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AN EMPIRICAL ANALYSIS OF THE DEMAND FOR HOUSES, DURABLES, AND NONDURABLES***

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Abstract

A standard neoclassical model of intertemporal choice is applied to households´ demand for nondurables, durables and houses, so that the role of credit rationing is particularly stressed. Empirical analysis is performed with Finnish quarterly data. Credit rationing is found to play an important role in the demand for all these goods. On the other hand, it is found that consumers have very short planning horizons and a strong emphasis on liquidity aspects. Moreover, the results suggest that assets and income enter the equations of these commodities in quite different ways.

1. INTRODUCTION

The past decade has seen a great deal of effort devoted to applied econometric work on consumer demand systems. During the course of this work it has become quite clear that there are difficulties in applying standard static models with durable goods. Intuitively this is, of course, almost self-evident, for it is difficult to envisage how, for example, consumer durables, to say nothing of houses, can be modelled without incorporating expectations about prices, interest rates and income or without paying any attention to (possible) credit market imperfections. However, it can be shown that fairly plausible results can be produced if such factors are explicitly considered.

In this paper, we analyze households' demand for nondurables, durables and houses. As a starting point we use a standard neoclassical intertemporal optimization model (see, e.g., Cramer (1954) and Deaton & Muellbauer (1980)). The derivation of the empirical model is based on a standard partial (stock) adjustment process. The model is estimated with Finnish quarterly data covering the period 1962(2)-1979(3). This data base allows us to analyze the nature of and to test the importance of credit rationing; roughly speaking, some degree of rationing can be said to have been present in the Finnish credit market throughout the period examined (see the discussion in Section 2)[1).

We use this three-commodity model as a vehicle for testing the role of different income and asset variables, given the credit rationing. Thus we test, for instance, whether the (different commodity) equations have the same income expectations parameters and whether assets are treated as one homogeneous stock by consumers. Finally, we analyze whether the partial (stock) adjustment processes of these commodities are interrelated. As a general remark, we can state that it is our intention mainly to compare the different commodity equations, hence we do not introduce any commodity-specific factors into the model.

The study is organized as follows: in Section 2 we derive the empirical model, in Section 3 the estimation results are presented, and in Section 4 some concluding remarks follow.

2. THEORETICAL CONSIDERATIONS

A standard neoclassical model of consumer (intertemporal) choice is used here. Besides nondurable goods, denoted by C, two stocks of durable goods are considered: consumer durables, D, and houses, H. It is assumed that the stocks of D and H yield consumption service flows proportional to their magnitude. Hence these stocks appear in the intertemporal utility function, which, given the supply of labor, can be written in the form:

(1) $$U = U(C_1, C_2, \ldots, C_T, D_1, D_2, \ldots, D_T, H_1, H_2, \ldots, H_T, A_T/P_T^*).$$

where 1 is the present and T the terminal period, and A_T/P_T^* is the real value of assets, which together with D_T and H_T represent the consumer's bequest. Note that we treat D and H as continuous variables (see Muth (1960) for the derivation of the corresponding volume index) and, what is more crucial, we assume that in efficiency-corrected units durables of different ages are perfect substitutes (see Muellbauer (1979) for a discussion on this assumption). Now the relevant intertemporal budget constraint corresponding to (1) is:

(2) $$\sum_{t=1}^{T} R_t p_t C_t + \sum_{t=1}^{T} R_t v_t^* D_t + \sum_{t=1}^{T} R_t u_t^* H_t + R_T A_T = W_1$$

where R_t is the discount factor with $R_1 = 1$, v_t^* and u_t^* are user costs of durables and houses, respectively, and W_1 is intertemporal wealth, which, in turn, can be expressed as:

(3) $$W_1 = v_t(1 - d)D_0 + u_t(1 - h)H_0 + (1 + r_1)A_0 + \sum_{t=1}^{T} R_t y_t$$

where d and h stand for the depreciation parameters of D_t and H_t, v and u are the purchase prices of consumer durables and houses and y is the consumer's (nonasset) disposable income. Thus, the last term on the right-hand side of (3) indicates the current and future (expected) discounted income of the consumer; in other words, it is the consumer's total <u>human</u> wealth, W_{1h}, whereas the other terms correspond to consumers' <u>nonhuman</u> wealth, W_{1n}. The user cost terms, v_t^* and u_t^*, mentioned above take the standard definition:

$$(4) \qquad v_t^* = v_t(r_{t+1} + d - (1-d)\Delta v_{t+1}/v_t)/(1+r_{t+1})$$

An analogous form holds for u^*. Now maximization of (1) subject to (2) gives under weak separability of U(.):

$$(5) \qquad C_t = C_t(W_t, R_t p_t, R_{t+1} p_{t+1}, \ldots, R_T p_T, R_t v_t^*, R_{t+1} v_{t+1}^*, \ldots, R_T v_T^*, R_t u_t^*, R_{t+1} u_{t+1}^*, \ldots, R_T u_T^*).$$

D(.) and H(.) have the same arguments as C(.). It is worth pointing out that these results rely on the assumption that households are free to lend and borrow at an identical rate of interest without any quantitative constraints. Note, too, that we have written out the maximization problem as if there were perfect knowledge about the future price and income (labor supply) terms which are moreover assumed exogeneous. Although these issues will play an important role in this paper, we prefer starting with a standard formulation, only then trying to integrate more realistic elements into the model.

Next we simply drop the future price terms from (5), impose zero degree homogeneity by deflating the wealth and price terms by P_t^* - which is the implicit deflator of household's expenditure - and linearize (5) to get:

$$
(6)\quad
\begin{cases}
C_t = b_0^1 + b_1^1\bar{p}_t + b_2^1\bar{v}_t + b_3^1\bar{u}_t + b_4^1\bar{W}_{ht} + b_5^1\bar{W}_{nt} \\
D_t = b_0^2 + b_1^2\bar{p}_t + b_2^2\bar{v}_t + b_3^2\bar{u}_t + b_4^2\bar{W}_{ht} + b_5^2\bar{W}_{nt} \\
H_t = b_0^3 + b_1^3\bar{p}_t + b_2^3\bar{v}_t + b_3^3\bar{u}_t + b_4\bar{W}_{ht} + b_5\bar{W}_{nt}
\end{cases}
$$

where $\bar{p}_t = p_t/P_t^*$, $\bar{v}_t = v_t^*/P_t^*$, $\bar{u}_t = u_t^*/P_t^*$, $\bar{W}_{ht}$ is consumer's (real) human wealth and $\bar{W}_{nt}$ consumer's (real) nonhuman wealth (the functional form is, in fact, tested in section 3.2.B, below. It will appear then that the linear approximation is not completely anjustified).

In the subsequent empirical analysis we use the following proxies for $\bar{W}_{ht}$: $\bar{y}_t$ and $\bar{y}_{pt}$, $\bar{y}_t$ being households' real disposable income (for details, see Appendix 1) and $\bar{y}_{pt}$ being a permanent income concept which was computed as follows:

$$
(7)\qquad \bar{y}_{pt} = \beta\bar{y}_t + (1-\beta)(1+g)\bar{y}_{pt-1}
$$

where β is the weight of current income in permanent income and g is the growth rate of permanent income (see e.g. Elliot (1980)). In computing $\bar{y}_{pt}$ it was assumed both that $g = 0$ and that g equals the estimate of z_1 in $\log y_t = z_0 + z_1 t$. Two definitions for non-human wealth $\bar{W}_{nt}$, cf. equation (3), were used: a 'narrow' one, A_{1t}, and a 'broad' one, A_{2t}. A_{1t} includes only liquid assets, i.e. M_2 + government bonds, while A_{2t} also includes households' residental property, durables and debts (see again Appendix 1).

Obviously, the system of equations (6) is not an appropriate starting point for econometric analysis. If we consider consumer durables, and houses in particular, it is literally impossible for consumers to immediately adjust their stocks of these commodities to the optimal level. Hence, there seem to be good grounds for a partial adjustment mechanism here. Denoting $[C_t \; D_t \; Y_t]'$ by Y_t , we can thus write:

$$(8) \qquad Y_t - Y_{t-1} = \Lambda(Y_t^* - Y_{t-1})$$

where Λ is a 3 x 3 matrix of adjustment parameters, λ_{ij}, $i,j = c, d, h$, with $0 \leq \lambda_{ii} \leq 1$. Y^* indicates the desired value of Y_t given by (6). Thus, we can write:

$$(9) \quad \begin{cases} C_t = \tilde{b}_0^1 + \tilde{b}_1^1\bar{p}_t + \tilde{b}_2^1\bar{v}_t + \tilde{b}_3^1\bar{u}_t + \tilde{b}_4^1\bar{W}_{ht} + \tilde{b}_5^1\bar{W}_{nt} + \tilde{b}_6^1 C_{t-1} + \\ \quad + \tilde{b}_7^1 D_{t-1} + \tilde{b}_8^1 H_{t-1} \\ D_t = \tilde{b}_0^2 + \tilde{b}_1^2\bar{p}_t + \tilde{b}_2^2\bar{v}_t + \tilde{b}_3^2\bar{u}_t + \tilde{b}_4^2\bar{W}_{ht} + \tilde{b}_5^2\bar{W}_{nt} + \tilde{b}_6^2 C_{t-1} + \\ \quad + \tilde{b}_7^2 D_{t-1} + \tilde{b}_8^2 H_{t-1} \\ H_t = \tilde{b}_0^3 + \tilde{b}_1^3\bar{p}_t + \tilde{b}_2^3\bar{v}_t + \tilde{b}_3^3\bar{u}_t + \tilde{b}_4^3\bar{W}_{ht} + \tilde{b}_5^3\bar{W}_{nt} + \tilde{b}_6^3 C_{t-1} + \\ \quad + \tilde{b}_7^3 D_{t-1} + \tilde{b}_8^3 H_{t-1} \end{cases}$$

where $\tilde{b}_6^1$ stands for $(1 - \lambda_{cc})$, $\tilde{b}_7^1$ for $-\lambda_{cd}$, $\tilde{b}_8^1$ for $-\lambda_{ch}$, and so on. In the first phase of our study we assume that the matrix Λ is diagonal, later, in section 3.3, we return to the general case.

As mentioned earlier, the Finnish credit market has been characterized by more or less continous and effective rationing; for empirical evidence, see e.g. Tarkka (1980). For this reason, we introduced two "liquidity" variables into the model: GA_t and RAT_t. The former corresponds to (the flow of) government loans to the household sector for housing construction (in real terms) and the latter serves as a general proxy for "tightness of money"[2]. When constructing this variable we use the difference between the banks' marginal cost of central bank borrowing (MC_t) and their weighted average lending rate (r_L) as the proxy for the degree of credit rationing (for details on constructing this series, see Tarkka (1981)). The original quarterly series seems highly erratic, also displaying (presumably) temporary changes in the banks' liquidity position which do not give rise to changes in their lending behavior. In order to eliminate these temporary changes in the banks' liquidity position, we smoothed the series as follows[3]:

$$(10) \qquad RAT_t = \sum_{i=j}^{j+3} (MC_{t-i} - r_{L,t-i}) \alpha \exp.(j-i),$$

the determination of j is considered in the next section. The values .75 and 1.00 were used for the smoothing factor, α, without, however, producing any noticeable difference in the results (the estimation results presented in the next section correspond to $\alpha = .75$).

How does the 'tightness of money' affect consumer demand? Two alternative ways can be considered: first it may be that "if money gets tighter", i.e. RAT_t increases, consumers decrease their spending in order to accumulate liquid assets to be able to carry out eventual purchases. That is, they expect that credit rationing will be effective and prevent them from purchasing with borrowed money. All this explanation means is that RAT_t affects the optimal level of consumption, i.e. Y_t^*, "directly", and hence this effect can be modelled simply by an additive RAT_t-term.

Now, if it is assumed that also GA_t affects Y_t^* through expectations, (9) can be completed to be:

$$(11) \qquad Y_{it} = \tilde{b}_0^i + \tilde{b}_1^i \bar{p}_t + \tilde{b}_2^i \bar{v}_t + \tilde{b}_3^i \bar{u}_t + \tilde{b}_4^i \bar{W}_{ht} + \tilde{b}_5^i \bar{W}_{nt} + \tilde{b}_6^i GA_t + \tilde{b}_7^i RAT_t + \tilde{b}_8^i Y_{it-1} + u_t^i ,$$

where Y_i = C, D, and H; u_t^i stand for the error terms. We start our study by assuming that these terms are mutually uncorrelated white noise. The system of equations (11) will, in fact, constitute the main specification in our empirical analysis.

The second explanation concerns the speed of partial adjustment, λ. That is, consumers try to reach the optimal levels of C_t, D_t, and H_t, being, however, constrained by inter alia the availability of credit. Thus, we postulate the following simple form for this relationship: $\lambda_t = \lambda_0 - \lambda_1 RAT_t$. Inserting this into (9) with GA_t as an additional additive variable gives for Y_t:

$$(12) \qquad Y_t = \bar{b}_0^i + \bar{b}_1^i RAT_t + \bar{b}_2^i \bar{p}_t + \bar{b}_3^i \bar{v}_t + \bar{b}_4^i \bar{u}_t + \bar{b}_5^i \bar{W}_{ht} + \bar{b}_6^i \bar{W}_{nt} + \bar{b}_7^i GA_t + \bar{b}_8^i Y_{t-1} + \bar{b}_9^i \bar{p}_t RAT_t + \bar{b}_{10}^i \bar{v}_t RAT_t + \bar{b}_{11}^i \bar{u}_t RAT_t + \bar{b}_{12}^i \bar{W}_{ht} RAT_t + \bar{b}_{13}^i \bar{W}_{nt} RAT_t + \bar{b}_{14}^i GA_t RAT_t + \bar{b}_{15}^i Y_{t-1} RAT_t + u_t.$$

Note that an additive RAT_t-term appears in (11) as well as in (12), hence complicating the discrimination between these two credit-rationing hypotheses.

3. EMPIRICAL RESULTS

3.1. The data

Finnish quarterly data covering the period 1962(2)-1979(3) was used in the analysis. The data is seasonally adjusted, and expressed in per capita terms. A detailed description of the time series used can be found in Appendix 1. Here only the following descriptive statistics of these time series are presented: the means of variables, $\bar{x}$, the standard deviations, s_x, the coefficients of correlation between x_t and x_{t-1} and the coefficients of correlation between C_t, D_t, H_t and the explanatory variables.

Table 1. Descriptive statistics of the data

	$\bar{x}$	s_x	$r_{x_t,x_{t-1}}$	r_{C_t,x_t}	r_{D_t,x_t}	r_{H_t,x_t}
C_t	2146.009	346.325	.994	1.000	.969	.966
D_t	2918.414	1229.828	.999	.969	1.000	.993
H_t	17435.487	4356.271	.999	.966	.993	1.000
$\bar{p}_t$	101.121	1.176	.925	-.691	-.547	-.574
$\bar{v}_t$	6.053	3.332	.697	-.246	-.264	-.237
$\bar{u}_t$	.261	2.178	.199	-.173	-.094	-.095
$\bar{A}_{1t}$	7528.348	1317.316	.980	.962	.904	.902
$\bar{A}_{2t}$	20040.691	437.396	.990	.993	.971	.971
GA_t	49.184	25.948	.965	.954	.945	.942
RAT_t	4.539	3.543	.887	-.421	-.303	-.278
$\bar{y}_t$	2462.691	437.396	.990	.993	.971	.971

Table 1 clearly illustrates the main problem with our time series, namely that they are highly autocorrelated, which, in turn, suggests the possibility of getting spurious regression results (see Granger & Newbold (1974)). On the other hand, we can mention here (formal evidence is presented later on) that the explanatory variables are strongly multicollinear. This is, of course, to be expected when working with nondifferenced economic time series. Unfortunately this observation does not justify ignoring these problems.

3.2. The estimation results

First, we present OLS estimates of (11). They are set out in Table 2 with standard errors in parentheses and asymptotic

Table 2. OLS estimates of (11)

	C_t	D_t	H_t
constant	848.676 (519.247) .054128	-2630.683 (1081.409) .009028	125.723 (432.767) .386400
$\bar{p}_t$	-4.318 (4.574) .175463	23.359 (10.210) .013058	1.029 (4.343) .409431
$\bar{v}_t$	.123 (1.192) .460336	-1.136 (1.152) .165478	.422 (.716) .282025
$\bar{u}_t$	-3.038 (1.869) .054128	-.265 (1.731) .440630	.566 (1.069) .302473
$\bar{A}_{2t}$	.010 (.005) .036833	.025 (.011) .014719	.023 (.006) .000168
$\bar{y}_t$	.327 (.068) .000005	.113 (.065) .043451	.009 (.039) .413303
GA_t	.709 (.513) .086312	.547 (.503) .142197	1.131 (.287) .000106
RAT_t	-3.675 (1.393) .005397	-.285 (1.325) .417184	-3.395 (.762) .000019
lagged dependent variable	.337 (.105) .001124	.833 (.044) .000000	.967 (.007) .000000
R^2	.993434	.999511	.999985
S	29.852	28.914	17.608
h	2.1409 .016141	3.4302 .000302	5.5692 .000000
Q(12)	10.7177 .553254	28.2498 .005085	84.4671 .000000
LM(6)	7.4162 .284065	13.2168 .039719	33.1557 .000010
P(15)	12.6353 .630444	16.1960 .369146	55.4370 .000002

marginal significance levels of the t-test statistics below the standard errors. The regression statistics include: coefficients of determination (R^2), Durbin's h-statistics (h), the Box-Pierce autocorrelation statistics with 12 degrees of freedom denoted by Q(12), Godfrey's LM autocorrelation statistics with 6 degrees of freedom denoted by LM(6), the standard deviations of residuals (S) and χ^2-statistics for parameter stability denoted by P(15). (Equation (11) was estimated separately for the period 1962(2)-1975(4) and the remaining 15 periods were used for post-sample forecasting; see, e.g., Davidson & Hendry et al (1978), p. 674).

When estimating (11), the following proxies were used in the first stage for $\bar{W}_{ht}$, $\bar{W}_{nt}$ and RAT_t, respectively: $\bar{y}_t$, which is the households' real disposable income, $\bar{A}_{2t}$, which is the "broad" definition of households' assets, and RAT_t with $j = 4$ (cf. (10)). Estimation results with $\bar{y}_{pt}$ and $\bar{A}_{1t}$ are considered later on. j was determined by estimating (11) with different values of j (from 0 up to 6). The residual sum of the squares of the whole model was minimized when $j = 4$. This implies an average lag of 5 periods[4)].

Turning now to the estimation results in Table 2, it can be seen that, with the exception of some of the price terms, all the coefficient estimates have the right sign, and in most cases we can reject the hypothesis that they are zeroes at conventional levels of significance (using the t-test).

The price terms certainly perform rather poorly; for example, the coefficient estimate of $\bar{u}_t$ in the housing equation is positive. However, too much stress should not be placed on this evidence. Price terms (4) are not very relevant in the case of effective credit rationing, as a brief glance at the time series for $\bar{v}_t$ and $\bar{u}_t$ readily reveals. Some of the observations for these user costs have negative values, implying that there should be infinite demand for these commodities. Yet such prolonged booms in sales have not occured.

As far as the "liquidity variables", GA_t and RAT_t, are concerned, the former, which indicates the (flow of) loans from the government to the household sector for the construction of houses, plays an important role in the demand for houses. However, it also has significant "spillover" effects on to the demand for durables and non-durables. The other variable, RAT_t, also performs very well, especially in the case of houses and nondurables. The good performance for houses is not unexpected, but it is interesting to observe that the RAT variable has quite a high t-ratio for nondurables as well. By contrast, the evidence for durables is somewhat puzzling. Even though the coefficient estimate has the right sign, it is far from significant by conventional standards. It can be argued, however, that credit rationing affects the demand for durables and houses mainly via the speed of adjustment, λ, without having much impact on the optimal level (stock) of consumption. For nondurables, on the other hand, the speed-of-adjustment effect may be of less importance, the effect on C_t^* dominating. These hypotheses will be reconsidered after estimating (11). Finally, the coefficient estimates of the lagged endogeneous variables imply average adjustment periods for C_t, D_t, and H_t, of 1.5, 6.0 and 30.0 quarters years respectively. These are fairly reasonable values, although that for H_t may appear a little big too high.

Before commenting further on the coefficient estimates, we go through some diagnostic tests on the error terms, test the functional form of (11), examine the effects of multi-collinearity, and finally study the robustness of the previous estimation results, especially with respect to the user cost terms.

A. Properties of the error term

We start by testing whether the covariance matrix of the error terms u_t^c, u_t^d, and u_t^h, is diagonal. That is why we estimated (11) using the maximum likelihood method. When a LR- test was carried out, the following χ^2-statistic 5.340/.142828 was obtained. Thus, given (11), the data does not support the hypothesis that the error terms are mutually correlated, and hence system method of estimation is not required here.

Next we consider the normality and heteroscedasticity of the error terms. The following measures or test statistics are therefore computed: the measures of skewness and excess (i.e. the measure of kurtosis), a χ^2-test with 7 classes, N(7), a Kolmogorov-Smirnov test, K-S, for the normal distribution, and finally a LR test for heteroscedasticity with 2 classes, LR(2) (see, e.g., Maddala (1977), p. 263; the ordering of residuals here is based on the absolute magnitude of the dependent variable). The corresponding values are presented in Table 3 together with expected values of the skewness and excess measures and 5 % critical values of N(7), K-S, and LR(2) (column $\bar{X}$).

Table 3. Test statistics on the error terms

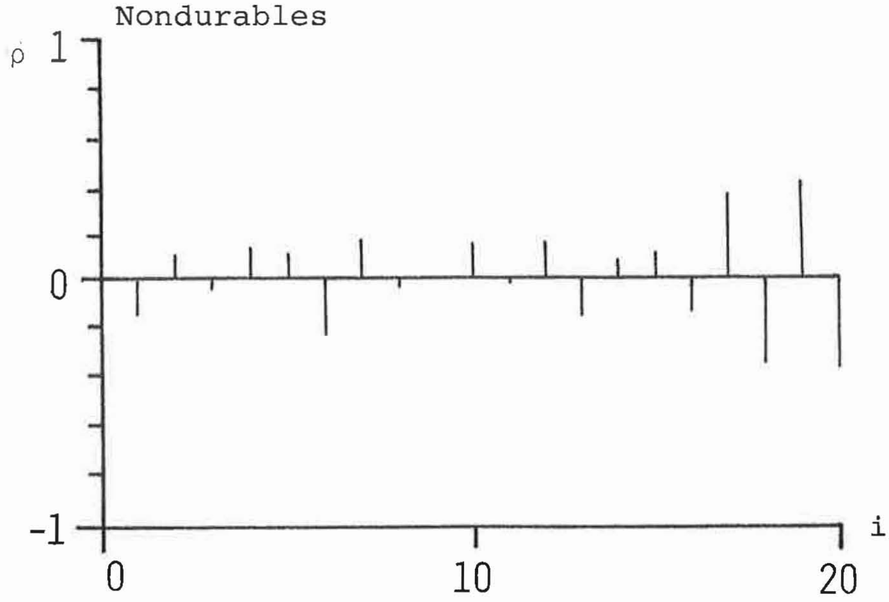
	C_t	D_t	H_t	$\bar{X}$
skewness	.4410	-.2313	-.2631	0
excess	-.0446	.1537	-.4580	0
N(7)	1.78	2.21	5.32	11.07
K-S	.0606	.0525	.0508	.1627
LR(2)	1.55	.00	1.68	3.84

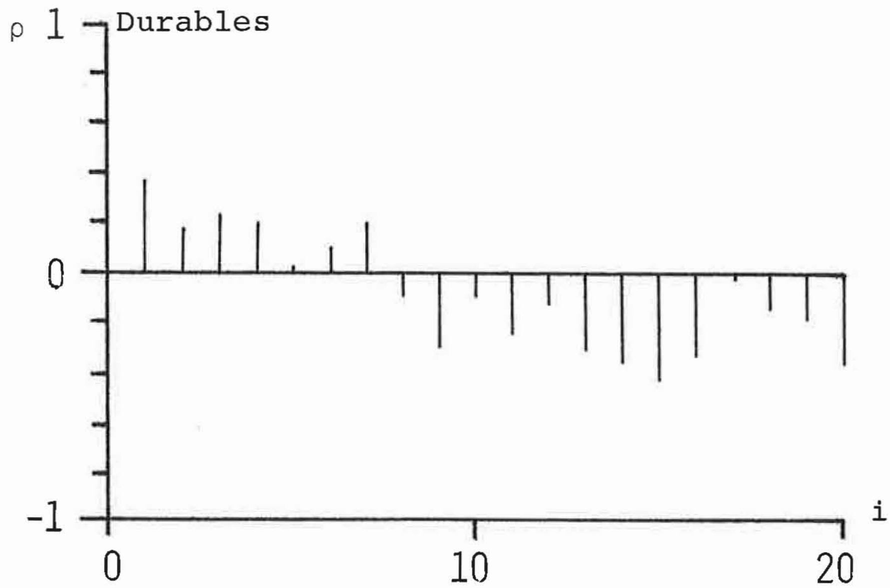
Summing up, we can state that the assumption $u^i \sim N(0,s_i^2)$ is not seriously violated. In particular, we wish to point out that a hypothesis of heteroscedasticity of the residuals can be rejected at all conventional levels of significance.

The D-W, LM(6), and Q(12) statistics in Table 2 indicate, however, that the main problem with the residuals is autocorrelation. This is especially true for houses, but to some extent applies to durables as well. The autocorrelograms in Figure 1 suggest that the residual of the nondurables equation is almost white noise, that of durables of the AR(1)-type and that of houses of the AR(2)- or of more complicated-type. Even if the proper autoregressive specifications differ between equations, we preferred estimating all equations with the same autoregressive structure, i.e. it was assumed that $u^i \sim AR(2)$[5]. The corresponding estimation results are presented in Table 4. The same notation is used as in Table 2 above, but now only the a_i's refer to the autocorrelation coefficients of the AR(2)-process, while A(2) gives χ^2-statistics for the test of H_0: $a_1 = a_2 = 0$.

If we compare Tables 2 and 4, we find relatively few marked differences. The main difference is that the houses and durables equations now have a better fit (due to a proper autoregressive specification). What is, perhaps, most interesting is that all the equations have a very good forecasting performance compared e.g. with Table 2. Hence the hypothesis of parameter stability cannot be rejected at any conventional levels of significance (cf. the values of P(15)). On the other hand, the Q(12)-statistics indicate that there is no longer hardly any autocorrelation. As far as the coefficient estimates are concerned, there are no qualitative differences between Tables 2 and 4. It may, however, be worth noting that the price terms have slightly higher t-ratios and that now the "own price" effects are all negative. The price terms still pose some problems in the sense that symmetry does not hold with cross price effects[6].

Figure 1. Autocorrelograms of OLS residuals





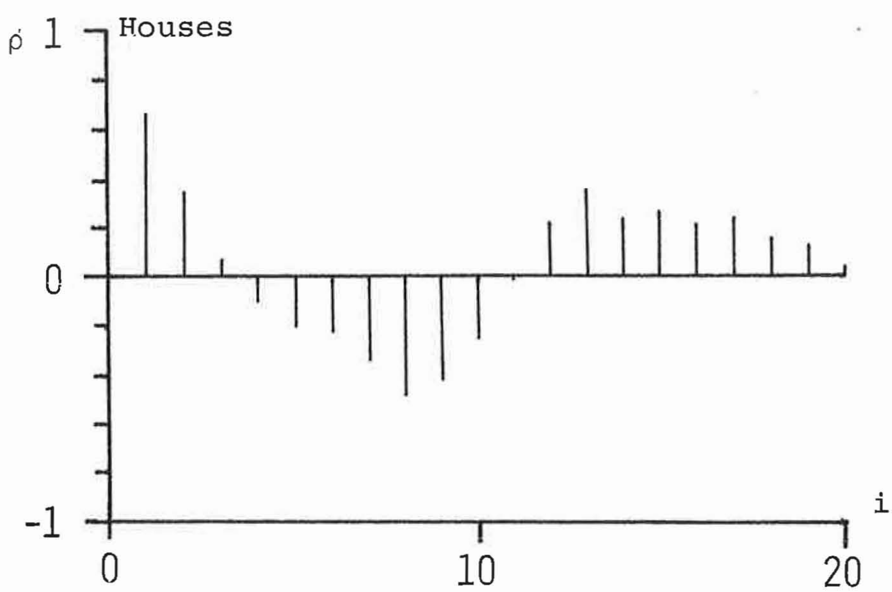


Table 4. GLS estimates of (11)

	C_t	D_t	H_t
constant	837.044 (505.224) .051110	-2055.152 (1306.670) .060882	1278.850 (593.571) .017833
$\bar{p}_t$	-5.020 (4.102) .113660	18.489 (12.153) .066926	14.641 (5.886) .007806
$\bar{v}_t$	-.526 (1.191) .330772	-2.665 (1.200) .015137	-.111 (.450) .405581
$\bar{u}_t$	-3.360 (1.970) .019111	.650 (1.550) .338006	-.298 (.526) .285421
$\bar{A}_{2t}$	.006 (.005) .142269	.029 (.014) .018250	.028 (.007) .000137
$\bar{y}_t$	.311 (.061) .000002	.064 (.062) .153607	.029 (.023) .102778
GA_t	.504 (.458) .137900	1.138 (.540) .018676	1.010 (.226) .000018
RAT_t	-2.816 (1.201) .011343	-.427 (1.605) .394051	-3.510 (1.033) .000607
lagged dependent variable	.437 (.121) .000326	.812 (.059) .000000	.961 (.009) .000000
$\hat{a}_1$	-.293 (.163) .038487	.455 (.140) .000926	1.041 (.129) .000000
$\hat{a}_2$	.024 (.139) .432796	.015 (.133) .456391	-.278 (.136) .022408
S	28.793	26.272	11.636
Q(12)	10.4940 .572706	11.5081 .485948	11.8012 .461775
A(2)	3.1274 .209360	13.0333 .001479	60.3651 .000000
P(15)	7.5746 .939704	1.6211 .999993	7.1295 .953956

B. Testing for the functional form of (11)

When deriving (6) - and thus also (11) - linear approximation was simply used. Of course, this approximation might produce a misspecified model, and thus it is worthwhile to test whether that is the case. That is why we estimated (11) using an extended Box and Cox procedure so that all variables, except the constant term, were transformed according to the following method: $X(\theta) = (X^{\theta} - 1)/\theta$ if $\theta \neq 0$ and $X(\theta) = \log X$ if $\theta = 0$. We did not introduce any multiplicative or higher terms to (11) - a was done by e.g. Hwang (1981) - thus, our testing boils down to the question whether linear or log linear approximation should be used for (11).

Due to the presence of autocorrelation (with the OLS residuals of (11)) θ was estimated simultaneously with the first-order autocorrelation coefficient using the extended autoregressive Box and Cox method introduced by Savin and White (1978). The results of this exercise are summarized in Table 5. These include the estimates of θ and ρ, and the values of different LR- test statistics. The numbers in parentheses are the (assymptotic) marginal significance levels of the χ^2-statistics[7].

statistics (see Neeleman (1973), p. 28) give the following incredible values: $\chi^2_C = 787.9$, $\chi^2_D = 845.6$, and $\chi^2_H = 825.3$. With 28 degrees of freedom these test statistics are significant at all conventional levels of significance. The wealth and lagged dependent variables are mainly responsible for this problem, as can be seen from the following values of the R^2-deletes (i.e. the R^2's of the LS-regressions of X_i on the remaining regressors) in, for instance, the nondurables equation: $R^2(\bar{p}_t) = .546$, $R^2(\bar{v}_t) = .167$, $R^2(\bar{u}_t) = .208$, $R^2(\bar{A}_{2t}) = .987$, $R^2(\bar{y}_t) = .985$, $R^2(GA_t) = .925$, $R^2(RAT_t) = .460$, $R^2(C_{t-1}) = .990$.

As is very well known, there is no simple solution to the problem of multicollinearity. Here we attempt ridge regression estimation (see, e.g., Hoerl & Kennard (1970)), that is, when estimating the equations we add a constant k to each diagonal element of the moment matrix. Coefficient estimates, the length of the estimate vector, L(B), and the residual variance are then computed for each value of k. These numbers give us some indication of how "precise" the OLS estimates are. The corresponding data is presented in Table 6. It might be useful to mention here that the "optimal" values of k, given by the Hoerl-Kennard formula (see Hoerl & Kennard & Baldwin (1975)) are 168.69, 12.20 and 161,85 for C_t, D_t, and H_t respectively.

Table 6. Ridge estimation results

Nondurables

k	$\bar{p}_t$	$\bar{v}_t$	$\bar{u}_t$	$\bar{A}_{2t}$	$\bar{y}_t$	GA_t	RAT_t	C_{-1}	L(B)	s^2
0	-4.310	0.122	-3.058	0.009	0.326	0.708	-3.674	0.336	6.499	890.749
10	-3.542	0.157	-2.970	0.009	0.327	0.601	-3.618	0.345	5.931	891.277
20	-3.011	0.177	-2.880	0.009	0.328	0.650	-3.558	0.352	5.543	892.347
30	-2.624	0.188	-2.793	0.008	0.329	0.644	-3.497	0.358	5.254	893.614
40	-2.329	0.195	-2.708	0.008	0.329	0.629	-3.436	0.364	5.024	894.961
50	-2.096	0.198	-2.628	0.008	0.330	0.617	-3.376	0.369	4.834	896.342
60	-1.909	0.200	-2.551	0.009	0.331	0.606	-3.317	0.373	4.670	897.741
80	-1.621	0.199	-2.409	0.007	0.332	0.586	-3.203	0.382	4.397	900.563
100	-1.412	0.195	-2.291	0.007	0.333	0.570	-3.096	0.389	4.172	903.391
150	-1.076	0.181	-2.011	0.006	0.335	0.536	-2.853	0.404	3.734	910.394
200	-0.873	0.167	-1.798	0.005	0.337	0.509	-2.645	0.416	3.401	917.163
250	-0.737	0.154	-1.625	0.005	0.339	0.486	-2.464	0.425	3.133	923.594
300	-0.539	0.142	-1.483	0.004	0.340	0.467	-2.305	0.434	2.910	929.640
400	-0.506	0.123	-1.262	0.004	0.343	0.435	-2.043	0.447	2.558	940.555
500	-0.420	0.109	-1.098	0.003	0.345	0.409	-1.834	0.457	2.292	950.015
600	-0.360	0.098	-0.972	0.003	0.347	0.388	-1.663	0.465	2.083	958.218
700	-0.314	0.089	-0.872	0.002	0.348	0.369	-1.522	0.472	1.915	965.354
800	-0.280	0.081	-0.791	0.002	0.350	0.354	-1.403	0.477	1.777	971.627
900	-0.252	0.075	-0.724	0.002	0.351	0.340	-1.301	0.482	1.661	977.151
1000	-0.229	0.070	-0.667	0.002	0.352	0.328	-1.213	0.486	1.563	982.053

Durables

k	$\bar{p}_t$	$\bar{v}_t$	$\bar{u}_t$	$\bar{A}_{2t}$	$\bar{y}_t$	GA_t	RAT_t	D_{-1}	L(B)	s^2
0	23.358	-1.133	-0.265	0.025	0.113	0.546	-0.284	0.833	23.411	835.716
10	10.499	-1.129	-0.003	0.013	0.132	0.377	0.376	0.884	10.611	857.812
20	6.785	-1.114	0.066	0.009	0.137	0.327	0.557	0.898	6.966	872.435
30	5.018	-1.098	0.095	0.007	0.140	0.302	0.635	0.905	5.266	880.659
40	3.985	-1.081	0.109	0.006	0.141	0.286	0.675	0.910	4.296	885.936
50	3.308	-1.065	0.117	0.006	0.142	0.276	0.697	0.912	3.675	889.548
60	2.829	-1.049	0.121	0.005	0.143	0.268	0.709	0.914	3.248	892.194
80	2.197	-1.019	0.122	0.005	0.143	0.256	0.716	0.917	2.706	895.837
100	1.798	-0.989	0.120	0.004	0.143	0.248	0.713	0.919	2.380	898.257
150	1.241	-0.923	0.111	0.004	0.143	0.233	0.687	0.921	1.950	901.940
200	0.951	-0.865	0.100	0.004	0.143	0.223	0.654	0.922	1.735	904.168
250	0.772	-0.814	0.091	0.003	0.143	0.215	0.621	0.923	1.604	905.776
300	0.651	-0.769	0.082	0.003	0.142	0.208	0.589	0.924	1.513	907.057
400	0.497	-0.692	0.069	0.003	0.142	0.196	0.533	0.925	1.389	909.082
500	0.402	-0.629	0.059	0.003	0.141	0.187	0.485	0.926	1.308	910.694
600	0.339	-0.577	0.051	0.003	0.141	0.179	0.446	0.926	1.249	912.048
700	0.293	-0.532	0.045	0.003	0.140	0.173	0.412	0.926	1.204	913.218
800	0.258	-0.494	0.040	0.003	0.140	0.167	0.382	0.927	1.169	914.245
900	0.231	-0.461	0.036	0.003	0.139	0.161	0.357	0.927	1.140	915.157
1000	0.209	-0.432	0.032	0.003	0.139	0.157	0.334	0.927	1.117	915.974

Houses

k	$\bar{p}_t$	$\bar{v}_t$	$\bar{u}_t$	$\bar{A}_{2t}$	$\bar{y}_t$	GA_t	RAT_t	H_{-1}	L(B)	s^2
0	1.028	0.421	0.566	0.023	0.008	1.131	-3.395	0.967	3.911	309.537
10	0.648	0.398	0.556	0.023	0.010	1.128	-3.330	0.967	3.767	309.616
20	0.475	0.386	0.535	0.022	0.011	1.124	-3.268	0.967	3.680	309.776
30	0.376	0.377	0.512	0.022	0.012	1.120	-3.208	0.968	3.610	309.984
40	0.311	0.370	0.490	0.022	0.014	1.117	-3.151	0.968	3.548	310.238
50	0.266	0.364	0.467	0.022	0.015	1.113	-3.096	0.968	3.490	310.541
60	0.232	0.358	0.446	0.022	0.016	1.109	-3.042	0.968	3.436	310.877
80	0.184	0.348	0.408	0.022	0.018	1.102	-2.941	0.967	3.335	311.654
100	0.153	0.339	0.373	0.022	0.020	1.095	-2.847	0.967	3.244	312.545
150	0.106	0.319	0.302	0.022	0.024	1.078	-2.636	0.967	3.042	315.118
200	0.081	0.301	0.249	0.022	0.028	1.063	-2.455	0.967	2.873	317.972
250	0.064	0.286	0.207	0.022	0.031	1.048	-2.298	0.967	2.729	320.949
300	0.053	0.272	0.175	0.022	0.035	1.034	-2.160	0.967	2.604	323.949
400	0.038	0.248	0.127	0.022	0.040	1.008	-1.928	0.957	2.398	329.803
500	0.030	0.229	0.095	0.022	0.044	0.983	-1.741	0.966	2.236	335.308
600	0.024	0.213	0.073	0.022	0.048	0.960	-1.588	0.966	2.105	340.405
700	0.020	0.199	0.056	0.022	0.051	0.939	-1.459	0.966	1.998	345.094
800	0.016	0.187	0.044	0.022	0.054	0.918	-1.350	0.966	1.908	349.407
900	0.014	0.177	0.034	0.021	0.057	0.898	-1.256	0.966	1.832	353.374
1000	0.012	0.160	0.027	0.021	0.059	0.880	-1.174	0.966	1.766	357.042

Relatively few really significant changes occur in the coefficient estimates. One is the substantial decrease in the coefficient estimate of $\bar{p}_t$ in the durables equation (similar, though less marked, changes also occur for houses and nondurables). Another change takes place in the human wealth proxy, $\bar{y}_t$. OLS estimates assign this variable a minor role in the case of durables, while for houses it is completely insignificant. Ridge estimation does, however, suggest that this modest performance is partly due to multicollinearity.

D. Robustness

In order to check the robustness of the previous estimation results, we also estimated (11) for the periods 1962(2)-1975(4), 1962(2)-1970(4) and 1971(1)-1979(3) with different error-term specifications. The results obtained are strikingly similar to those presented in Tables 2 and 4. To save space, we do not present them here[8].

Another check of robustness concerned the user cost terms u_t^* and v_t^*. That this should be necessary is already evident from the fact that the (t+1)th period prices and the rate of interest appear in (4). Clearly, there are good grounds for reconsidering the "perfect foresight" assumption used above and replacing u_{t+1}, v_{t+1} and r_{t+1} with the corresponding anticipated values (denoted below by an asterisk).

This was done here by applying the rational expectations hypothesis, so that, for instance, $\Delta v^*_{t+1}/v_t$ was determined as a least squares prediction of $\Delta v_{t+1}/v_t$ with respect to some relevant set of information (including variables which agents might have been used in forming estimates of $\Delta v_{t+1}/v_t$)[9).]

When these anticipated values, $\Delta u^*_{t+1}/u_t$, $\Delta v^*_{t+1}/v_t$ and r^*_{t+1}, were plugged into (4) and used in estimating (11), there were only slight changes in the corresponding OLS estimates, compared with those presented in Table 2. The main change was a slight deterioration in the t-ratios of the price terms.

The user cost terms, defined by (4), suffer from another weakness, in the sense that the income tax deductions for interest are not concerned. However, if we regonize that e.g. a homeowner is permitted deductions for (mortgage) interest, (4) should be rewritten as[10)]:

$$(4') \qquad v^*_{mt}=v_t((1-m_{t+1})r_{t+1} + d - (1-d)\Delta v_{t+1}/v_t)/(1+(1-m_{t+1})r_{t+1}),$$

where m_t denotes the homeowner's marginal tax rate. We also computed OLS estimates of (10) by using these tax-adjusted user cost terms v^*_{mt} and u^*_{mt} so that m was replaced by the average income tax rate. Once again, these results were very similar to those presented in Table 2. Hence, they are not tabulated here.

3.3. Testing hypotheses

Price terms: If (11) is viewed primarily as an expenditure system, one would be very interested in the behavior of the price terms. For example, one would like to know, whether symmetry holds with the cross-price terms. It happens to be, however, that this kind of questions are not of great relevance here: our estimates for the price terms are simply not precise enough to allow rigorous testing for such hypotheses. This came out when the significance of the price terms was tested in the context of estimating (11) in a system form. Then, we could not reject the hypothesis that all price terms have coefficients identically equal to zero; the corresponding F-statistic was: F_s = 1.2130/.289341. We can thus conculude that, given (11), the relative prices do not constitute an important determinant of households´ consumption behavior.

Wealth terms: The general performance of the wealth terms is illustrated by means of Table 7. When constructing this table we have paid attention to the fact that the estimation results with respect to the wealth terms are very much affected by the inclusion or exclusion of the "credit rationing" terms, GA and RAT. This change was especially striking with the human wealth proxy, $\bar{y}_t$: in all cases the corresponding t-ratios increased - with houses even considerably - when these variables were excluded from (11).

Table 7. Testing for the significance of the wealth proxies

Proxies	Nondurables	Durables	Houses
$\bar{y}_t/A_{1t}$ with GA and RAT	+/..	+/-	+/-
$\bar{y}_t/A_{2t}$ with GA and RAT	+/..	../+	../+
$\bar{y}_t/A_{1t}$ without GA and RAT	+/+	+/-	+/..
$\bar{y}_t/A_{2t}$ without GA and RAT	+/..	+/+	+/+

+ indicates a positive coefficient estimate with the t-ratio exceeding 2.00 (which is the critical value in two-sided test with 65 df.), - indicates a negative coefficient estimate and .. an estimate with t-ratio less than 2.00.

As for the nonhuman wealth variable, $\bar{W}_{nt}$, we have constructed two alternative proxies; the one based on a narrow definition of assets, A_1, and the other on a broad definition of assets, A_2. When estimating the equations by OLS, we found (cf. Table 7) that the narrow definition slightly outperformed the broad one with nondurables while with durables and houses the broad one was clearly better in terms of the sign and t-ratio of the coefficient estimate. Thus, taken as a whole, our evidence suggests that given the specification of the rest of the system, A_2 can be considered the relevant nonhuman wealth concept for our system of equations. Thus, taken as a whole, consumer assets are treated as one homogeneous stock by households. This result can be contrasted with that of Elliott (1980) who found a narrow definition of assets to be better than a broad one. His evidence was, however, based only on a consumption function in which durables and nondurables were aggregated. In this sense his results are compatible with those obtained in this study. Our study does, however, suggest that this better performance of the narrow asset variable might only be a special case.

If we compare the relative performance of the human and non-human wealth variables in the context of (11), we find that the explanatory power of $\bar{y}_t$ diminishes when the goods become more durable, while at the same time the nonhuman wealth proxy, $\bar{A}_{2t}$, becomes more significant[11)]. Even if the relative importance of $\bar{y}_t$ and $\bar{A}_{2t}$ differs between nondurables, durables and houses, we can definitely reject the hypothesis that the wealth terms do not at all appear in the demand functions. When testing the hypothesis that, given (11), $\tilde{b}_4 = \tilde{b}_5 = 0$, we obtained the following F-statistics for nondurables, durables, houses, and the whole system, respectively: F_c = 21.364/.000000, F_d = 9.890/.000187, F_h = 10.343/.000134, and F_s = 17.120/.000000[12)].

As referred earlier, we used instead of $\bar{y}_t$ another proxy for the human wealth variable, $\bar{W}_{ht}$, that is, the concept of permanent income, $\bar{y}_{pt}$. It was computed according to (7) by using a search method (for details, see e.g. Maddala (1977), p. 146), in which (11) was regarded as the proper equation and estimation was carried out with the following values of β : 0, .1, ,2, ...9, 1.0. The estimation results were practically identical in the case $g = 0$ and $g = \hat{z}_1 = .0089$ (cf. (7)). As a whole, the results followed the same pattern as with $\bar{y}_t$. The main feature in these results was the difference between equation-specific values of β_i. The residual sums of the squares were minimized when $\beta_c = .9$, $\beta_d = .2$ and $\beta_h = .2$ while the value of .8 was obtained when the β_i's were constrained to be equal. By applying the LR-test we could not, however, reject the hypothesis that the β_i's are the same for all equations. The corresponding χ^2 statistic (with g = 0) turned out to be 1.3064/.253048. This way of testing for the equality of the parameters, β_i, gives a somewhat misleading result in this case due to the fact that the permanent income proxies were totally insignificant with the demand for houses equation.

Because the parameters β_i are of some interest here, we also used an alternative way of estimating them. That is, we postulated the following equation for the desired demand for Y_{it} (that is, in fact, (6) without the price terms):

$$(13) \qquad Y^*_{it} = a^i_0 + a^i_i y_{pt} + a^i_2 \bar{A}_{2t} + u^i_t \qquad i = c, d, h.$$

Then, by using (7) and (8), and assuming g = 0 and Λ diagonal, we ended up with the following equation:

$$(14) \qquad Y_{it} = a^i_0 \lambda_i \beta_i + (1 - \lambda_i + 1 - \beta_i) Y_{it-1} - (1 - \lambda_i)(1 - \beta_i) Y_{it-2} + $$

$$+ a^i_1 \lambda_i \beta_i \bar{y}_{t-1} + \lambda_i a^i_2 \bar{A}_{2t} - \lambda_i (1 - \beta_i) a^i_2 \bar{A}_{2t-1} + u^{*i}_t ,$$

$$u^{*i}_t = \lambda_i u^i_t + \lambda_i (1 - \beta_i) u^i_{t-1} .$$

In the first phase, also RAT was included into (13). Then, however, there were serious difficulties in the converging process, presumably due to the insignificance of $\bar{y}_t$ and $\bar{y}_{pt}$ in the housing equation (in the case RAT was included as an explanatory variable). When (14) was estimated by non-linear LS the following parameter estimates were obtained for λ_i and β_i:

Table 8. Nonlinear LS estimates of β_i and λ_i.

Parameter	Nondurables	Durables	Houses
$\hat{\lambda}_i$	.345 (.139)	.094 (.034)	.032 (.016)
$\hat{\beta}_i$	.943 (.061)	.570 (.125)	.166 (.109)
$\hat{\lambda}_i$	1.291 (.113)	.138 (.020)	.026 (.006)
$\hat{\beta}_i$	$.268^x$ (.039)	$.268^x$ (.039)	$.268^x$ (.039)

Numbers inside parentheses are assymptotic standard deviations, x indicates that the parameters are constrained to be equal.

As can be seen, the estimates are quite close to those obtained earlier (as for the estimates of λ_i, recall that the coefficient estimate of the lagged dependent term in (11) is simply $(1 - \hat{\lambda}_i)$).

If we apply the LR-test, we cannot even now reject the hypothesis that the β_i´s are the same over the three equations; $\chi^2 = 3.3562/.186721$. Recall, however, that this result is based on the "overparsimonious" equation (13).

It is interesting to compare the previous results concerning the wealth variables with those of Muellbauer (1979). Muellbauer used an (intertemporal) linear expenditure system with two commodities: nondurables and durables. Using quarterly data from U.K. he could clearly reject the hypothesis that these commodities have demand equations with the same asset and income variables.

In this respect our results are similar to those of Muellbauer, even though they are not equally destructive as regards to the neoclassical theory of consumer behavior. In our study the puzzling result is that, given a specification which includes credit rationing proxies, the demand for nondurables is to a large extent determined by current income and liquid assets while e.g. the demand for houses is almost unaffected by these variables. Instead, it is total non-human wealth and, with some reservations, permanent income which play the decisive role. Thus, it seems that these outcomes represent different maximization problems which, in turn, might reflect some kind of nonsymmetry of credit rationing effects.

One thing is still merit note. The values of $\hat{\beta}_i$ are rather high compared to those obtained elsewhere, especially in USA. For example, Darby (1974) found that $\hat{\beta}$ is approximately equal to .1. The estimates of Zellner and Geisel (1970), even if they displayed some varitey, were of the same magnitude. Our estimates indicate that consumers assign a large weight to current income in permanent income. In other words, consumption taken as a whole is very sensitive with respect to changes in current income. It also means that consumers have a very short planning horizon (with e.g. $\beta = .268$ the average lag is less than 3 quarters), which is, of course, compatible with the idea of effective credit rationing.

Credit rationing terms: The role of credit rationing is examined here by estimating (11) and (12) with and without the (additive and multiplicative) GA and RAT terms. The corresponding equation-specific F-test statistics (which are, of course, only approximative due to autocorrelation) and their marginal levels of significance are reported in Table 9. As far as the whole system of equations is concerned, we found that, given (11), the null hypotheses $H_0' : \tilde{b}_6 = \tilde{b}_7 = 0$ and $H_0'' : \tilde{b}_7 = 0$ could be definitely rejected (the corresponding F-statistics were: 9.246/.000000 and 12.068/.000000). On the other hand, given (12), we could reject the null hypothesis that the coefficients of the multiplicative terms of RAT_t are identically equal to zero (computing the F-statistic gave: F = 2.567/.000476).

The evidence in Table 9 is quite straightforward: in the case of nondurables the additive RAT_t-term improves the fit, but the multiplicative RAT_t-terms do not. As for durables, the additive RAT_t-term does not improve the fit, but the multiplicative RAT_t-terms do, even if not very significantly. In the case of houses both the additive and multiplicative RAT_t-terms clearly improve the fit. These results do not depend on the way in which the GA_t-variable is treated[13]. Thus, it can be seen that credit rationing effects the demand for various goods in different ways. Even so, the following general description can be made: When "money gets tighter", people decrease their (overall) spending and begin to accumulate liquid assets. However, with "larger (durable) items", like houses, consumers are more likely to face binding borrowing restrictions and this also reduces purchasing and thus consumption expenditure on these goods.

Lagged Dependent terms: Finally, we test the hypothesis that the adjustment processes of different goods are interrelated, that is, whether the matrix Λ of the adjustment parameters is diagonal, as assumed above. The hypothesis was tested by estimating (11) also in an unrestricted form with each equation containing all the three lagged dependent terms. The following F-statistics were then obtained for the nondurables, durables, and houses, respectively: $F_c = 1.8172/.171456$, $F_d = 3.2109/.047459$, and $F_h = 4.5385/.014676$. When the whole system of equations was estimated, the following F-test statistics was obtained: $F_s = 4.1010/.000703$. Thus, the hypothesis that the off-diagonal terms of Λ are identically equal to zero can be rejected. Moreover, it appears that the more durable the commodities are, the more plausible

Table 9. Credit rationing tests

explanatory variables under H_0	additional explanatory variables	C_t	D_t	H_t
constant, $\bar{p}_t$, $\bar{v}_t$, $\bar{u}_t$, $\bar{y}_t$, $\bar{A}_{2t}$, Y_{-1}	RAT_t	5.8842 .018201	.1240 .725930	12.8421 .000667
constant, $\bar{p}_t$, $\bar{v}_t$, $\bar{u}_t$, $\bar{y}_t$, $\bar{A}_{2t}$, Y_{-1}	GA_t, RAT_t	3.9345 .024708	.6237 .539340	16.2667 .000002
constant, $\bar{p}_t$, $\bar{v}_t$, $\bar{u}_t$, $\bar{y}_t$, $\bar{A}_{2t}$, Y_{-1}, GA_t	RAT_t	7.0792 .009952	.1355 .714071	20.3202 .000030
constant, $\bar{p}_t$, $\bar{v}_t$, $\bar{u}_t$, $\bar{y}_t$, $\bar{A}_{2t}$, Y_{-1}	GA_t, RAT_t, $RAT_t\bar{p}_t$, $RAT_t\bar{v}_t$, $RAT_t\bar{u}_t$, $RAT_t\bar{y}_t$, $RAT_t\bar{A}_{2t}$, RAT_tGA_t, RAT_tY_{-1}	2.0762 .048024	1.7364 .103072	6.5455 .000003
constant, $\bar{p}_t$, $\bar{v}_t$, $\bar{u}_t$, $\bar{y}_t$, $\bar{A}_{2t}$, Y_{-1}, GA_t	RAT_t, $RAT_t\bar{p}_t$, $RAT_t\bar{v}_t$, $RAT_t\bar{u}_t$, $RAT_t\bar{y}_t$, $RAT_t\bar{A}_{2t}$, RAT_TGA_t, RAT_tY_{-1}	2.2255 .039475	1.7791 .101597	5.5227 .000041
constant, $\bar{p}_t$, $\bar{v}_t$, $\bar{u}_t$, $\bar{y}_t$, $\bar{A}_{2t}$, Y_{-1}, GA_t, RAT_t	$RAT_t\bar{p}_t$, $RAT_t\bar{v}_t$, $RAT_t\bar{u}_t$, $RAT_t\bar{y}_t$, $RAT_t\bar{A}_{2t}$, RAT_tGA_t, RAT_tY_{-1}	1.4803 .193974	2.0298 .067876	2.4889 .027270

Y_{-1} indicates the lagged dependent variable.

the hypothesis of interrelated adjustment processes is. The latter result can be illustrated by presenting the estimates of the adjustment parameters λ_{ij}, i,j = c, d, h.

$$\Lambda = \begin{bmatrix} \underset{(.103)}{.744} & \underset{(.042)}{-.042} & \underset{(.011)}{.019} \\ \underset{(.098)}{.034} & \underset{(.040)}{.179} & \underset{(.011)}{.028} \\ \underset{(.006)}{.004} & \underset{(.002)}{.007} & \underset{(.006)}{.036} \end{bmatrix}$$

(inside parentheses the standard deviations). The signs of the parameters are all except one positive indicating - to use the terminology of Nadiri and Rosen (1973), p. 67 - "dynamic subsitution" between these commodities. That is, e.g. the "excess demand" for houses does temporarily increase the consumption of durables, and vice versa[14)].

4. CONCLUDING REMARKS

We applied a standard neoclassical model of intertemporal choice to households´ demand for nondurables, durables and houses so that the role of credit rationing and different income and asset measures, given this rationing, were particularly stressed. The model was tested with quarterly Finnish data over 1962-1979. It appeared then that credit rationing plays an important role affecting both the desired levels of demand and the speed of adjustment. It also came out that consumers have a very short planning horizon and a strong emphasis on liquidity aspects, this was especially true with the demand for nondurables. Moreover, the results suggest that various measures of income and assets enter the equations of nondurables, durables and houses in quite different ways.

Obviously, further analysis is needed so that more affirmative conclusions can be drawn. For example, the demand for liquid assets should be introduced into the model, and a uniform framework of expectations formation needs to be specified.

FOOTNOTES

1) As another institutional detail we can mention that housing investment is of great importance in Finland, as the following ratios between the gross fixed capital formation (residental buildings) and GDP show: Denmark .052, Finland .066, Germany .069, Norway .051, Sweden .054, United Kingdom .037 and United States .040 (the data concerns the period 1965-1976, see National Accounts of OECD Countries, Vol II, OECD 1976). We may add here that in the Finnish, as in most national accounts, housing among durable goods is given a special treatment in the sense that income and expenditure both include actual and imputed rents, as well as repairs and maintenance. The services of other durables are not concerned. In this paper, all (durable) goods are treated in the same way. For instance, housing is simply considered a separate durable category.

2) The Finnish government loans to the household sector for the construction of houses are of great importance because of their magnitude, eligibility rules, low interest rates and favourable non-price terms. In this connection we can refer to the American debate on the importance of "credit availability" for the production of housing. According to e.g. Hendershott (1980) and Jaffee & Rosen (1979) the availability of credit plays an important role. An opposite view is presented by e.g. Meltzer (1974).

3) In Finland, the banks' borrowing from the central bank is both the major way of absorbing temporary liquidity changes and a permanent source of finance for lending to the non-bank public. Under these circumstances the difference between the cost and return on lending at the margin can be regarded as an indicator of the banks' liquidity situation.

4) As for individual equations, the residual sum of the squares for nondurables was minimized when $j = 1$, for durables when $j = 5$, and for houses when $j = 4$, the respective R^2's then being .993497, .999514 and .999985.

5) The H_t-equation was also estimated assuming that the error term follows an AR(4)-process. This had practically no effect on the results and the autoregressive terms were not significant, i.e. we could not reject the H_0 : $a_3 = a_4 = 0$, $\chi^2_2 = 1.2110/.545801$.

6) Because our data is very aggregative, it is not self-evident that symmetry should hold here (cf. Diewert (1977)).

7) Because $\bar{v}_t$, $\bar{u}_t$, and RAT_t contain negative values, they have not been transformed, i.e. $\theta = 1$ with them. We re-estimated the equations, however, also by transforming first these variables so that all of them had the minimum value of 1. Using then the extended autoregressive Box and Cox method gave the following estimates of θ for non-durables, durables and houses, respectively: -.320, 1.380, and .810. These results are very similar to those presented in Table 5.

8) These results are available from the authors upon request. As for the data set 1971(1)-1979(3), we also used the banks' hire purchasing limits as a proxy for credit rationing. When it was introduced as an additive term into (11), correct signs were obtained while the t-ratios were rather low.

9) In this connection the set of information included: constant, time trend, $\Delta v_t/v_{t-1}$, $\Delta v_{t-1}/v_{t-2}$, GDP at constant prices, the corresponding deflator, volume of exports, export prices, volume of imports, import prices, volume of public consumption, the corresponding deflator, volume of private investment, M_{1t}, the rate of unemployment, all, except the rate of unemployment and the time trend, being expressed in log difference terms for period t. The same information set was used for $\Delta u^*_{t+1}/u_t$ and r^*_{t+1}, only the lagged terms of $\Delta v_{t+1}/v_t$ being replaced by the respective "own" terms.

10) According to the Finnish tax rule homeowners are permitted deductions for (practically the whole of mortgage) interest, on the other hand, they do not have to include gross imputed rent on their tax return. As for interest from other loans, there is certain upper limit for deductions.

11) This fact should not, however, be stressed too much because of the existence of strong multicollinearity (cf. Table 5; ridge estimation does increase all the t-ratios of the income proxy, $\bar{y}_t$- in the housing equation the change is relatively small but in the durables equation the t-ratio of the $\bar{y}_t$-term exeeds that of the $\bar{A}_{2t}$-term). As far as the OLS results are concerned, the correlations of the estimated coefficients for $\bar{y}_t$ and $\bar{A}_{2t}$ are -.419, -.585 and -.558 for C_t, D_t and H_t, respectively.

12) These test results should, in fact, be contrasted to the Fisherian analysis (cf. Fisher (1965) and Hess (1974)) in which wealth is an endogeneous variable and assets stocks appear in the wealth maximization rather than the utility maximization problem. In terms of that analysis, W_t, should not appear in (5).

13) The additional multiplicative terms include variables which are not significant under H_0. Thus, our test procedure is rather unfavourable with respect to the "speed of adjustment" effect of credit rationing.

14) In this context it might be interesting to arrange a joint test for the hypotheses that the adjustment processes are interrelated and the speed of adjustment parameters depend on the degree of credit rationing. The corresponding test was, in fact, carried out by estimating (12) in the system form so that $\lambda_{ijt} = \lambda^0_{ij} - \lambda^1_{ij} RAT_t$ for all i, j = c,d,h. Then, the following LR-test statistics were obtained for the hypotheses that: $\lambda_{ijt} = 0$ for $i \neq j$, that: $\lambda^1_{ij} = 0$ for all i,j, and that: $\lambda_{ijt} = 0$ for $i \neq j$ and $\lambda^1_{ij} = 0$ for all i,j, respectively: $\chi^2_{12} = 39.50/.000087$, $\chi^2_{27} = 64.02/.000077$, and $\chi^2_{33} = 86.70/.000001$. Hence, the general form of the adjustment matrix, Λ, is supported by the data.

Appendix 1. Variables and data sources

C: equals total consumption expenditure minus expenditure on consumer durables, d_t, and housing (services), h_{st}. The first two series were kindly provided by the Bank of Finland, h_{st} (which in practice includes actual and imputed housing rents) was constructed by using an annual series for h_{st} together with a quarterly index of the corresponding price index (both from the Central Statistical Office of Finland) and a quarterly series of the stock of houses, H_t.

D: the stock of consumer durables, D_t, was constructed according to: $D_t = (1-d/2)d_t + (1-d)D_{t-1}$, where d stands for the depreciation parameter. Using the studies of Korpelainen (1967) and Roe (1969) as a reference, we assumed $d = 1/18$. D(1959) was computed from an annual series of d_t from 1950 up to 1960, so that D(1950) was simply fixed at zero.

H: the stock of houses, H_t, was constructed by using the estimates of Vihavainen - Valppu - Suokko - Björk (1980) for the years 1965 and 1977 as benchmarks and deriving the other observations from: $H_t = (1-h/2)h_t + (1-h)H_{t-1}$, where h stands for the depreciation parameter and h_t the gross investment in houses. h was estimated to be .0063; Jussi Karko (ETLA) kindly performed the computations. The series for h_t was kindly provided by the Bank of Finland.

p: an implicit price deflator of C_t.

v: an implicit price deflator of d_t.

u: an implicit price deflator of h_t.

A_1: the "narrow" definition of assets includes currency, demand deposits, time deposits and government bonds. All these series were kindly provided by the Bank of Finland. It is estimated that these items constitute c. 90 % of liquid assets in the use of funds of the household sector.

A_2: the "broad" definition of assets includes A_1, the stock of consumer durables, D_t, the stock of houses, H_t, (cf. (3)), and consumer debt, L_{ht}. The latter series was constructed by using the corresponding annual series (see Luottokantatilasto, the Central Statistical Office of Finland) and a quarterly series of banks´ (total) lending (this series was kindly provided by the Bank of Finland).

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