	0.90 (0.37)
ERT*	1.85 (0.22)	1.00 (0.24)	−0.13 (0.11)	0.12 (0.37)	−0.63 (0.59)	−0.22 (0.17)
Other	−6.49 (1.52)	4.18 (2.31)	1.38 (1.12)	9.83 (4.11)	−4.49 (3.48)	−4.41 (6.53)

Uncompensated price elasticities, 1980	Food	Housing	Clothing	Personal care	ERT[a]	Other
Food	−1.27 (0.18)	0.17 (0.13)	−0.07 (0.08)	−0.93 (0.16)	1.96 (0.25)	−0.36 (0.08)
Housing	−0.01 (0.09)	−0.23 (0.17)	−0.19 (0.05)	0.24 (0.11)	−1.06 (0.19)	0.15 (0.09)
Clothing	−0.23 (0.22)	−0.61 (0.20)	−0.29 (0.14)	0.77 (0.22)	−0.58 (0.34)	0.18 (0.16)
Personal care	−1.67 (0.26)	0.65 (0.25)	0.48 (0.13)	−1.29 (0.54)	0.02 (0.69)	0.89 (0.37)
ERT*	1.54 (0.22)	−1.45 (0.24)	−0.25 (0.11)	−0.06 (0.37)	−0.98 (0.59)	−0.23 (0.17)
Other	−6.84 (1.52)	3.69 (2.31)	1.25 (1.12)	9.63 (4.11)	−4.88 (3.48)	−4.43 (6.53)

Compensated price elasticities, 1985	Food	Housing	Clothing	Personal care	ERT[a]	Other
Food	−1.23 (0.20)	0.35 (0.14)	−0.05 (0.09)	−0.96 (0.17)	2.30 (0.28)	−0.39 (0.09)
Housing	0.20 (0.09)	0.09 (0.16)	−0.10 (0.05)	0.39 (0.10)	−0.73 (0.18)	0.15 (0.08)
Clothing	−0.15 (0.26)	−0.48 (0.23)	−0.12 (0.17)	1.03 (0.26)	−0.51 (0.40)	0.23 (0.19)
Personal care	−1.31 (0.24)	0.89 (0.23)	0.49 (0.12)	−1.12 (0.49)	0.25 (0.63)	0.81 (0.34)
ERT*	1.83 (0.22)	−0.99 (0.24)	−0.14 (0.11)	0.14 (0.37)	−0.63 (0.59)	−0.21 (0.17)
Other	−5.96 (1.39)	3.88 (2.12)	1.25 (1.03)	9.04 (3.77)	−4.09 (3.19)	−4.12 (5.98)

Uncompensated price elasticities, 1985

	Food	Housing	Clothing	Personal care	ERT[a]	Other
Food	−1.32 (0.20)	0.19 (0.14)	−0.08 (0.09)	−1.03 (0.17)	2.19 (0.28)	−0.40 (0.09)
Housing	−0.02 (0.09)	−0.28 (0.16)	−0.18 (0.05)	0.23 (0.10)	−1.00 (0.18)	0.14 (0.08)
Clothing	−0.34 (0.26)	−0.81 (0.23)	−0.19 (0.17)	0.89 (0.26)	−0.75 (0.40)	0.22 (0.19)
Personal care	−1.47 (0.24)	0.61 (0.23)	0.43 (0.12)	−1.25 (0.49)	0.04 (0.63)	0.79 (0.34)
ERT*	1.57 (0.22)	−1.43 (0.24)	−0.24 (0.11)	−0.05 (0.37)	−0.96 (0.59)	−0.23 (0.17)
Other	−6.25 (1.40)	3.38 (2.12)	1.15 (1.03)	8.82 (3.77)	−4.46 (3.19)	−4.14 (5.98)

Compensated price elasticities, 1990

	Food	Housing	Clothing	Personal care	ERT[a]	Other
Food	−1.22 (0.20)	0.34 (0.14)	−0.06 (0.09)	−0.96 (0.17)	2.29 (0.28)	−0.39 (0.09)
Housing	0.21 (0.09)	0.10 (0.16)	−0.10 (0.05)	0.40 (0.10)	−0.75 (0.18)	0.15 (0.08)
Clothing	−0.16 (0.26)	−0.50 (0.24)	−0.11 (0.17)	1.04 (0.26)	−0.51 (0.41)	0.24 (0.19)
Personal care	−1.28 (0.23)	0.87 (0.22)	0.48 (0.12)	−1.12 (0.48)	0.25 (0.61)	0.79 (0.33)
ERT*	1.81 (0.22)	−0.98 (0.24)	−0.14 (0.11)	0.15 (0.36)	−0.62 (0.59)	−0.21 (0.17)
Other	−5.67 (1.33)	3.71 (2.02)	1.19 (0.98)	8.63 (3.59)	−3.88 (3.04)	−3.98 (5.70)

Uncompensated price elasticities, 1990

	Food	Housing	Clothing	Personal care	ERT[a]	Other
Food	−1.33 (0.20)	0.17 (0.14)	−0.09 (0.09)	−1.03 (0.17)	2.16 (0.28)	−0.40 (0.09)
Housing	0.01 (0.09)	−0.23 (0.16)	−0.17 (0.05)	0.25 (0.10)	−1.00 (0.18)	0.14 (0.08)
Clothing	−0.39 (0.26)	−0.87 (0.24)	−0.19 (0.17)	0.87 (0.26)	−0.80 (0.41)	0.22 (0.19)
Personal care	−1.45 (0.23)	0.58 (0.22)	0.42 (0.12)	−1.25 (0.48)	0.02 (0.61)	0.78 (0.33)
ERT*	1.54 (0.22)	−1.42 (0.24)	−0.23 (0.11)	−0.05 (0.36)	−0.96 (0.59)	−0.23 (0.17)
Other	−5.96 (1.33)	3.22 (2.02)	1.10 (0.98)	8.41 (3.59)	−4.25 (3.04)	−4.00 (5.70)

[a] *ERT = Education, recreation and transport*

is hardly ever rejected (see e.g. Blundell et al. 1993). Our data suggest that the symmetry condition should be rejected, as is the case in most other studies based on micro-level data. Although the test statistic is high, a comparison of the unrestricted parameter estimates with the Γ-symmetry-constrained estimates indicates that the difference between the two sets of estimates is rather small (except for some of the diagonal terms of Γ). Therefore, we have decided to impose the symmetry condition on our model (see also Blundell et al. 1993).

From Table 11 it can be seen that all compensated own price elasticities are negative except for the consumption category *housing*. The fact that the own compensated price elasticity of *housing* is positive already indicates that the negativity condition on the Slutsky matrix is not satisfied for the 'average' consumer. We have checked the negativity condition somewhat further. It appears that 2 out of 5 eigenvalues of the Slutsky matrix were found to be negative and again this implies that the negativity condition is not satisfied. This is the case in all periods.

On average, *housing* and *clothing* are price inelastic and *food* and *personal care* are price elastic. The own (un)compensated price elasticity of food is high compared to results obtained in other studies. Substitution effects are highest for the price changes in *personal care* and *education, recreation and transport*. Table 11 also suggests that some goods are complements of each other. This result underlines the importance of considering 'flexible functional forms' of the cost function (like the AID cost function) in the empirical application. Restrictive specifications like the Linear Expenditure System do not allow for the existence of complements. Although we did not perform a formal test, the average compensated and uncompensated price elasticities appear to be fairly constant over time.

5.3 The effects of demographics, female employment and household expenditure on the budget shares

In Figs. 3 to 8 the effects of demographics and female employment on the allocation of household expenditure is presented.[24] In these figures the same types of households are considered as those in the discussion of the budget elasticities (see Sect. 5.2). Figure 3 suggests that for all levels of household expenditure singles spend less on *food* than couples. Couples with children have a larger budget share of *food* compared to couples without children, and the budget share increases with the age of the children and the number of children. The downward sloped curves reveal that *food* is a necessity for each type of household, as already discussed in Sect. 5.2. Contrary to the budget share of *housing* the budget share of *food* barely depends on the employment state of the spouse. Figure 4 indicates that the presence of children has a depressing effect on the budget share of *housing*.[25] We have obtained a similar result for *education, recreation and transport* (Fig. 5) at least at low levels of household expenditure (<Dfl. 50,000). These results are intuitively plausible because *housing* and *education, recreation and transport* are typically consumption categories with large economies of scale and for which children have relatively low needs (young children may share rooms). Figures 4 to 6 clearly show that whether or not these goods are luxury depends on the type of household. Households with an employed spouse spend relatively more on

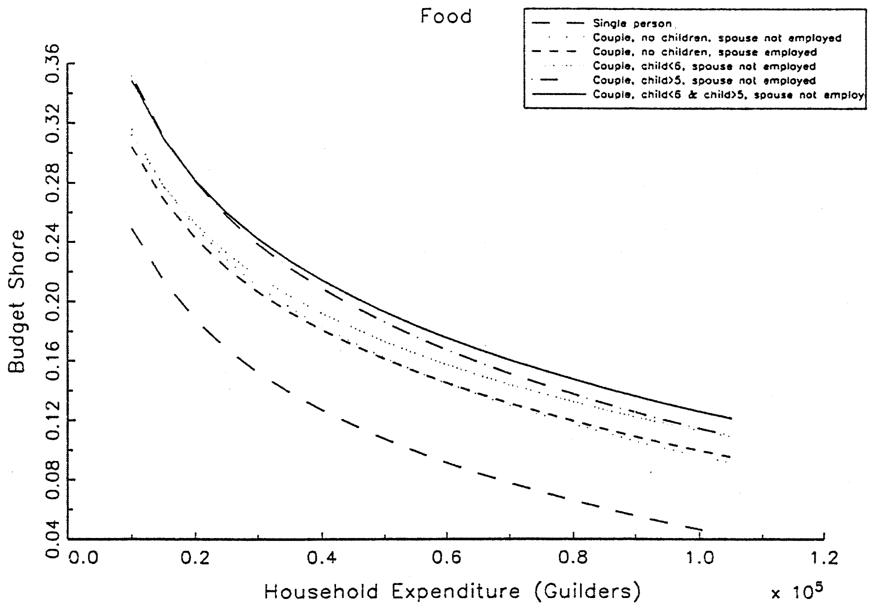


Fig 3. The relationship between household expenditure and the budget share for *food* for each type of household.

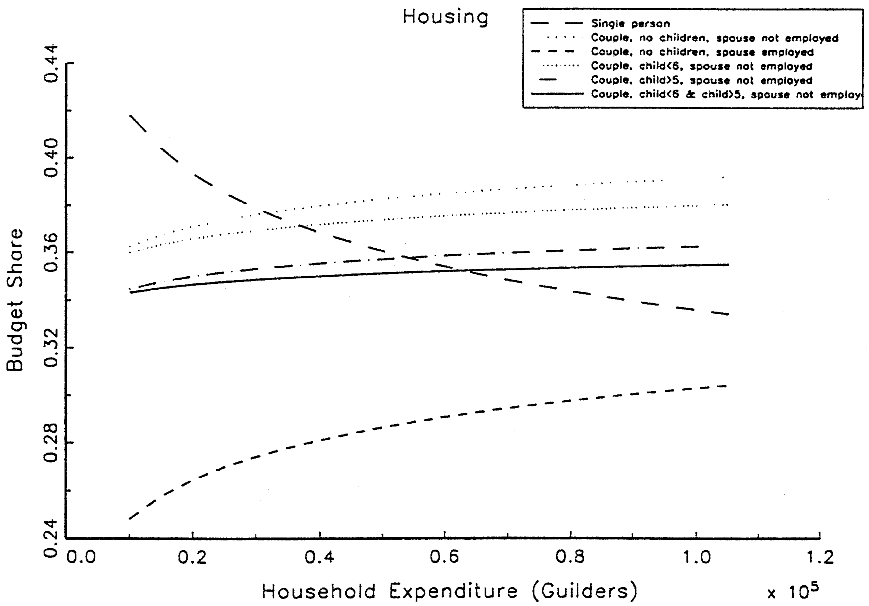


Fig 4. The relationship between household expenditure and the budget share for *housing* for each type of household.

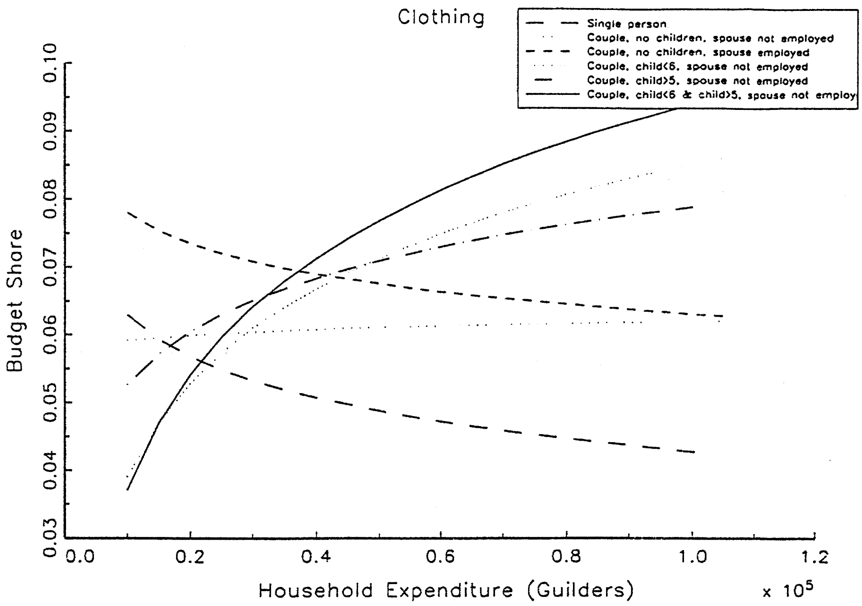


Fig 5. The relationship between household expenditure and the budget share for *clothing* for each type of household.

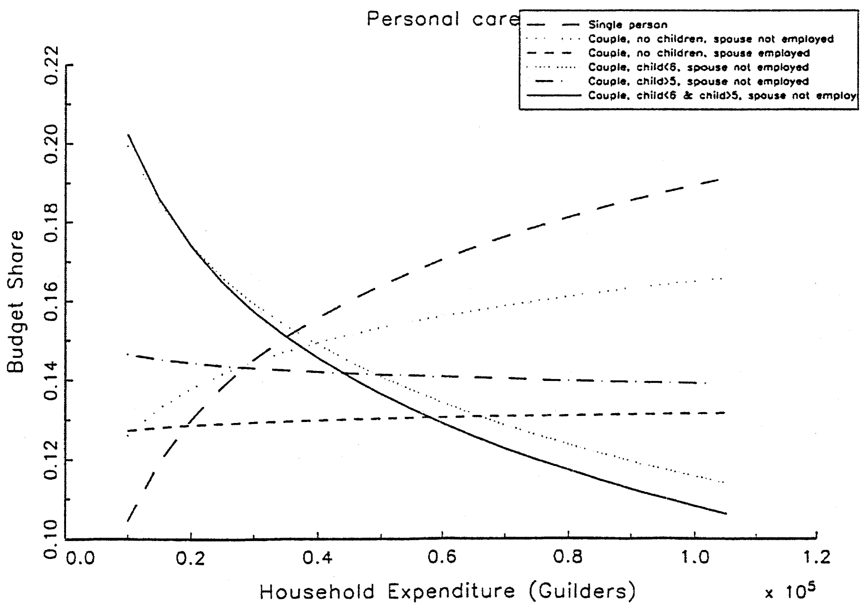


Fig. 6. The relationship between household expenditure and the budget share for *personal care* for each type of household.

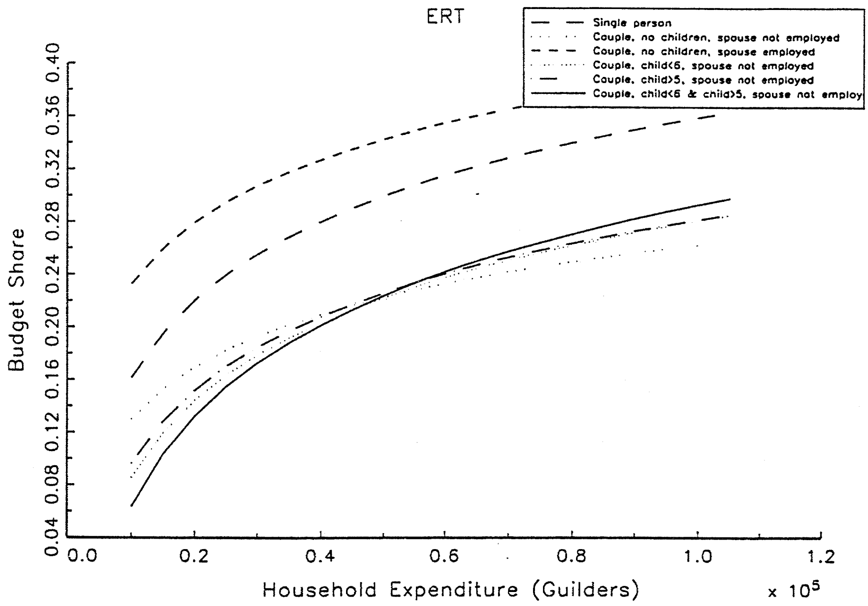


Fig. 7. The relationship between household expenditure and the budget share for *education, recreation and transport* (ERT) for each type of household.

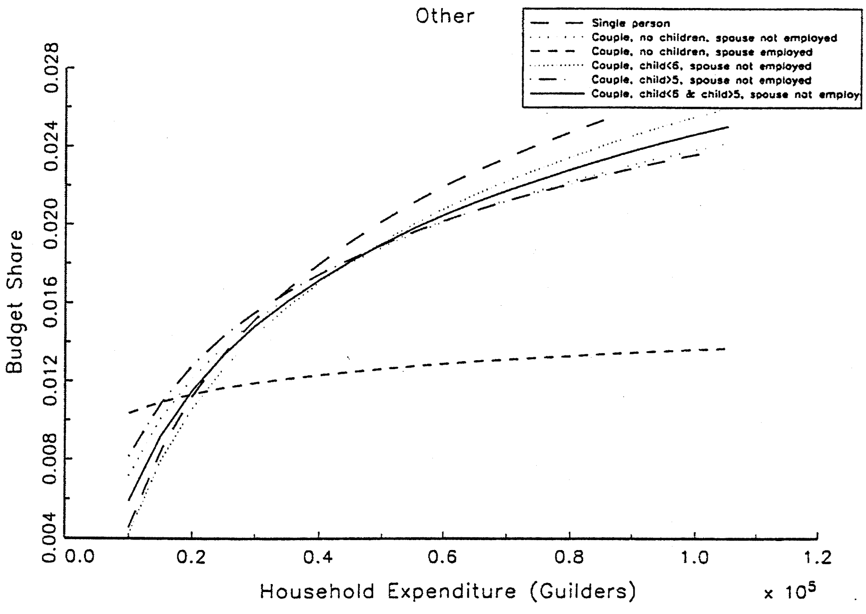


Fig. 8. The relationship between household expenditure and the budget share for *other* for each type of household.

development and *clothing* and less on *housing* and *personal care*. This supports the discussion in the introduction on the necessity of controlling for the employment status of the spouse. A working spouse increases costs of transport (included in *education, recreation and transport*) and *clothing*. Economies of scale and restrictions on the mortgage market lead to a reduction in the budget share of *housing* once the spouse is employed.

6. Conclusions

In this paper we have estimated an Almost Ideal Demand (AID) system on Dutch micro-level data. Special attention has been devoted to the specification of demographic effects. We find that the interactions between household expenditure and household characteristics are of significant importance in explaining the allocation of household expenditure to consumer goods. In particular, we find that consumer goods may change with household characteristics from luxuries to necessities. The importance of interaction terms has some interesting consequences. Firstly, it implies that budget and price elasticities cannot be estimated consistently from aggregated data. Secondly, the Independence of Base Utility (IB) assumption is violated, which means that nothing can be inferred about the value of equivalence scales from budget survey data alone. Hence additional information is required to identify the equivalence scale. We like the suggestion of Kapteyn (1994) to employ for that purpose direct measurements of feelings of well-being elicited in surveys. Kapteyn has made a first attempt to use subjective information in conjunction with budget survey data, but further research is needed in order to assess the equivalence scale. Thirdly, it is possible to estimate the AID parameter α_0 rather precisely. Consequently, it is not necessary and even undesirable to follow the common practice to set α_0 to the minimum level of household expenditure observed in the data.

Our analysis confirms the result of Browning and Meghir (1991) that consumer goods and female employment are not separable from each other. Consequently, female employment not only has an expenditure (income) effect but also an allocation effect. Our empirical results suggest that households with a working spouse spend relatively more on *education, recreation and transport* and *clothing* and less on *housing* and *personal care*. *Clothing* is a necessity for a household with a working spouse and a luxury for a household with a non-working spouse.

Appendix

The identification of the structural parameters

In the second step of the estimation procedure we estimate the relationship between the parameters of interest and the reduced form parameters by Asymptotic Least Squares. This relationship is given by the system of equations (3.2). This relationship is non-linear in the parameters of interest. We split up the second estimation step into several relatively easy substeps that are linear in the parameters of interest. First we estimate the following relationship:

$$B_{0t} = B'_{0t};$$
$$B_{1t} = \Delta_t^* - B_{2t}\zeta_t^{*T};$$
$$B_{2t} = B'_{2t};$$
$$B_{3t} = B'_{3t};$$
$$B_{4t} = \zeta_t^* \otimes \; - B_{3t}.$$

with

$$\Delta_t^* = \Delta - \eta_t \ln(a^*(p_t)) \quad \text{and} \quad \zeta_t^* = \zeta + \Delta^T \ln(p_t).$$

In the second step we assume time stability of the parameters Δ and ζ and estimate the following relationship:

$$B'_{0t} = B''_{0t};$$
$$B'_{2t} = B''_{2t};$$
$$B'_{3t} = B''_{3t};$$
$$\Delta_t^* = \Delta - B'_{3t} \ln(a^*(p_t));$$
$$\zeta_t^* = \zeta + \Delta^T \ln(p_t).$$

In the next step we estimate the parameters α_0, α and Γ:

$$B''_{0t} = \alpha + \Gamma \ln(p_t) - B''_{2t}(\alpha_0 + \alpha^T \ln(p_t) + 1/2(\ln(p_t) \otimes \ln(p_t))^t VEC(\Gamma));$$
$$B''_{2t} = B'''_{2t};$$
$$B''_{3t} = B'''_{3t};$$
$$\ln(a^*(p_t)) = \alpha_0 + \alpha^T \ln(p_t) + 1/2(\ln(p_t) \otimes \ln(p_t))^T VEC(\Gamma);$$
$$\Delta = \Delta';$$
$$\zeta = \zeta'.$$

In the final step we impose the theoretical restriction that the gamma matrix is symmetric: $\Gamma = \Gamma^T$. In this last step we also recover the β_t and η_t per time period: $B''_{2t} = \beta_t$ and $B''_{3t} = \eta_t$.

Endnotes

1 The IB condition stipulates that the equivalence scale (as a ratio of two cost functions) is independent of the base level of utility at which the cost comparison is made.

2 Due to this rationing scheme, two-income households may not be able to attain the desired level of housing consumption. Empirical findings of Aldershof et al. (1997) support this theory.

[3] $U(q,z)$ is an ordinal utility function. For analytical convenience this function can be normalized by choosing a specific functional form.

[4] In case of couples, the man is defined to be the head of household (see Sect. 4).

[5] Weak separability of consumer goods from h holds if and only if $U'(q,h,z) = F(U(q,z),h,z)$, where $U'(q,h,z)$ is total household utility and $U(q,z)$ is the (indirect) utility of consumption. In words: if weak separability holds, the allocation of household expenditure to consumer goods is not affected by h.

[6] A necessary variable to model h, or rather leisure, as a commodity is the hourly wage rate which we do not observe.

[7] The dual problems is formulated as follows: $c(u,p,z,h) = \min_q\{p^T q | U(q,z,h) > u\}$. We use Shephard's Lemma to derive the Hicksian demand equations and we substitute the indirect utility function in the Hicksian demand equations to obtain the Marshallian demand equations (see for instance Deaton and Muellbauer, 1980a, Chapter 2).

[8] Necessary variables for this are the interaction terms between $(\ln(x))^2$ and household characteristics (z and h) which we do not have (see Sect. 4).

[9] Basically, the argument boils down to the fact that $\Sigma_i z_i \ln(x_i) \neq \Sigma_i z_i \Sigma_i \ln(x_i)$, where the sum is taken over the individuals within a group, see Blundell et al. (1993).

[10] Implicitly this imposes some structure on the functional form of the utility function (see Deaton and Muellbauer 1980b). This seems in contrast with the fact that the objective of some of the studies mentioned above is to identify equivalence scales without imposing any structure on the utility function. Preliminary results indicated that the estimation results are quite sensitive with respect to the choice of α_0.

[11] Ray, however, does not estimate α_0 but does estimate ζ. In the estimation procedure Ray makes the usual assumption that the parameter α_0 is equal to the minimum level of household expenditure.

[12] To be more precise, Pashardes uses the Stone price index approximation after deriving the Marshallian demand function. In our case this would result in substituting $\ln a(p,z,h) = \alpha_0 + \zeta^T(z,h)^T + w(z,h)^T \ln p$ in equation (2.4), where $w(h,z)$ is a vector of budget shares of a household with characteristics (z,h).

[13] The null-hypothesis for this test is that the parameters of the interaction terms between household characteristics and household expenditure are all equal to zero.

[14] As will be discussed in Sect. 4, the Dutch budget survey is a rotating panel. Unfortunately, we did not have access to the household identifier. For this reason alone we were not able to take unobserved heterogeneity into account.

[15] This means we do not estimate a system of equations of I goods but of (I-1) goods. However, for convenience we wrote down the model as in equations (3.1) and (3.2). The I^{th} parameters of the α and β vectors and the I^{th} row and column of the Γ matrix are constructed by using the adding up conditions. The same holds for the β and η matrices.

[16] A 'non-family household' is a household of which the head, with or without a partner, lives together with at least one person who is not a (step)child.

[17] The rent is imputed for home-owners.

[18] To be more clear to this: let X denote a (Nxk)-matrix containing k characteristics of N households. Instead of having this X matrix we have the moment matrix $X^T X$. This is a (kxk)-matrix. This enables us to analyze on household level. However, especially concerning the interactions between variables, we are severely restricted in the flexibility of the empirical specification by which characteristics and interactions were *a priori* included in X.

[19] As mentioned in Sect. 3, the instruments are the demographic variables (z), educational attainment and age (squared) of both the head of the household and the partner, a dummy variable equal to 1 if the household is a single-parent family and 0 otherwise, and marital status.

[20] Bound et al. (1995) warn about the finite sample properties of the IV estimator when instruments are only weakly correlated with the endogenous right hand side variable. The partial R^2 and the partial F-statistic reveal whether or not there is a sufficiently strong correlation between the excluding instruments and the endogenous variables. The partial F-test statistic ranges from 12.8 to 58.7 (the critical value is equal to 1.69 at a 5% level of significance) and the partial R^2 ranges from 0.09 to 0.24.

[21] Browning and Meghir (1991) have also experimented with the specification of the model on the basis of the results of the Sargan tests. They also find that inclusion of the variable 'age of

spouse' (and regional dummies) decreased the Sargan test statistics considerably but did not significantly affect the estimates of the parameters of interest.

[22] Intuitively we say that a rejection of the null-hypothesis of the Sargan test causes a bias in the exogeneity test against rejection of exogeneity.

[23] Nelson (1993) claims that the estimate of the matrix Γ is not sensitive to the choice of α_0. However, in our case the estimates of Γ and consequently the (un)compensated price elasticities change dramatically if instead of estimating α_0 we set this parameter equal to the minimum level of household expenditure observed in the data.

[24] In these figures we consider the 1990 values of the β_t and η_t parameters.

[25] A similar result has been found by Nelson (1993).

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