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by
Rob Alessie
and
Arie Kapteyn

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HABIT FORMATION, INTERDEPENDENT PREFERENCES AND DEMOGRAPHIC EFFECTS IN THE ALMOST IDEAL DEMAND SYSTEM*

Rob Alessie and Arie Kapteyn

Estimation of demand systems for aggregate consumption data tends to give results that are quite different from results obtained on the basis of micro-data. Apart from the aggregation problem itself, a reasonable explanation for these differences may be that omitted factors cause a different bias in aggregate data than in micro-data. One obvious omitted factor in micro-studies is the interdependence of preferences. The fact that consumer preferences are influenced by the behaviour of others is well-documented in the psychological and sociological literature, yet it is almost universally ignored in micro-studies of consumer demand. Although preference interdependence is not accounted for explicitly in studies based on macro data, it can be said to play a role implicitly: to the extent that the consumption of the Jones' influences the consumption of the Browns and *vice versa*, these external effects show up in aggregate data since these reflect the consumption of both the Jones' and the Browns.¹

This suggests that estimation of micro-models will yield biased predictions of aggregate demand for different goods. On the other hand, a great deal of information is lost in the aggregation process, so that one would like to use micro-data for that reason alone. Hence it would be worthwhile to have a micro-model which can yield unbiased predictions of aggregate quantities. This paper is an attempt to construct and estimate such a model. It appears that this micro-model should include at least three taste shifters, viz. demographic effects, habit formation and preference interdependence. In the paper we build these three effects into the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980).

The incorporation of demographic effects in AIDS has been done before. Basically, we adopt a specification that is closely related to Ray's (1983) approach. Myopic habit formation in AIDS was modelled earlier by Blanciforti and Green (1983), but their specification is inconsistent with adding up (see section I below). Preference interdependence has only been modelled in the LES-framework; see Gaertner (1974) and Pollak (1976) for theoretical contributions and Kapteyn *et al.* (1989) for an empirical analysis. Here we follow closely the econometric framework of the latter paper, but apply it to AIDS.

Our way of modelling habit formation deserves some further comment.

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¹ This is analogous to 'omitted variables with group structure' as analysed by Pakes (1983).

Nowadays it is common practice to model consumption behaviour by means of the Life Cycle Hypothesis (LCH) of Modigliani. If one does not take into account habit formation, the LCH says that the individual maximises an (expected) intertemporally (additive) separable utility function under an appropriate life time budget constraint. It is well known that the separability of the objective function implies two stage budgeting. In the first stage the consumer determines total expenditures in each period by equating the (discounted) marginal utility of wealth in all periods. In the second stage the household allocates total expenditures within a period to the different categories. The first stage and the second stage allocation can be described by an Euler equation and by a demand system respectively (cf. e.g. MaCurdy (1983)). In the life cycle model, habit formation can be introduced in two ways. Habit formation is defined to be myopic (or naive) when in each period the consumer takes into account his consumption history but does not recognise the impact of present consumption on future tastes. In contrast to the myopic case, rational habit formation refers to a consumer, who is forward as well as backward looking. In our model we assume myopic habit formation. In that case the intertemporal utility function is still (additively) separable (cf. Muellbauer (1988)). Consequently the two stage budgeting property still holds and estimation of a demand system including lagged consumption variables is allowed. However, time consistency problems normally arise, because even in an environment of perfect certainty, households are constantly being surprised by the fact that due to the myopic nature of the habit formation process the utility function shifts over time. Alessie and Melenberg (1990) show that such problems can be avoided and that estimation of an Euler equation is possible only if one models habit formation in AIDS as proposed in this paper and if one assumes that the elasticity of intertemporal substitution is equal to minus one.

In case of rational habit formation the individual plans his/her consumption in a time consistent way and the intertemporal utility function is not separable, which implies that the two stage budgeting rule mentioned above is not valid anymore. Spinnewijn (1981) shows that under some restrictive assumptions rational habit formation can be handled in a two stage budgeting concept by adding the cost of habits to the rental price of commodities and redefining the life time budget constraint. This means that estimation of a demand system is allowed under the following restrictions: constant real interest rate and constant relative price structure over the life cycle and absence of liquidity constraints (cf. Pashardes (1986) and Alessie and Melenberg (1990)).

In this paper we do not consider the question whether habit formation is myopic or rational. Philips and Spinnewijn (1981) show that under particular restrictive classes of preferences (LES) myopic and rational habit formation models are observationally equivalent in the demand system context. Muellbauer and Pashardes (1988) also note that in the case of second order flexible preferences it is difficult to discriminate in empirical practice between naive and rational habit formation. Until now the empirical evidence is rather mixed. Pashardes (1986) find that a rational habit formation model is to be preferred to a myopic one, while Muellbauer (1988) obtains the opposite result.

The paper is organised as follows: in section I we set out the basic model and

include family size effects, habit formation and preference interdependence. In section II we discuss a number of assumptions regarding the stochastic structure of the model, which allow for easy estimation of reduced form parameters. This section contains also a discussion of the identification of the structural parameters. Section III gives estimation results on the basis of a two-year panel of households in the Netherlands. All three effects built into AIDS appear to have very significant effects. To see whether the model gives different predictions of aggregate consumption than 'standard' micro-models, we analyse its dynamic properties by calculating interim and long run multipliers in section IV, and compare these with the multipliers that correspond to two simplified versions of the model. The first one ignores preference interdependence, and the second one leaves out both preference interdependence and habit formation. It turns out that the three models behave quite differently.

Section V contains some concluding remarks and suggestions for future research. To contain the length of the paper within reasonable bounds, many technical details are omitted. These can be found in a working paper which is available on request: Alessie and Kapteyn (1985).

I. THE MODEL

The AIDS cost function has the following form

$$\ln c_n[t, u_n(t), p(t)] = \ln a_n[t, p(t)] + u_n(t) b[p(t)], \quad (1a)$$

where

$$\ln a_n[t, p(t)] = \alpha_{0n}^*(t) + \sum_{i=1}^I \alpha_{in}^{**}(t) \ln p_i(t) + \frac{1}{2} \sum_{i=1}^I \sum_{j=1}^I \gamma_{ij} \ln p_i(t) \ln p_j(t), \quad (1b)$$

$$b[p(t)] = \beta_0 \prod_{i=1}^I p_i(t)^{\beta_i} \quad (1c)$$

with

$\alpha_{in}^{**}(t), \beta_i, \gamma_{ij}, \alpha_{0n}^*(t)$ and β_0 : parameters,

$$\sum_{i=1}^I \alpha_{in}^{**}(t) = 1, \sum_{i=1}^I \beta_i = 0; \sum_{i=1}^I \gamma_{ij} = \sum_{j=1}^I \gamma_{ij} = 0; \gamma_{ij} = \gamma_{ji}.$$

The index $n, n \in \{1, \dots, N\}$ indicates one of the N consumers in society,² the indices i and $j, i, j \in \{1, \dots, J\}$ indicate goods; $u_n(t)$ and $\mathbf{p}(t) := [p_1(t), \dots, p_I(t)]'$ denote the utility level at time t of individual n and the vector of prices at time t respectively. The demand functions corresponding to (1) are

$$w_{in}(t) = \alpha_{in}^{**}(t) + \sum_{j=1}^I \gamma_{ij} \ln p_j(t) + \beta_i \{\ln x_n(t) - \ln a_n[t, \mathbf{p}(t)]\}, \quad (2)$$

where $w_{in}(t)$ and $x_n(t)$ denote the budget share of good i and total expenditures respectively. Deaton and Muellbauer (1980) have argued that after nor-

² For the purpose of this paper we use the terms 'family', 'consumer', 'individual' and 'household' as synonyms. This convention can be justified by another convention, namely that we only consider the individuals who are heads of households.

malisation such that $0 \leq u_n(t) \leq 1$, the function $a_n[t, \mathbf{p}(t)]$ can be interpreted as the level of subsistence expenditures. We assume that subsistence expenditures depend on family size (not on its composition) and that they are subject to habit formation and preference interdependence. Our specifications of these influences are discussed consecutively.

As regards demographic effects, we adopt an approach similar to Ray's (1983). We specify³

$$\alpha_{0n}^*(t) = \alpha_0 + \rho \ln f_{sn}(t) \quad (3)$$

$$\alpha_{in}^{**}(t) = \alpha_{in}^*(t) + \delta_i \ln f_{sn}(t), \quad (4)$$

where $f_{sn}(t)$ is the number of people in family n in period t . Unlike Ray (1983) we assume that the parameters β_i do not depend on family size. This means, that the equivalence scales are independent of the utility of the reference household. Furthermore in our model we do not take into account the composition of the family, but only its size, which means that equivalence scale weights do not depend on the age distribution of a family. These assumptions are made for simplicity mainly, and should be relaxed in future research. From the cost function (1) and the relations (3) and (4) it follows, that the effect of family size, f_s , on the cost of living of a family is partly price independent, with an elasticity equal to ρ , and partly dependent on prices with an elasticity equal to $\sum_i \delta_i \ln p_i(t)$, where the δ_i 's sum to zero to satisfy adding up (cf. equation (5) below). The budget share of the i th expenditure category for family n at time t is now derived from (1), (3) and (4) to be

$$\tilde{w}_{in}(t) = \alpha_{in}^*(t) + \sum_{j=1}^I \gamma_{ij} \ln p_j(t) + \beta_i \{\ln x_n(t) - \ln a_n[t, \mathbf{p}(t)]\}, \quad (5)$$

with $\tilde{w}_{in}(t) := w_{in}(t) - \delta_i \ln f_{sn}(t)$. Notice that $\sum_i \tilde{w}_{in}(t) = 1$. For a one person family $\tilde{w}_{in}(t) = w_{in}(t)$; for $f_{sn}(t) \neq 1$, $\tilde{w}_{in}(t)$ will generally be different from $w_{in}(t)$. The quantity $\tilde{w}_{in}(t)$ will be referred to as a 'family size adjusted' budget share. From now on the analysis will be mainly in terms of adjusted budget shares, because it essentially allows us to ignore variations in family size.

Next we specify the role of habit formation and preference interdependence. In order to understand the way in which we model these effects, it is necessary to introduce the notion of a (family size adjusted) 'mean perceived budget share' of good i at time t , $m_{in}(t)$. It is defined as follows

$$\tilde{m}_{in}(t) := \sum_{k=1}^N z_{nk}^i(t) \tilde{w}_{ik}(t), \quad (6)$$

The non-negative *reference weight*, $z_{nk}^i(t)$ [$\sum_k z_{nk}^i(t) = 1$], denotes the relative importance individual n attaches to the consumption of good i by family k at

³ The equations (3) and (4) imply that the cost function can be split into two parts. The first part is the cost function of the reference household which in our case consists of one person. The formula of this cost function almost coincides with (1). Only the following adjustment has to be made: substitute into (1b) α_0 for $\alpha_{0n}^*(t)$ and $\alpha_{in}^*(t)$ for $\alpha_{in}^{**}(t)$ respectively. The second part of the cost function describes the equivalence scale $m_0[f_{sn}(t), \mathbf{p}(t)]$ which depends on prices and not on utility and which has the following form:

$$\ln m_0[f_{sn}(t), \mathbf{p}(t)] = [\rho + \sum_i \delta_i \ln p_i(t)] \ln f_{sn}(t).$$

time t . So, $\tilde{m}_{in}(t)$ is a weighted mean of budget shares of the various consumers in society. One might say that the set of $\tilde{m}_{in}(t)$ ($i = 1, \dots, I$) represents the average expenditure pattern in society, as individual n sees it. The observed expenditure pattern is family size adjusted. Notice that the reference weights include $z_{nn}^i(t)$, i.e. the weight that individual n attaches to his own consumption. For the rest, it seems obvious that many of the $z_{nk}^i(t)$ will be zero, simply because individual n does not know individual k , or at least does not observe k 's consumption pattern.

We incorporate habit formation and interdependence of preferences by expressing the parameters $\alpha_{in}^*(t)$ as linear functions of the mean perceived budget shares, lagged one period:

$$\alpha_{in}^*(t) = \alpha_i + \sum_{j=1}^I a_{ij} \tilde{m}_{jn}(t-1). \quad (7)$$

In order to satisfy adding up, $\sum_{i=1}^I a_{ij} = 0, j = 1, \dots, I$ has to hold. The $\tilde{m}_{jn}(t-1)$ in (7) are defined in terms of prices of period t . That is, the $\tilde{w}_{ik}(t-1)$ that feed into the definitions of $\tilde{m}_{in}(t-1)$, cf. (6), are the budget shares that would have obtained if the t th period prices would have been valid in period $t-1$. By this 'deflation' we specify the influence of the consumption patterns in the previous period on preferences in period t in terms of quantities consumed, rather than in money outlays. Due to data limitations, we use in our treatment of habit formation and preference interdependence only a one-period lag of $\tilde{m}_n(t)$ rather than more distant memory.

We make some major simplifying assumptions about the reference weights $z_{nk}^i(t)$, inspired by our wish to have a model that can be estimated empirically. First assume that the own reference weight $z_{nn}^i(t)$, i.e. the weight that individual n attaches to his own consumption, is constant across individuals and time. Say,

$$z_{nn}^i(t) := \theta_2^i n \in \{1, \dots, N\}, \quad \text{for all } t. \quad (8)$$

Define $\theta_3^i := 1 - \theta_2^i$. The second assumption is that the reference weights for different goods are proportional, i.e.

$$z_{nk}^i(t) = \theta_3^i v_{nk}, \quad \text{for all } t \quad (9)$$

where the v_{nk} are parameters, satisfying $0 \leq v_{nk} \leq 1$, $\sum_{k=1}^N v_{nk} = 1$, $v_{nn} = 0$. We shall also refer to the v_{nk} as reference weights. We shall often refer to the set of individuals $\{k | v_{nk} > 0\}$ as the *reference group* of individual n . Due to the assumptions (8) and (9) we may rewrite relation (7).

$$\alpha_{in}^*(t) = \alpha_i + \sum_{j=1}^I a_{ij} \theta_2^j \tilde{w}_{jn}(t-1) + \sum_{j=1}^I a_{ij} \theta_3^j \sum_{k=1}^N v_{nk} \tilde{w}_{jk}(t-1). \quad (10)$$

We expect that $w_{in}(t)$ and $\tilde{m}_{in}(t-1)$ are positively related, i.e. $a_{ii} > 0$. Intuitively, the product of the parameters a_{ii} and θ_3^i measures the *conspicuousness* of good i .⁴ The higher $a_{ii} \theta_3^i$ is, the more one's consumption is influenced by the

⁴ The term 'conspicuousness' is used more often in the context of price dependent preferences (see, for example, Veblen (1989), Bassmann *et al.* (1983)). Veblen noted that the direct utility function depends on

consumption of others. Persistence in consumption patterns ('habit formation') is measured by the coefficient $b_{ii} = a_{ii} \theta_2^i$.

The model is closely related to the one analysed by Kapteyn *et al.* (1989), who have tested the hypothesis of interdependent preferences, building on theoretical notions of Gaertner (1974) and Pollak (1976). They have also modelled shifts in subsistence expenditures and they give a justification for this procedure by referring to evidence found in the economic and psychological literature. However, their model is based on the restrictive Linear Expenditure System (LES) and since they have only cross-section data at their disposal, their model does not account for habit formation.

Blanciforti and Green (1983) and Ray (1984) have given a dynamic generalisation of the Almost Ideal Demand System in order to allow for habit formation. However, since these models are estimated for macro time series, the analyses allow for multiple interpretations, such as interdependent preferences. Moreover, the extension given by Blanciforti and Green, does not satisfy the theoretical requirements of utility theory. They have incorporated habit formation by expressing the parameter $\alpha_{in}^{**}(t)$ in equation (1) as a linear function of own consumption of good i lagged one period, i.e. $\alpha_{in}^{**}(t) = \alpha_i^0 + \alpha_i^1 q_{in}(t-1)$. Imposition of the adding up restriction immediately implies $\alpha_i^1 = 0, i = 1, \dots, I$. So, either we have habit formation and violation of adding up, or we have adding up and no habit formation.

In what follows we take period t as our base period, and without loss of generality all prices in period t are set equal to one. Using this convention, combining (4), (6), (10) and taking into account that $\sum_{j=1}^I w_{jn}(t-1) = 1$ and $\sum \delta_i = 0$, yields

$$\begin{aligned} w_{in}(t) = & (\alpha_i - \beta_i \alpha_0) + a_{ii} + \sum_{j=1}^{I-1} (a_{ij} \theta_2^j - a_{ii} \theta_2^i) w_{jn}(t-1) \\ & + \sum_{j=1}^{I-1} (a_{ij} \theta_3^j - a_{ii} \theta_3^i) \sum_{k=1}^N v_{nk} w_{jk}(t-1) \\ & - \sum_{j=1}^{I-1} (a_{ij} \theta_2^j - a_{ii} \theta_2^i) \delta_j \ln f s_n(t-1) \\ & - \sum_{j=1}^{I-1} (a_{ij} \theta_3^j - a_{ii} \theta_3^i) \delta_j \sum_{k=1}^N v_{nk} \ln f s_k(t-1) \\ & + \beta_i \ln x_n(t) + (\delta_i - \beta_i \rho) \ln f s_n(t) + u_{in}(t) \end{aligned} \quad (11)$$

where an error term $u_{in}(t)$ has been added to represent omitted factors, measurement error in the endogenous variables, etc. We assume that the $u_{in}(t)$ are independently and identically distributed across households, with mean zero and a singular covariance matrix, in order to satisfy adding up.

prices because by buying 'conspicuous' goods people get social confirmation of their relative ability to pay and consequently gain utility. Empirical studies by e.g. Bassmann *et al.* (1988) show the importance of price dependent preferences.

II. STOCHASTIC SPECIFICATION, REDUCED FORM, AND IDENTIFICATION

The main problem with estimation of (11) is the number of unknown reference weights v_{nk} . In principle there are $N(N-2)$ independent reference weights that would have to be estimated if they were considered to be constants. To circumvent this problem we interpret the v_{nk} as random drawings from some distribution and we make three assumptions that partly characterise this distribution. We closely follow the analysis in Kapteyn *et al.* (1989) and Alessie and Kapteyn (1985). A central concept in our approach is the notion of a *social group*, i.e. a set of people who share certain characteristics like education, age, type of job, etc. The idea is to choose assumptions which justify the use of the social group to which an individual belongs as a proxy for his reference group. For reasons of space we shall not repeat the assumptions here (the exact formulation of the 3 assumptions can be found in Alessie and Kapteyn (1985)), but only mention the result that the three assumptions allow us to approximate

$$\sum_{k=1}^N v_{nk} w_{ik}(t-1), \quad \sum v_{nk} \ln x(t) \quad \text{and} \quad \sum_{k=1}^N v_{nk} \ln f_{sk}(\tau), \quad \tau = t, t-1$$

by a convex combination of population means and social group means as follows:

$$\sum_k v_{nk} \ln x_k(t) = (1-\kappa) \ln \bar{x}_n(t) + \kappa \eta_x(t) + \hat{v}_x(t), \quad (12)$$

$$\sum_k v_{nk} \ln f_{sk}(\tau) = (1-\kappa) \ln \bar{f}_{sn}(\tau) + \kappa \eta_{fs}(\tau) + \hat{v}_{fs}(\tau), \quad \tau = t, t-1 \quad (13)$$

$$\sum_k v_{nk} w_{ik}(t-1) = (1-\kappa) \bar{w}_{in}(t-1) + \kappa \eta_{wi}(t-1) + \hat{v}_{wi}(t-1), \quad i = 1, \dots, I \quad (14)$$

where $\ln \bar{x}_n(t)$ is the mean of log-total expenditures in the social group to which individual n belongs (i.e., the mean of log-total expenditures of all individuals with the same characteristics as individual n); $\ln \bar{f}_{sn}(t)$ is the mean log-family size in this social group; $\bar{w}_{in}(t-1)$ is the mean lagged i th budget share in the social group; the η 's are means of the same variables, but now for society as a whole; the $\hat{v}$'s are well-behaved but heteroskedastic error terms; $0 \leq \kappa \leq 1$. If $\kappa = 0$, individual n gives no weight to people outside his or her social group. $\kappa = 1$ indicates that knowledge of n 's social group does not give information concerning his or her reference group.

Notice, that (12)–(14) are consistent with (11) in the sense that if (12)–(13) and (11) hold for a particular value of t , say $t = t_0$, then they may also hold for $t_0 + 1$, etc. Substitution of (13) and (14) into (11) yields the following reduced form:

$$\begin{aligned} w_{in}(t) = & \hat{\alpha}_t + c_t \ln f_{sn}(t) + \beta_t \ln x_n(t) + \sum_{j=1}^{I-1} d_{ij} w_{jn}(t-1) \\ & + \sum_{j=1}^{I-1} e_{ij} \bar{w}_{jn}(t-1) - s_t \ln f_{sn}(t-1) - t_t \ln \bar{f}_{sn}(t-1) + \epsilon_{in}(t). \end{aligned} \quad (15)$$

The reduced form parameters can be expressed as functions of the structural parameters as follows:

$$b_{ij} = a_{ij} \theta_2^j \quad (16)$$

$$\begin{aligned} \hat{\alpha}_i = & (\alpha_i - \beta_i \alpha_0) + a_{ii}(1 - \kappa \theta_3^i) + \sum_{j=1}^I a_{ij} \theta_3^j \kappa \eta_{w_j}(t-1) \\ & - \sum_{j=1}^I a_{ij} \theta_3^j \kappa \eta_{fs}(t-1), \quad \sum_{i=1}^I \hat{\alpha}_i = 1 \end{aligned} \quad (17)$$

$$c_i = \delta_i - \beta_i \rho, \quad \sum_{i=1}^I c_i = 0 \quad (18)$$

$$d_{ij} = b_{ij} - b_{ii}, \quad \sum_{i=1}^I d_{ij} = 0 \quad (19)$$

$$e_{ij} = (1 - \kappa)(a_{ij} \theta_3^j - a_{ii} \theta_3^i), \quad \sum_{i=1}^I e_{ij} = 0 \quad (20)$$

$$s_i = \sum_{j=1}^{I-1} d_{ij} \delta_j, \quad \sum_{i=1}^I s_i = 0 \quad (21)$$

$$t_i = \sum_{j=1}^{I-1} e_{ij} \delta_j, \quad \sum_{i=1}^I t_i = 0. \quad (22)$$

The error term $\epsilon_{in}(t)$ is a combination of the errors $u_{in}(t)$ added to (11) and $\hat{v}_{fs}(t-1)$ and the $\hat{v}_{w_i}(t-1)$, introduced in (13) and (14). Of course, the variances of the three sources of error cannot be identified separately. Given the assumptions mentioned in the previous section and which are stated in Alessie and Kapteyn (1985), $\epsilon_{in}(t)$ is well-behaved in the sense that for large enough N its distribution is closely approximated by that of a random variable with mean zero and uncorrelated with the other variables on the right hand side of (15)⁵ (cf. Alessie and Kapteyn (1985)). However, since the variances of $\hat{v}_{fs}(t-1)$ and the $\hat{v}_{w_i}(t-1)$ vary with households, the error term $\epsilon_{in}(t)$ is heteroskedastic.

Under our assumptions, all reduced form parameters can be estimated consistently from data in which there is no price variation. The reduced form parameters do not contain enough information to identify all structural form parameters. This can be seen as follows. The β_i are reduced form parameters, and hence identified. Next use (18) and (21) (or (22)) to determine the parameters δ_i and ρ . Notice that without habit formation and interdependence of preferences the δ_i and ρ would not be identified, since the c_i sum to zero. Consequently, we would have had only $I-1$ pieces of information to identify I independent parameters δ_i and ρ .

The values of the parameters b_{ij} may be derived from equations (19) and (20). Knowing b_{ij} and using (16) and (20) we can determine the structural parameters θ_2^j , θ_3^j ($= 1 - \theta_2^j$) and a_{ij} up to a constant of proportionality. If we

⁵ We assume that the $\ln x_n(t)$ is a strictly exogenous variable.

knew the value of κ , we could solve θ_2^j , θ_3^j and a_{ij} . Thus we lack one piece of information to identify all parameters of interest. The model of Kapteyn *et al.* (1989) contains less identifying information, because it does not incorporate habit formation. If we impose the condition that the model (11) has to be dynamically stable, then it turns out that this puts an upper bound on κ (see Appendix A of Alessie and Kapteyn (1985)). For the data used in the empirical part of this paper, $0 \leq \kappa \leq 0.08$, to ensure stability.⁶

Although we do not know the value of the parameters a_{it} , θ_2^t and θ_3^t , we are still able to assert something about habit formation and preference interdependence. As mentioned in Section I, b_{it} ($= a_{it}\theta_2^t$) measures persistence in consumption patterns, which reflects habit formation. From (20) we can derive $(1-\kappa)a_{it}\theta_3^t$. A comparison of the magnitude of this expression across goods tells us something about which goods are the most conspicuous ones. The $(I+1)$ parameters α_i and α_0 cannot be identified from (17). Since the α_i and α_0 are of no particular interest we do not pay further attention to them.

III. ESTIMATION AND RESULTS

Under the extra assumption that the error terms in (15) follow a multivariate normal distribution, the unknown parameters can be estimated by means of maximum likelihood. For the estimation we have used the LISREL-V program. By using this package we ignore the complication that the error terms $\epsilon_{in}(t)$ in (15) are heteroskedastic. LISREL-V will still produce consistent estimates of the structural parameters, but the standard errors of these parameters are inconsistent. This problem is solved by also presenting standard errors calculated from (White's) heteroskedastic-consistent variance-covariance matrix.

The data used stem from a consumer expenditure survey in the Netherlands, held in 1980 and 1981. For 1,579 households expenditures and some background information have been recorded for both 1980 and 1981. The definition of social groups in the sample is based on three different characteristics: age of head of household (5 brackets), educational attainment of head of household (5 levels), type of occupation of head of household (5 types). Thus we can have a maximum of 125 social groups, of which 66 are represented in the sample. Six expenditure categories have been distinguished: 1. Food, 2. Housing, 3. Clothes, footwear, 4. Medical care, 5. Education, entertainment, 6. Transportation/other. 'Other' is a very small category (approximately 1% of total expenditures). As much as possible, durable components have been removed from the expenditure categories, to avoid complications due to the investment nature of durables. By removing durables, we assume implicitly, of course, that the household's utility function is weakly separable in durables and non-durables. The appendix presents means and

⁶ This approach to bounding an otherwise unidentified parameter on the basis of weak prior information (in this case: stability of the model) is similar to the approach in linear errors-in-variables models where one can bound the unidentified regression parameters on the basis of weak assumptions regarding the unknown measurement error variances. See, for instance, Koopmans (1937) and Bekker *et al.* (1987).

standard deviations of the variables. From this appendix it appears that given the goods classification mentioned above zero expenditures almost never occur. Therefore estimation of the model by means of multivariate TOBIT is not needed.

The estimation results for the parameters of main interest are given in Table 1. The complete set of estimates is given in the Appendix. In this appendix we

Table 1

Estimation Results for the Main Parameters of Main Interest (t-values in parentheses)

$\beta_1 = -0.033$ (-6.925)	$b_{11} = -0.072$ (-0.333)
$\beta_2 = -0.011$ (-1.711)	$b_{22} = 0.311$ (1.216)
$\beta_3 = 0.013$ (3.938)	$b_{33} = 0.515$ (4.778)
$\beta_4 = -0.017$ (-5.244)	$b_{44} = 0.623$ (5.298)
$\beta_5 = 0.032$ (6.485)	$b_{55} = 0.622$ (2.856)
$\beta_6 = 0.016$	$b_{66} = 0.470$
$(1-\kappa) a_{11} \theta_1^2 = 0.002$ (0.126)	$\rho = 0.580$ (3.048)
$(1-\kappa) a_{22} \theta_2^2 = 0.037$ (0.474)	$\chi^2(23) = 29.39$
$(1-\kappa) a_{33} \theta_3^2 = 0.203$ (2.231)	$\ln L = 13298.06$
$(1-\kappa) a_{44} \theta_4^2 = 0.328$ (2.559)	
$(1-\kappa) a_{55} \theta_5^2 = 0.221$ (1.330)	
$(1-\kappa) a_{66} \theta_6^2 = 0.184$	

also present both the t-values based on White's heteroskedastic-consistent variance covariance matrix of the parameters. It appears that the t-values provided by LISREL are quite similar to the White t-values. From this, one can conclude tentatively that the heteroskedasticity of the error term is not severe. From a statistical viewpoint the estimates are quite satisfactory, t-values are usually in excess of 2, the likelihood ratio test statistic provided by LISREL to test the restrictions imposed by the model on the covariance matrix of the observable variables indicates acceptance of these restrictions.

A positive β_1 is equivalent to a (short run) expenditure elasticity larger than one. From Table 1 we thus conclude that Food, Housing, and Medical Care are necessities. It is easy to see from (3) that under constant relative prices the elasticity of the cost of living of a household with respect to its size is equal to ρ . The estimate of ρ (0.58) looks quite plausible.

The estimates of b_{ii} , which is equal to $a_{ii} \theta_i^2$, suggest that habit formation is most important for expenditures like education/entertainment, clothes/footwear and medical care, whereas the lagged budget share of food has a non-significant influence on today's budget share of expenditures on food. As far as preference interdependence is concerned, we conclude from the estimates of $(1-\kappa) a_{ii} \theta_i^2$ that the order of conspicuousness is: medical care, education/recreation, clothes/footwear, transportation/other, housing, food. The conspicuousness of medical care is partly an artefact, because wage-earners below a certain income level are compulsory insured in a so-called sick-fund with premium payments proportional to income. The three characteristics that define social groups correlate strongly with income and thus we get a strong

Table 2
Estimates of some Structural Parameters for $\kappa = 0$

$a_{11} = -0.07$	$\theta_1^1 = 1.02$	$\theta_3^1 = -0.02$
$a_{22} = 0.35$	$\theta_2^1 = 0.89$	$\theta_3^2 = 0.11$
$a_{33} = 0.72$	$\theta_3^1 = 0.72$	$\theta_3^3 = 0.28$
$a_{44} = 0.95$	$\theta_1^2 = 0.66$	$\theta_3^4 = 0.34$
$a_{55} = 0.84$	$\theta_2^2 = 0.74$	$\theta_3^5 = 0.26$
$a_{66} = 0.66$	$\theta_3^2 = 0.71$	$\theta_3^6 = 0.28$

correlation between a household's budget share of medical care and the corresponding budget share in the social group. In the model this turns up as conspicuousness. To see if preference interdependence plays a significant role, we have performed likelihood ratio tests of model (15) against a model with $\theta_3^1 = \theta_3^2, \dots = \theta_3^6 = 0$.⁷ The test statistic, which, under the null, follows a $\chi^2(6)$ distribution equals 51.55, which is highly significant. Similarly, the hypothesis of no habit formation is rejected decisively: $\chi^2(26) = 2602.34$. On the other hand we have tested the restrictions on the reduced form parameters in (15) implied by the structural model. We have tested the joint restrictions (19) and (20). The resulting likelihood ratio statistic $\chi^2(14) = 14.76$ does not indicate rejection.

In sum, restrictions implied by the model are not rejected, restrictions that arise from the omission of preference interdependence or habit formation are decisively rejected. Parameter estimates generally have the expected sign and plausible magnitudes.

III.1. *Sensitivity of estimates for values of κ*

As noted in Section II, the parameter κ is not identified, but can be bounded between zero and 0.08 under the assumption that the model is dynamically stable. These bounds on κ translate into bounds on the non-identifiable structural parameters. In Alessie and Kapteyn (1985) estimates of the a_{ij} and the θ_j^i are presented for the two extreme values of κ . It turns out that neither the estimates of the a_{ij} nor the estimates of the θ_2^i and θ_3^i change much if we vary κ . Most of the estimates only change in the third digit and only a few of them change in the second digit.

Let us briefly consider the estimates for the case where $\kappa = 0$ (see Table 2). We note that for all goods θ_2^i is quite a bit larger than θ_3^i , indicating that habit formation is substantially more important in the formation of one's preferences than preference interdependence. Preference interdependence is *relatively* (i.e., relative to habit formation) most important for clothes, footwear, medical care and transportation. Habit formation is relatively most important for food (θ_2^1 is essentially equal to one) and housing. It should be stressed that the importance of habit formation and preference interdependence cannot be

⁷ The model with $\theta_3^i = 0$, is model (11) with the terms $w_{jn}(t-1)$ and $\ln f_{jn}(t-1)$ omitted. In fact $\kappa = 1$ would also make these terms vanish. Thus, we have tested the composite hypothesis that the θ_3^i are zero or $\kappa = 1$.

measured by θ_2^i and θ_3^i alone. For this purpose one also needs the estimates of a_{ij} , particularly for $i = j$, which indicate the extent to which preferences can be influenced. The total influence of habit formation and preference interdependence is better measured by $a_{ii}\theta_2^i$ and $a_{ii}\theta_3^i$ respectively. Preferences for food seem to be rather immutable, whereas preferences for clothes, medical care, education/entertainment, and transportation are influenced quite a bit by one's own past consumption or consumption in the reference group.

IV. DYNAMIC BEHAVIOUR

Given the apparent superiority of the model with preference formation (to be called the 'full model' from now on) to simpler versions, it is of interest to compare the implications of the full model with those of the more restrictive models. The first thing to notice is that the further we simplify the model, the fewer parameters can be identified. For example, in the full model we can identify all b_{ij} , whereas in the model with only habit formation we can only identify $b_{ij} - b_{ii}$.

The full model and the model with only habit formation give rather different outcomes with respect to the effect of family size on the cost of living. For the full model we find $\rho = 0.58$ (cf. table A1 of the appendix), whereas according to the model with only habit formation $\rho = 0.95$.⁸ In the 'static model' (neither preference interdependence nor habit formation) ρ is not identified. Since ρ is the elasticity of a household's cost of living with respect to its size, the implications of the two estimates for, say, income maintenance policy would be quite different.

To get some more feeling for the different implications of the three models, we briefly investigate some aspects of the dynamic behaviour of the models. We do this by computing the effect of a one-time, but permanent, increase in the total expenditures of each family by a factor $1+g$. A convenient way of characterising these effects is by means of interim and long run multipliers. These are presented in table 3. For a derivation of the formulas used to calculate the multipliers, the reader is referred to Appendix A of Alessie and Kapteyn (1985). The derivations in the Appendix deal with the general case that the total expenditures of different households increase by different factors. In Table 3 we only give results for the case that g is identical across households. The calculations for Table 3 have been carried out under the assumption that $\kappa = 0$. Table 3 should be read as follows. In order to compute the effect of an increase in total expenditures by a factor $1+g$ on the budget share of an expenditure category, one should multiply the entries in Table 3 by $\ln(1+g)$.

A number of aspects about Table 3 are worth noticing. First, the long run multipliers of the model with only habit formation are rather close to the multipliers of the static model. This is a rather striking result because the two models assume quite different short and intermediate run behaviour. In the static model interim and long run multipliers are equal, because the consumers

⁸ The estimation results of the restricted models are available upon request.

Table 3
Interim Multipliers for Three Models

Period	Food	Housing	Clothes/ Footwear	Medical care	Education/ Entertainment	Transportation/ Other
Full model ($\kappa = 0$)						
1	-0.033	-0.011	0.013	-0.017	0.032	0.015
2	-0.052	-0.019	0.020	-0.027	0.053	0.025
3	-0.064	-0.027	0.024	-0.032	0.067	0.031
4	-0.071	-0.033	0.027	-0.035	0.076	0.036
5	-0.075	-0.038	0.028	-0.037	0.082	0.039
10	-0.083	-0.055	0.031	-0.034	0.096	0.045
∞	-0.098	-0.097	0.038	-0.007	0.115	0.049
Model without preference interdependence						
1	-0.039	-0.014	0.013	-0.016	0.037	0.019
2	-0.056	-0.020	0.017	-0.022	0.052	0.029
3	-0.063	-0.023	0.018	-0.025	0.059	0.034
4	-0.066	-0.025	0.018	-0.026	0.061	0.037
5	-0.067	-0.025	0.018	-0.026	0.062	0.038
10	-0.068	-0.026	0.018	-0.026	0.063	0.039
∞	-0.068	-0.026	0.018	-0.026	0.063	0.039
Static model						
1, 2, ..., ∞	-0.065	-0.027	0.015	-0.015	0.054	0.038

immediately adjust their consumption level to the new steady state value. In the model with only habit formation the budget shares $w_{in}(t)$ depend on $w_{jn}(t-1)$, $j = 1, \dots, n$, so that $w_{in}(t)$ is affected both by the increase of $\ln x_n(t)$ and $\ln x_n(\tau)$, $\tau = t-1, t-2, \dots$. The intermediate and long run multipliers of the full model are clearly different from the two other models. Due to preference interdependence, the change in $w_{in}(t)$ for individual n is not only caused by the increase in his or her total expenditures $\ln x_n(\tau)$, $\tau = t, t-1, \dots$, but also by the increase of the total expenditures by members of his or her reference group.⁹

Secondly, the full model takes a much longer time to reach a steady state than the model without preference interdependence. Thirdly, we observe some non-monotonic effects in the full model. For medical care the effect of an increase in expenditures leads initially to a modest fall of its budget share. This decrease at first becomes larger when time goes on, but the long run effect is virtually zero.

In Table 4 interim multipliers are given that have been calculated under the assumption that $\kappa = 0.08$, i.e. close to instability. One sees that in the first 5 or 10 periods the interim multipliers for both cases are rather similar. However, as might be expected for this almost unstable model, the long run multipliers for $\kappa = 0.08$ are substantially larger than for $\kappa = 0$.

⁹ The calculation of interim and long run multipliers, presented in Table 3, is rather easy because we have assumed the growth rate of total expenditures to be identical across households. In that case we do not need to know the values of the reference weights v_{nk} , $n, k = 1, \dots, N$, (cf. Alessie and Kapteyn (1985)). The vector of long run multipliers is equal to $(I-A)\beta$, where $A = (a_{ij})$, $i, j = 1, \dots, I$ (cf. equation (10)).

Table 4
Interim Multipliers for the Full Model ($\kappa = 0.08$)

Period	Food	Housing	Clothes/ Footwear	Medical care	Education/ Entertainment	Transportation/ Other
1	-0.033	-0.011	0.013	-0.017	0.032	0.015
2	-0.052	-0.020	0.021	-0.027	-0.054	0.025
3	-0.065	-0.028	0.025	-0.033	0.069	0.032
4	-0.073	-0.034	0.028	-0.036	0.079	0.037
5	-0.078	-0.040	0.029	-0.037	0.086	0.040
10	-0.088	-0.062	0.033	-0.033	0.103	0.048
∞	-0.152	-0.222	0.064	0.074	0.172	0.064

V. CONCLUDING REMARKS

The full model has different properties than the simpler models we have compared it with. Being different is only a necessary condition for being better, not a sufficient one. Yet, on statistical grounds, the full model is clearly to be preferred to the simpler models, so that some attention for preference interdependence seems to be justified.

Our modelling of preference interdependence has had to rest strongly on statistical assumptions, because the data do not contain direct information about reference groups. In future data collection efforts, information on reference groups should have a high priority. In addition, longer lived panels are necessary for several reasons. First of all, the dynamics could be modelled more appropriately than is possible on the basis of just two waves. In particular, this would allow us to investigate an alternative explanation of our results, which cannot be precluded on the basis of the present data, viz. unobserved individual effects. Secondly, we would then be able to identify the parameters γ_{ij} of the Almost Ideal Demand System (cf. equation (1)). Given these parameters we may calculate price elasticities and perform some interesting policy analysis, such as, for instance, measuring the effects of the indirect tax harmonisation in the EC countries on consumer demand. It should be stressed however that we need a considerably longer panel for this purpose. Thirdly, a longer panel the model would allow us to identify the parameter κ .

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APPENDIX

Data and estimation results: some tables

Below we give the sample means of the variables and their standard deviation. The following symbols are used:

$w_1(\tau)$ = budget share of food in period τ , $\tau = t, t-1$

$w_2(\tau)$ = budget share of housing in period τ , $\tau = t, t-1$

Table A1

Estimation Results for the Full Model

(Two t-values are given within parentheses. The first t-value is provided by the LISREL package. The second t-value is based on White's heteroskedastic-consistent variance covariance matrix of the parameter estimates.)

$$w_{in}(t) = \hat{\alpha}_i + \beta_i \ln x_n(t) + (\delta_i - \beta_i \rho) \ln f_{in}(t)$$

$$+ \sum_{j=1}^I b_{ij} [w_{jn}(t-1) - \delta_j \ln f_{jn}(t-1)] + \sum_{j=1}^I b_{ij} \phi_j [\bar{w}_{jn}(t-1) - \delta_j \ln \bar{f}_{jn}(t-1)] + \epsilon_{in}(t)$$

where $\phi_j := (1 - \kappa) \theta_j^2 / \theta_1^2$

$\beta_1 = -0.033$ (-6.93, -5.55)	$\delta_1 = 0.020$ (1.69, 1.70)	$b_{11} = -0.072$ (-0.33, -0.29)
$\beta_2 = -0.011$ (-1.71, -1.45)	$\delta_2 = -0.040$ (-3.90, -3.37)	$b_{21} = -0.394$ (-1.55, -1.40)
$\beta_3 = 0.013$ (3.94, 3.95)	$\delta_3 = 0.018$ (3.48, 3.34)	$b_{31} = 0.100$ (0.93, 0.91)
$\beta_4 = -0.017$ (-5.24, -4.45)	$\delta_4 = 0.003$ (0.46, 0.43)	$b_{41} = 0.104$ (0.88, 0.73)
$\beta_5 = 0.032$ (6.49, 4.83)	$\delta_5 = -0.005$ (-0.45, -0.41)	$b_{51} = 0.271$ (1.24, 1.23)
$\beta_6 = 0.016$	$\delta_6 = 0.004$	$b_{61} = -0.009$
$b_{12} = -0.602$ (-2.82, -2.40)	$b_{13} = -0.542$ (-2.50, -2.16)	$b_{14} = -0.543$ (-2.56, -2.18)
$b_{22} = 0.311$ (1.22, 1.09)	$b_{23} = -0.311$ (-1.22, -1.11)	$b_{24} = -0.407$ (-1.61, -1.45)
$b_{32} = 0.086$ (0.80, 0.79)	$b_{33} = 0.515$ (4.77, 4.70)	$b_{34} = 0.115$ (1.10, 1.10)
$b_{42} = 0.079$ (0.67, 0.56)	$b_{43} = 0.156$ (1.32, 1.11)	$b_{44} = 0.623$ (5.30, 4.33)
$b_{52} = 0.121$ (0.55, 0.56)	$b_{53} = 0.230$ (1.06, 1.07)	$b_{54} = 0.187$ (0.87, 0.86)
$b_{62} = 0.005$	$b_{63} = -0.048$	$b_{64} = 0.025$
$b_{15} = -0.491$ (-2.31, -1.97)	$b_{16} = -0.559$ (-2.62, -2.24)	$\phi_1 = -0.022$ (-0.11, -0.10)
$b_{25} = -0.373$ (-1.49, -1.35)	$b_{26} = -0.297$ (-1.18, -1.08)	$\phi_2 = 0.118$ (1.45, 1.32)
$b_{35} = 0.091$ (0.88, 0.87)	$b_{36} = 0.053$ (0.51, 0.50)	$\phi_3 = 0.394$ (2.50, 2.41)
$b_{45} = 0.118$ (1.04, 0.84)	$b_{46} = 0.123$ (1.07, 0.89)	$\phi_4 = 0.527$ (3.76, 3.40)
$b_{55} = 0.622$ (2.86, 2.84)	$b_{56} = 0.210$ (0.97, 0.98)	$\phi_5 = 0.357$ (3.00, 2.71)
$b_{65} = 0.033$	$b_{66} = 0.470$	$\phi_6 = 0.392$ (2.61, 2.03)
$\rho = 0.580$ (3.05, 2.92)	$\ln L = 13298.06$	$\chi^2(23) = 29.39$

$w_3(\tau)$ = budget share of clothing and footwear in period τ , $\tau = t, t-1$

$w_4(\tau)$ = budget share of medical care in period τ , $\tau = t, t-1$

$w_5(\tau)$ = budget share of transportation in period τ , $\tau = t, t-1$

$\bar{w}_i(t-1)$ = average budget shares in the social group $i = 1, \dots, 5$

$x(t)$ = total expenditures

$\ln f_5(t-1)$ = log family size in period τ , $\tau = t, t-1$

$\ln \bar{f}_5(t-1)$ = average log family size in the social group in period $t-1$

	means	std. dev.	fraction of zero budget shares		means	std. dev.	fraction of zero budget shares
1. $w_1(t)$	0.231	0.070	0.0	10. $w_1(t-1)$	0.238	0.072	
2. $w_2(t)$	0.325	0.100	0.0	11. $w_2(t-1)$	0.300	0.095	
3. $w_3(t)$	0.083	0.045	0.003	12. $w_3(t-1)$	0.087	0.046	
4. $w_4(t)$	0.140	0.046	0.0	13. $w_4(t-1)$	0.140	0.045	
5. $w_5(t)$	0.128	0.071	0.0	14. $w_5(t-1)$	0.140	0.071	
6. $w_6(t)$			0.003	15. $w_1(t-1)$	0.238	0.026	
6. $\ln x(t)$	3.332	0.420		16. $w_2(t-1)$	0.300	0.042	
7. $\ln f_3(t)$	0.974	0.531		17. $w_3(t-1)$	0.087	0.012	
8. $\ln f_3(t-1)$	0.971	0.526		18. $w_4(t-1)$	0.140	0.012	
9. $\ln f_3(t-1)$	0.971	0.323		19. $w_5(t-1)$	0.140	0.028	

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