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TESTS OF THE DYNAMICS AND FUNCTIONAL FORM OF RETAIL DEMAND FOR CLOTHING AND FOOTWEAR IN WESTERN EUROPE

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The issue of whether the absolute values of the long term elasticities of demand for clothing and footwear are larger or smaller than the corresponding short term elasticities is addressed in this paper. Alternative functional forms of retail demand are compared. Six alternative models of retail demand for clothing and footwear in Germany, France, Italy and the United Kingdom, containing a range of different dynamic structures and functional forms, were estimated using single-equation regression. Diagnostic statistics and non-nested hypothesis tests were used to discriminate between these models. The absolute values of the long term elasticities of demand were found to be not higher than the short term elasticities.

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The ultimate source of the demand for wool and cotton is responses at the retail level. Analysis of the retail demand for products derived from fibres is important in the medium and long term forecasting of raw fibre demand and in the evaluation of decisions, such as wool promotion expenditure decisions, which influence retail demand.

An important issue in relation to retail demand is its dynamics; specifically, whether the long term elasticities of demand are larger or smaller than the corresponding short term elasticities. Another important issue is the functional form of retail demand equations. These are addressed in this paper through non-nested tests of alternative hypotheses of demand structures.

Equations were estimated for the four major economies of the European Community; namely, the Federal Republic of (FR) Germany, France, Italy and the United Kingdom. The European Community is a major destination for Australian wool and cotton. In 1986-87, 25 per cent of Australian raw wool exports and approximately 13 per cent of Australian raw cotton exports were destined for these four countries. Though the share of Australian fibres in raw fibre markets is different from the share in retail demand due to trade in semi-manufactured and manufactured fibre products, these figures provide a good approximation of the share in retail demand.

The expenditure category 'clothing and footwear' is used in this study to represent the retail demand for products derived from the types of fibres produced in Australia; that is, predominantly apparel wool and cotton. Data on the expenditure category 'clothing' would have been preferable because only a small proportion of the weight of footwear is apparel wool or cotton. However, such data are available for the countries studied only from 1970 onward. Since expenditure on clothing represents about 90 per cent of the expenditure on clothing and footwear in each of the countries in the study, the inaccuracy introduced by the use of the more aggregated category is likely to be small.

In the next section, previous research on retail demand for clothing and footwear is reviewed, with particular attention to the dynamics of demand. Next, alternative models of retail demand are defined. These models are estimated and tested against each other using non-nested hypothesis tests and qualitative comparisons of diagnostic statistics. Conclusions and implications for forecasting and policy analysis are drawn in the final section.

Previous Research

Clothing and footwear have been classed as semi-durables in previous research (Houthakker and Taylor 1966; Johnson, Hassan and Green 1984), but not all previous studies have taken into account the effect of their durability on the dynamics of consumer demand. Other sources of dynamics in consumer purchasing behaviour are persistence in consumer habits (Houthakker and Taylor 1966) and information and recognition lags.

If a product is non-durable, or if the consumer gains utility through the purchase of new goods only, lags in consumer behaviour can be treated as a process of partial adjustment toward a desired rate of purchasing (Nerlove 1958), which is represented in additive form as follows:

$$(1) \qquad Q_t - Q_{t-1} = \tau \, (Q_t^* - Q_{t-1})$$

where Q_t is the quantity purchased in period t and Q^*_t is the desired level of purchases in period t. Partial adjustment of purchases can also be represented in a multiplicative rather than an additive manner, in which case the levels of the variables in equation (1) are replaced by their logarithms.

If, on the other hand, the product is durable or semi-durable, or consumption is subject to habit formation, consumers are likely to partially adjust toward a desired level of consumer stocks. This process can be represented as:

$$(2) \qquad S_t - S_{t-1} = \rho(S^*_t - S_{t-1})$$

where S_t is the level of a state variable (representing either physical stocks or a psychological stock of habits) in period t, and S^*_t is the desired level of the state variable in period t.

The demand for durables was modelled by Houthakker and Taylor (1966) as being negatively related to household stocks of consumer durables; that is:

$$(3) \qquad Q_t = \alpha + \beta \bar{S}_t + \gamma X_t + \epsilon P_t$$

where $\bar{S}_t$ is the average level of consumer stocks in period t; X_t is the real total consumer expenditure in period t; P_t is the real price of the product in period t; and $\beta < 0$ for a negative effect of stocks on consumption.

[illegible]ing the stock variable changes as a linear function of time, the aver[illegible] level of stocks in period t is:

$$(4) \qquad \bar{S}_t = (S_t + S_{t-1})/2.$$

The stock of these durables was assumed by Houthakker and Taylor to increase with new purchases and to depreciate at a constant rate, δ, relative to the average level of stocks; that is:

$$(5) \qquad S_t - S_{t-1} = Q_t - \delta \bar{S}_t.$$

Solving equations (3), (4) and (5) to eliminate the unobservable stocks variable gives the estimable equation:

$$(6) \qquad Q_t = \frac{\alpha \delta}{1 - (\beta - \delta)/2} + \frac{1 + (\beta - \delta)/2}{1 - (\beta - \delta)/2} Q_{t-1} + \frac{\gamma (1 + \delta/2)}{1 - (\beta - \delta)/2} \Delta X_t$$

$$+ \frac{\gamma \delta}{1 - (\beta - \delta)/2} X_{t-1} + \frac{\epsilon (1 + \delta/2)}{1 - (\beta - \delta)/2} \Delta P_t$$

$$+ \frac{\epsilon \delta}{1 - (\beta - \delta)/2} P_{t-1}$$

where ΔX_t is the first difference in real total expenditure and ΔP_t is the first difference in real prices.

The short term (one year) total expenditure and real price effects on consumption are given by γ and ϵ respectively, while the corresponding long term effects are given by $\gamma\delta/(\delta - \beta)$ and $\epsilon\ \delta/(\delta - \beta)$ respectively. For semi-durables such as clothing and footwear, the effects of consumer stocks and habit formation may counteract each other (Sexauer 1977) and β and δ may be low as a result.

Winder (1971) compared the Houthakker-Taylor model with a stock adjustment model in which the desired level of stocks was a linear function of real expenditure and the real price of the product:

(7) $$S_t^* = k_0 + k_1 X_t + k_2 P_t.$$

The adjustment toward the desired level of stocks was assumed to be by the process modelled in equation (2), and stocks were assumed to depreciate at a constant rate as modelled in equation (5). Solving these equations led to the following dynamic demand equation:

(8) $$Q_t = k_0\rho + (\delta - \rho)\ \bar{S}_t + \rho k_1 X_t + \rho k_2 P_t$$

where:

(9) $$k_0\rho = \alpha,\ (\delta - \rho) = \beta,\ \rho k_1 = \gamma \text{ and } \rho k_2 = \epsilon$$

Note that a positive value of β is equivalent to $(\delta - \rho) > 0$; that is, it indicates that the rate of depreciation is higher than the coefficient of stock adjustment, rather than necessarily indicating habit formation and a large influence of psychological stocks.

Eliminating the unobservable stocks variables, the estimable form of the stock adjustment model proposed by Winder is:

(10) $$Q_t = \frac{k_0\rho\ \delta}{1 + \ /2} + \frac{1 - \rho/2}{1 + \ /2} Q_{t-1} + \frac{\rho k_1 (1 + \delta/2)}{1 + \ /2} \Delta X_t$$
$$+ \frac{\rho k_1 \delta}{1 + \rho/2} X_{t-1} + \frac{\rho k_2 (1 + \delta/2)}{1 + \rho/2} \Delta P_t + \frac{\rho k_2 \delta}{1 + \rho/2} P_{t-1}$$

Equations (6) and (10) are not derived from utility theory and do not explicitly take account of interactions among commodities. Systems of demand equations derived from utility theory have been proposed (see Deaton and Muellbauer 1980 for a survey of these). Two of the most popular systems are the Rotterdam model (see Theil 1975 for an exposition) and the Almost Ideal Demand System or AIDS model (Deaton and Muellbauer). In both of these models, however, the dependent variable is a transformation of the expenditure share of the commodity in the budget and the explanatory variables are based on logarithms of prices and incomes. Because of these nonlinearities, a highly complicated functional form, which may not yield a solution in estimation, results if stock and depreciation effects are included in the specifications.

The Rotterdam model (Theil 1975) is based on first differences in the dependent and explanatory variables and thus contains dynamic elements. In this model the short term and long term elasticities are the same. A simple single-equation version of the Rotterdam model can be derived by making the relative price of the good under consideration the only price variable (using implicit price deflators to approximate the theoretically correct Frisch price index), and approximating the Divisia volume index of the change in consumers' real income by the change in the logarithm of real total expenditure; as follows:

$$(11) \quad \bar{w}_t \, \Delta(\ln Q_t) = r_1 \, \Delta(\ln X_t) + r_2 \, \Delta(\ln P_t)$$

where $\bar{w}_t$ is the average budget share of the good under consideration; $\Delta(\ln Q_t)$ is the change in the logarithm of purchases of the good under consideration; $\Delta(\ln X_t)$ is the change in the logarithm of real expenditure; and $\Delta(\ln P_t)$ is the change in the logarithm of real prices of the good under consideration.

Deaton and Muellbauer (1980) used a multi-commodity framework in their static demand equations but reverted to a single-equation approach when treating demand for durables. This is because there are problems in applying some of the restrictions of consumer demand theory (homogeneity and symmetry) when purchases of durables are involved; namely, intertemporal budget constraints and the distinction between the price and the user cost of a durable.

Prices and expenditures are entered in equation (8) in linear form. However, it is possible that clothing and footwear, like food, become less important components of the budget as total expenditures rise or real prices fall and basic needs for clothing and footwear are satisfied. Furthermore, Turnovsky (1976) argued that prices and total expenditures affected consumption in a multiplicative rather than an additive pattern. One way in which these effects can be incorporated is by entering prices and total expenditures as logarithms rather than as levels.

Dewbre, Vlastuin and Ridley (1986) estimated a single retail demand equation for clothing and footwear across eight OECD countries (the United States, Belgium, France, FR Germany, Italy, Japan, the Netherlands and the United Kingdom) using a combined cross-section, time-series version of the Houthakker-Taylor stock adjustment model. They imposed constant demand coefficients across countries and did not allow for possible non-zero disturbance covariances between countries. They found that the long term elasticities of demand with respect to prices and total expenditures were one-third of the short term elasticities.

In a joint project, the AWC and BAE (1987) related consumption of wool at the retail level in the same eight OECD countries to: the price of raw wool relative to the price of cotton and synthetic fibres; consumer expenditure; wool promotion expenditure; and a lagged dependent variable. They imposed constant coefficients across all countries and accounted for cross-country correlations among disturbances through the use of Zellner's Seemingly Unrelated Regressions (ZSUR) technique. They assumed that there was a partial adjustment of purchases to the desired level, and estimated a coefficient of adjustment of 0.7, which implies (contrary to the above result) that long term demand elasticities are three times the short term values.

Houthakker (1965) justified pooling across countries on the basis that the estimates obtained for separate countries are often implausible. Pollak and Wales (1987) noted that when different countries' demand systems are identical, efficient estimation requires pooling. They examined the validity of pooling international consumption data by testing the effect of imposing constant coefficients across countries, using demand for food, clothing and footwear and a miscellaneous category in the United States, Belgium and the United Kingdom. They used the quadratic expenditure system in static form and in a form in which one set of price response parameters depended on past consumption. They found that pooling was rejected for most pairs of countries and specifications.

A major unresolved empirical question suggested by this literature is whether the absolute values of the long term elasticities of demand for clothing and footwear are larger or smaller than the corresponding short term ones. A range of models of dynamic consumer demand are suggested by the foregoing discussion. These models will be detailed in the next section, and tested in subsequent sections in order to resolve this empirical question.

Models of Retail Demand

From the range of models discussed in the previous section, six models of retail demand for clothing and footwear are examined. All are single-equation models. Multi-commodity models were not examined, for reasons given in the previous section. It was assumed that consumers predetermined their total expenditure and did not influence retail prices; thus, total expenditure and prices are assumed to be exogenous. Provided this assumption is correct, there should be no simultaneity bias if estimation is by a single-stage technique. Further, in the demand for clothing and footwear as durables, current total expenditure is assumed to act as a proxy for future income and current wealth. The models allow for different dynamic structures and functional forms in retail demand. They are:

(i) the semi-logarithmic 'partial adjustment of consumer stocks' (SPACS) model;

(ii) the linear 'partial adjustment of consumer stocks' (LPACS) model;

(iii) the linear 'partial adjustment of purchases' (LPAP) model;

(iv) the semi-logarithmic 'partial adjustment of purchases' (SPAC) model;

(v) the logarithmic 'partial adjustment of purchases' (GPAP) model; and

(vi) the Rotterdam (R) model.

In the first two models, consumers are assumed to have a desired level of wardrobe stocks of clothing and footwear, toward which they partially adjust according to the process described in equation (2). An alternative explanation of behaviour which should lead to similar results in terms of elasticities of demand in the short and long terms is the Houthakker-Taylor state adjustment model. This is so because coefficients in the partial adjustment of consumer stocks equation can be expressed as a combination of the coefficients in the Houthakker-Taylor model. A linear (type ii) version of this model is given by equation (6). A second alternative for model (ii) is Winder's interpretation of a partial adjustment of consumer stocks, given in equation (10). Both these versions of model (ii) were tried. For model (i), equations (2), (4) and (5) are assumed to apply and the desired level of consumer stocks is taken as a linear function of the logarithms of real total expenditures and real prices. The estimable form of model (i) is then as in equation (9) except that the levels of real total expenditure and real prices are replaced by their logarithms.

In the next three models, consumers are assumed to have a desired rate of purchases of clothing and footwear per person per year, toward which they partially adjust by an additive process in models (iii) and (iv) and by a multiplicative process in model (v). In model (iii), the desired level of purchases is a linear function of the levels of current real total expenditures and real prices, as follows:

$$(12) \qquad Q_t^* = a_0 + a_1 X_t + a_2 P_t$$

and the estimable equation, which is derived by solving equations (1) and (12) to eliminate the desired purchases variable, is:

$$(13) \qquad Q_t = \tau a_0 + (1 - \tau) Q_{t-1} + \tau a_1 X_t + \tau a_2 P_t.$$

In models (iv) and (v), the desired level of purchases is a linear function of the logarithms of current real total expenditures and real prices.

The simple single-equation version of the Rotterdam model (11) was used. The methods used in estimating these models and the tests used in distinguishing between the models are explained in the next section.

Methods

Before estimating the models, choices of econometric techniques had to be made, particularly with regard to pooling across countries. Since the models cannot be expressed as sub-models of one another, non-nested hypothesis tests were used in combination with diagnostic statistics to distinguish between the models.

The price of clothing and footwear was represented by the implicit price deflator for the corresponding expenditure category of national accounts statistics. Houthakker (1965) wrote that biased elasticity estimates may result if there are errors in the calculation of implicit price deflators. However, these were the most representative retail prices available for the whole sample period. Total expenditures and prices were deflated by an implicit price deflator for expenditure categories other than clothing and footwear which was constructed from the data. This procedure imposes the Slutsky-Schultz condition, or row constraint, of consumer demand theory.

All variables in each model were expressed as deviations from the sample means. This was done to aid convergence in the nonlinear models. Hence, no constant term was included in the equations. One degree of freedom was lost by this transformation.

Since models (i) and (ii) are nonlinear in the parameters, they were estimated by single-equation nonlinear least squares; structural parameters are presented in the section on results. Models (iii), (iv) and (v) were estimated by ordinary least squares, because these models are linear in the parameters in the reduced form and each of the structural parameters can be uniquely identified from the reduced form estimates. The reduced form parameters are also presented in the results section.

Model tests

For comparisons between models with the same dependent variable, the C test proposed by Davidson and MacKinnon (1981) was used. The structure of the test is as follows. Consider two non-nested regression models, H_0 and H_1, for some dependent variable, y_t:

(14) $H_0: y_t = f(x_{1t}, \Omega_t) + u_{1t}$; and

(15) $H_1: y_t = g(x_{2t}, \Omega_2) + u_{2t}$.

where x_{1t} and x_{2t} are matrixes of explanatory variables; Ω_1 and Ω_2 are corresponding parameter vectors; and u_{1t} and u_{2t} are random errors, assumed to be normally distributed with zero means and constant variances.

The C test employs the following regression:

(16) $y_t - f(x_{1t}, \Omega_1) = k(g(x_{2t}, \Omega_2) - f(x_{1t}, \Omega_1)) + v_t$.

The parameter k is assumed to have a t-distribution with N-J-2 degrees of freedom, where N is the sample size and J is the number of parameters estimated. Hence, the C test consists of a t-test of the hypothesis that k is significantly different from zero. The test is applied both forwards and backwards (that is, with the null and alternative hypotheses swapped).

Where models to be compared have different dependent variables, the BM test proposed by Bera and McAleer (1983) was used. The use of this test is shown below for the comparison between the LPACS models and the Rotterdam model. The alternative hypotheses are:

(17) $$H_0: Q_t = \frac{k_0\rho\ \delta}{1+\rho/2} + \frac{1-\rho/2}{1+\rho/2} Q_{t-1} + \frac{\rho k_1 (1+\delta/2)}{1+\rho/2}\Delta X_t$$

$$+ \frac{\rho k_1 \delta}{1+\rho/2} X_{t-1} + \frac{\rho k_2 (1+\delta/2)}{1+\rho} \Delta P_t + \frac{\rho k_2 \delta}{1+\rho/2} P_{t-1}$$

$$= f(Q_{t-1}, \Delta X_t, X_{t-1}, \Delta P_t, P_{t-1})$$

(18) $H_1: g(Q_t) = \tilde{w}_t \Delta(\ln Q_t) = r_1 \Delta(\ln X_t) + r_2 \Delta(\ln P_t)$

where variables and parameters are as defined in equations (10) and (11). Denote the predicted value of the dependent variable in H_0 as $\hat{Q}_t$ and in H_1 as $g(\tilde{Q}_t)$. In order to test (17) and (18), an artificial model is constructed by weighting the errors of H_0 and H_1 as follows:

(19) $(1 - m)(\hat{Q}_t - f(Q_{t-1}, \Delta X_t, X_{t-1}, \Delta P_t, P_{t-1}))$

$$+ m(g(\tilde{Q}_t) - r_1 \Delta(\ln X_t) - r_2 \Delta(\ln P_t)) = e_t$$

in which e_t is normally, independently and identically distributed under H_0: $m = 0$ or H_1: $m = 1$. After rearrangement of (19), we have the two artificial models:

(20) $Q_t = f(Q_{t-1}, \Delta X_t, X_{t-1}, \Delta P_t, P_{t-1}) + \theta_0 e_{1t} + e_t$

and

(20) $g(Q_t) = r_1 \Delta(\ln X_t) + r_2 \Delta(\ln P_t) + \theta_1 e_{0t} + e_t$

in which $\theta_0 = -m/(1-m)$ and $\theta_1 = -(1-m)/m$.

Tests of H_0: $\theta_0 = 0$ in (20) and H_1: $\theta_1 = 0$ in (21) are equivalent to tests of $m = 0$ and $m = 1$, respectively. Since e_{1t} and e_{0t} are unobservable, the tests of H_0 and H_1 can be made tractable by replacing e_{1t} by η_{1t} and e_{0t} by η_{0t}, where η_{1t} and η_{0t} are residuals obtained from the following auxiliary regressions:

(22) $\tilde{w}_t (\ln \hat{Q}_t - \ln Q_{t-1}) = r_1 \Delta(\ln X_t) + r_2 \Delta(\ln P_t) + \eta_{1t}$

(23) $\exp(g(\tilde{Q}_t)/w_t + \ln Q_{t-1}) = f(Q_{t-1}, \Delta X_t, X_{t-1}, \Delta P_t, P_{t-1}) + \eta_{0t}$

The residuals from (22) and (23) are denoted as $\hat{\eta}_{1t}$ and $\tilde{\eta}_{0t}$, respectively. Replacing e_{1t} in (20) with $\hat{\eta}_{1t}$ and e_{0t} with $\tilde{\eta}_{0t}$ enables H_0 and H_1 to be tested. The test of $\theta_0 = 0$ in (20) has the exact t(N-J-2) distribution under H_0, where N is the sample size and J is the number of parameters estimated. The test of $\theta_1 = 0$ in (21) has an approximate t(N J-2) distribution under H_1 (McAleer 1984).

<u>Data availability</u>

Data on total private consumption expenditures and on expenditures on clothing and footwear are available back to 1970 using the present System of National Accounts (SNA), and from 1960 to 1970 using the former SNA. A different accounting system was used previous to that, and data were obtained back to 1952, but in that case the expenditure category used was clothing and other personal effects rather than clothing and footwear. Data sources were the Organisation for Economic Co-operation and Development (OECD 1986 and 1985) and the United Nations (UN 1979, 1976, 1974, 1970, 1965 and 1959). Data from the former SNA were linked to the data from the present SNA to create a continuous data series from 1960 to 1985 for each country. These series have 26 observations each, but one observation is lost when variables are lagged. Data for the years between 1952 and 1959 were not used for estimation because the definition of categories was different from that used in later years; they were reserved in case artificial stock variables were to be calculated, but this proved unnecessary.

Note that the data are on purchases within each country, not on purchases by the residents of each country. Because of the ease of travel within Europe, this distinction may be important.

Since there were at least three regressors in each of the hypothesised models, there were fewer than 23 degrees of freedom in each model, implying that the efficiency of ZSUR may have been no higher than that of OLS (Mehta and Swamy 1976). For this reason, single-equation techniques were used to estimate separate regressions for each country.

Patterns in Purchases, Prices and Expenditures

Patterns in the purchases of clothing and footwear, real prices and total private final consumption expenditure are described in this section. This qualitative and graphical analysis is a useful adjunct to the quantitative analysis in the next section because it indicates where peculiarities or problems may be encountered in the quantitative analysis.

The purchases of clothing and footwear are shown in Figure 1. These were measured as expenditures on clothing and footwear per person per year deflated by the implicit price deflator for clothing and footwear. Variables used in the rest of the paper were converted from national currencies to 'international' US dollars (as defined in OECD 1985) at 1980 values, using purchasing power parities published by the OECD (1985).

Clothing and footwear purchases have risen over the whole sample period in each country, but changed little in France between 1972 and 1985. They are higher in FR Germany than in the other three countries, although purchases in the United Kingdom rose by approximately 25 per cent between 1981 and 1985 to reach almost the same level as Germany. This strong rise contrasted with the stagnation in purchases in the other three countries over the same period. It raises the question of whether in these years there could have been large purchases of clothing and footwear in the United Kingdom by non-residents (including tourists and business travellers), combined with reduced purchases of clothing and footwear by non-residents in the other three countries. Such a pattern could be a response to the lower relative price of clothing and footwear in the United Kingdom compared to the other three countries over these years (see Figure 2 for relative prices).

Real private final consumption expenditure, shown in Figure 3, has risen in each country, but at a lower rate in the United Kingdom than in the other three countries. Until 1969 or 1970, consumption expenditure was higher in the United Kingdom than in the other countries, but since then real consumption expenditure in France and Germany has overtaken that in the United Kingdom. Italian consumption expenditure has been the lowest of the four countries over the entire period.

The real price of clothing and footwear, shown in Figure 2, has been lower in Germany than in France and Italy between 1965 and 1985. The real price of clothing and footwear dropped quite sharply in the United Kingdom between 1952 and 1985. It is possible that, in the face of such a substantial change in real prices, consumer expectations of future prices

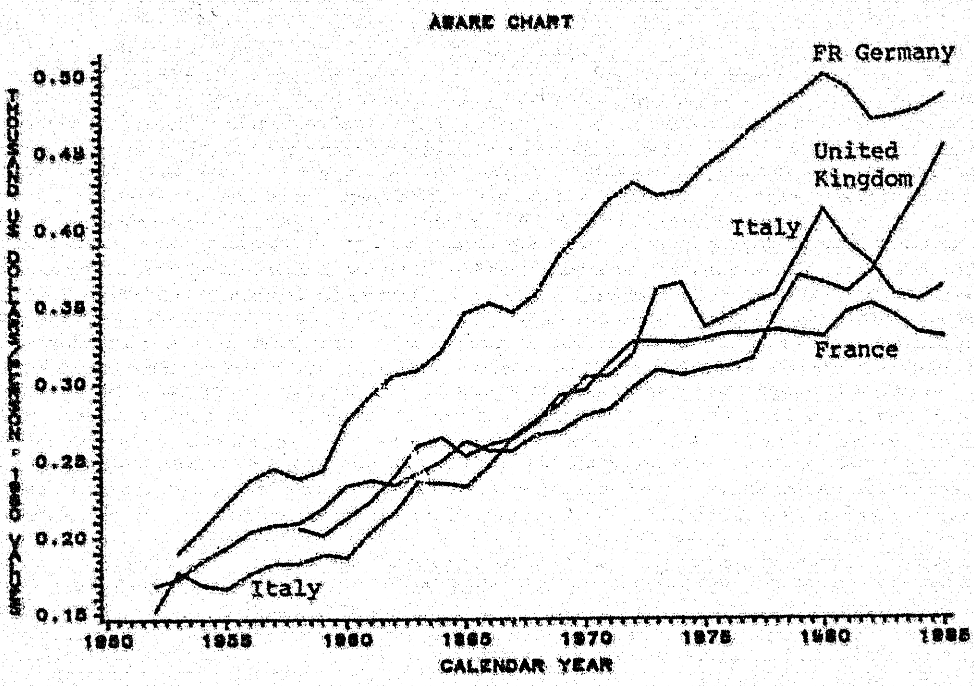

FIGURE 1 - Clothing and Footwear Purchases, Europe

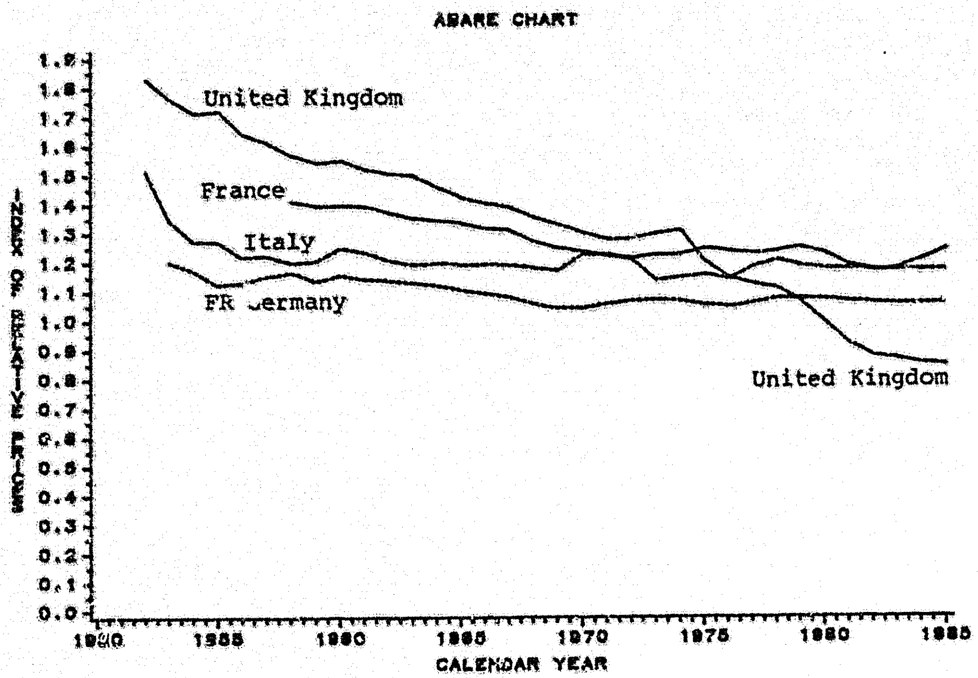

FIGURE 2 - Clothing and Footwear Prices, Europe

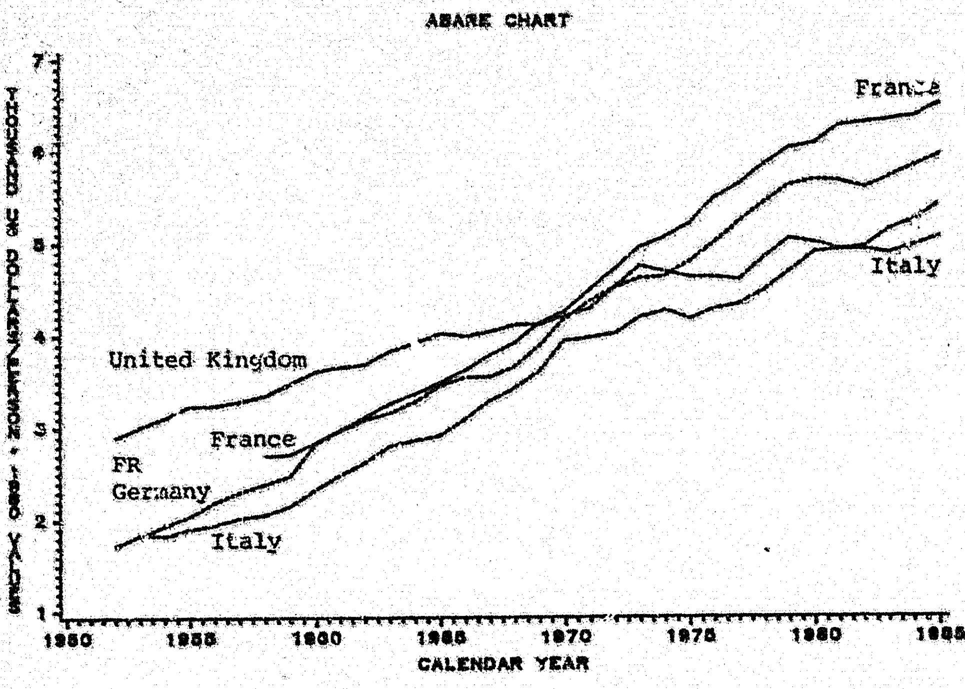

FIGURE 3 - Real Total Expenditure, Europe

are important. In contrast, there has been little variation in the real price of clothing and footwear in Germany, while changes in real prices in France and Italy have been less pronounced than those in the United Kingdom. It is possible that, in Germany, consumers have little perception of changes in real prices, and as a result the own-price elasticity of demand in Germany may be small.

The real price of clothing and footwear in the United Kingdom slopes downward almost monotonically and is collinear with real total expenditure per person in that country and with time. Under these circumstances an unstable estimate of the price coefficient could possibly be obtained.

Results and Discussion

Results for models (i) through (vi) for the four countries are shown in Tables 1 through 6 respectively. In all cases the sample period is 1961-85. Results for models (i) and (ii) presented in Tables 1 and 2 were estimated using nonlinear least squares (NLS) regression for a small sample (25 observations after lags were taken). The hypothesis test statistics (that is, the t-tests of the null hypothesis that the coefficients are aqual to zero, and the Durbin's h) are valid only for large samples and are provided only as rough guides for the interested reader. The corrected R-squared can be applied as a descriptive statistic, but the one calculated by the computer package is of the final linearisation of the iterative process and is therefore only an approximation to the true statistic. Models (iii) through (vi) were estimated using OLS regression and the conventional interpretation can be applied to the hypothesis test statistics.

The consumer stock adjustment models were estimated using the Houthakker-Taylor (1966) formulation, as in equation (6), rather than the

Winder (1971) formulation, as in equation (10), because convergence problems were experienced for some countries with the Winder formulation.

Results for both stock adjustment models (models (i) and (ii)) are now discussed together because they were similar in essential aspects. The coefficients were of the expected sign in all countries except the United Kingdom, where the signs of the depreciation rate and the stock parameters were contrary to expectations. These 'wrong' signs cast doubt on the reliability of the long term elasticity estimates for the United Kingdom in the stock adjustment models. Estimates of depreciation rates were low for the other countries, and were lower for the linear model than for the semi-logarithmic model. The stock adjustment parameters for the other countries were low, indicating that there is only a slight adjustment toward the desired stock level within a year. The depreciation rates and stock adjustment parameters were higher for Germany and France than for Italy.

TABLE 1

Nonlinear Least Squares Estimates of Structural Parameters of the Semi-logarithmic Consumer Stock Adjustment Model: Model (i)

Demand equation parameter	Country: FR Germany	France	Italy	United Kingdom
k_1 (log total expenditure)	0.486 (5.3)	0.360 (2.7)	0.544 (6.2)	0.395 (6.5)
k_2 (log price)	-0.0750 (-0.45)	-0.312 (-3.7)	-0.332 (-3.4)	-0.0223 (-0.42)
δ (depreciation)	0.204 (1.1)	0.115 (1.6)	0.122 (1.5)	-0.0305 (-0.38)
β (effect of stock)	-0.133 (-1.3)	-0.182 (-1.8)	-0.0612 (-0.73)	0.0838 (3.7)
ρ (stock adjustment rate)	0.337	0.297	0.183	-0.114
Corrected R^2	0.993	0.981	0.980	0.993
Durbin's h	-0.45	-0.75	2.20	2.02
Cond.	15	9	6	3
<u>Elasticities at mean of dependent variable</u>				
Real price				
- short term	-0.18	-1.0	-1.1	-0.07
- long term	-0.11	-0.40	-0.70	-0.02
Real total expenditure				
- short term	1.2	1.2	1.7	1.3
- long term	0.71	0.46	1.1	0.34

Figures in parentheses are t-ratios.

which implies that in the former countries clothing and footwear are replaced more quickly and there is quicker adjustment toward the desired stock level. This is understandable: real total expenditure was relatively high in Germany and France and the real price of clothing and footwear was relatively low in Germany during the sample period (see Figures 2 and 3). This would make replacement of clothes and footwear and adjustment to desired stock levels more affordable in Germany and France than in Italy.

All of the corrected R-squared statistics were high, indicating that the models explained a high proportion of the variation in purchases of clothing and footwear. There was little difference in the corrected R-squared statistics between the linear and semi-logarithmic models for each country.

TABLE 2

Nonlinear Least Squares Estimates of Structural Parameters of the Linear Consumer Stock Adjustment Model: Model (ii)

Demand equation parameter	Country			
	FR Germany	France	Italy	United Kingdom
k_1 (total expenditure)	0.110 (6.6)	0.0655 (2.6)	0.143 (7.5)	0.911 (7.3)
k_2 (price)	-0.163 (-1.1)	-0.261 (-3.6)	-0.268 (-3.8)	-0.0497 (1.1)
δ (depreciation)	0.0967 (1.1)	0.0918 (1.4)	0.0480 (0.71)	-0.0306 (0.37)
β (effect of stock)	-0.0946 (-1.6)	-0.170 (-2.1)	-0.0451 (-0.67)	0.0731 (4.3)
ρ (stock adjustment rate)	0.191	0.262	0.0931	-0.104
Corrected R^2	0.993	0.979	0.984	0.994
Durbin's h	-0.98	0.76	2.2[illegible]	1.90
Cond.	7	6	5	2
<u>Elasticities at mean of dependent variable</u>				
Real price				
- short term	-0.42	-1.1	-1.0	-0.19
- long term	-0.21	-0.38	-0.52	-0.06
Real total expenditure				
- short term	1.2	1.0	1.8	1.3
- long term	0.61	0.37	0.93	0.39

Figures in parentheses are t-ratios.

The estimated elasticities were of the expected signs (negative real price elasticities and positive real total expenditure elasticities), and the long term elasticities were lower in absolute value than the short term elasticities in all cases. An explanation for this pattern is that if there is a rise in incomes or fall in prices, consumers purchase more and enlarge their stocks toward the new desired level, but in the long term this larger stock tends to depress purchases.

Short term real price responses at the sample means were not significant, and certainly inelastic, for Germany and the United Kingdom, and almost unit elastic for France and Italy. Long term real price responses were inelastic at the sample means for the four countries. As mentioned above, a possible explanation for a low own-price elasticity of demand in Germany is that there was little price variation in that country during the sample period (see Figure 2), so that real price changes may have rarely been large enough to reach a threshold level to which consumers would respond. A possible explanation for the low price elasticity of demand in the United Kingdom, together with negative depreciation rates and stock adjustment parameters, is that purchases of clothing and footwear in that country by non-residents could have been important in the last few years of the sample period. If non-resident purchases are important and volatile, past purchases are not a reliable indicator of the wardrobe stocks of clothing and footwear retained in the United Kingdom. Hence, the estimated parameters of the consumer stock adjustment model will be biased.

Short term real total expenditure effects were elastic at the sample means except for France, where they were approximately unit elastic. Long term real expenditure effects were inelastic at the sample means, except for Italy, where they were approximately unit elastic. A likely explanation for the finding that estimated real total expenditure elasticities were higher for Italy than for France or Germany hinges on the lower real total expenditure per person in Italy than in France and Germany (see Figure 3), which would tend to make clothing and footwear a relative luxury, and its consumption therefore more dependent on total expenditure in Italy than in France and Germany.

Three different functional forms (the linear, semi-logarithmic and logarithmic) of the purchases adjustment model were estimated - models (iii), (iv) and (v), respectively. Their results are now contrasted with each other and compared with those of the stock adjustment models. The corrected R-squared statistics, although still high, were lower for models (iii) and (iv) than for models (i) and (ii), indicating that partial adjustment of purchases explained less of the variation in the data than partial adjustment of consumer stocks. (The corrected R-squared statistics for model (v) - and also for model (vi) - are not directly comparable with those of the first four models because their dependent variables are of different forms from those models.)

As indicated by the Durbin's h statistics in Tables 3, 4 and 5, the purchases adjustment equations for Germany, Italy and the United Kingdom had positive first order autocorrelation significant at the 5 per cent level, while those for France had positive first order autocorrelation significant at the 10 per cent level.

The estimated parameters of adjustment of purchases were between zero and one, implying that the absolute values of the long term elasticities of demand are higher than those of the short term elasticities. However, since misspecification appears to be present, the estimates are likely to be

TABLE 3

Ordinary Least Squares Estimates of Parameters
of the Linear Purchases Adjustment Model: Model (iii)

Demand equation parameter	Country			
	FR Germany	France	Italy	United Kingdom
$a_1 * \tau$ (total expenditure)	0.0290 (2.9)	0.00294 (0.84)	0.0343 (2.6)	0.0246 (1.7)
$a_2 * \tau$ (price)	-0.206 (-2.4)	-0.186 (-3.6)	-0.137 (-1.1)	-0.0215 (-0.6)
τ (purchases adjustment)	0.525 (3.5)	0.437 (3.4)	0.536 (3.1)	0.212 (1.1)
Corrected R^2	0.985	0.972	0.950	0.975
Durbin's h	3.41*	1.98	5.52*	6.45*
Cond.	14	9	9	11

Figures in parentheses are t-ratios. Asterisk indicates that autocorrelation was significantly different from zero at the 5 per cent level of significance.

TABLE 4

Ordinary Least Squares Estimates of Parameters
of the Semi-logarithmic Purchases Adjustment Model: Model (iv)

Demand equation parameter	Country			
	FR Germany	France	Italy	United Kingdom
$b_1 * \tau$ (log total expenditure)	0.199 (4.0)	0.0205 (1.0)	0.136 (2.9)	0.0846 (1.5)
$b_2 * \tau$ (log price)	-0.112 (-1.4)	-0.229 (-3.5)	-0.143 (-0.96)	-0.0479 (-1.1)
τ (purchases adjustment)	0.73 (4.6)	0.469 (3.3)	0.562 (3.4)	0.241 (1.2)
Corrected R^2	0.988	0.972	0.953	0.975
Durbin's h	4.10*	2.27*	4.50*	13.34*
Cond.	17	10	8	12

Figures in parentheses are t-ratios. Asterisk indicates that autocorrelation was significantly different from zero at the 5 per cent level of significance.

TABLE 5

Ordinary Least Squares Estimates of Parameters of the Logarithmic Purchases Adjustment Model: Model (v)

Demand equation parameter	Country: FR Germany	France	Italy	United Kingdom
$c_1 * \tau$ (log total expenditure)	0.387 (3.4)	0.0582 (0.9)	0.490 (2.9)	0.680 (3.7)
$c_2 * \tau$ (log price)	-0.569 (-2.5)	-0.776 (-3.3)	-0.512 (-1.1)	-0.305 (-2.9)
τ (purchases adjustment)	0.618 (4.1)	0.454 (3.5)	0.602 (3.5)	0.701 (3.7)
Corrected R^2	0.987	0.971	0.966	0.985
Durbin's h	3.13*	1.85	5.07*	12.51*
Cond.	15	7	10	15

Figures in parentheses are t-ratios. Asterisk indicates that autocorrelation was significantly different from zero at the 5 per cent level of significance.

TABLE 6

Ordinary Least Squares Estimates of Parameters of the Rotterdam Model: Model (vi)

Demand equation parameter	Country: FR Germany	France	Italy	United Kingdom
$_1$ (change in log total expenditure)	0.0892 (9.1)	0.0479 (3.5)	0.106 (8.2)	0.105 (11.3)
r_2 (change in log price)	-0.0497 (-1.4)	-0.0834 (-2.6)	-0.0844 (-3.2)	-0.0203 (-2.9)
Corrected R^2	0.798	0.566	0.780	0.858
Durbin's h	1.77	1.31	1.36	1.46
Cond.	1.3	1.5	1.1	1.1
<u>Elasticities at mean budget share</u>				
Real price	-0.50	-1.0	-0.89	-0.25
Real total expenditure	0.90	0.58	1.1	1.3

Figures in parentheses are t-ratios.

inconsistent. For this reason, no elasticity estimates are presented for the purchases adjustment models.

All the estimates from the Rotterdam model - model (vi) - had the correct sign (see Table 6). With one exception, all the parametar estimates were significantly different from zero at the 5 per cent level. The collinearity among explanatory variables was quite low, contributing to low standard errors of parameter estimates. There was no significant autocorrelation in the parameter estimates. The corrected R-squared statistics are moderate to high for each country but, as noted above, cannot be directly compared with those for the other models because of the different dependent variable used.

The estimates of total expenditure elasticities at mean budget shares from the Rotterdam model were, for each country, between the short term and long term estimates from the consumer stock adjustment models for each country. Lower elasticities were estimated for France and Germany (which had relatively high real total expenditure in the sample period) than for Italy and the United Kingdom. The estimated price responses for France and Italy were almost unit elastic, a result which is in line with the short term estimates from the stock adjustment models. The estimated price responses for Germany and the United Kingdom, although inelastic, were higher than those from the stock adjustment.

The first order correlations found in models (iii), (iv) and (v) indicate correlated errors, omitted variables, incorrect functional form and/or incorrect transformation of variables (McAleer and Deistler 1986). Autocorrelation was present for all three models, indicating either that a more complicated functional form was required or, more probably - since the models differ in form -, some other shortcoming.

The presence of correlated errors was judged to be unlikely. The purchases adjustment model, in contrast to the similar adaptive expectations model, does not naturally have an associated first order autocorrelated error term (Theil 1979, p.262). If consumers respond positively in the current year to errors in purchases that they made in the preceding year, then positive first order autocorrelation would be expected also in the stock adjustment and Rotterdam models, but such autocorrelation was not detected in those models.

The other possible sources of apparent autocorrelation are omitted variables and incorrect transformation of variables. Variables other than lagged total expenditure and lagged prices which were omitted from the purchases adjustment models were also omitted from the other models. If these omitted variables were the source of the indicated autocorrelation, then significant autocorrelation statistics would be expected for the other models, whereas the diagnostic statistics for autocorrelation in the other models were not significant. Hence, it is likely that the most important source of apparent autocorrelation in the purchases adjustment models is dynamic misspecification. This can be ameliorated by replacing the purchases adjustment models with more plausible models; namely, the Rotterdam model or the stock adjustment model.

The role of non-nested tests is to test alternative models which are adequate in other regards (McAleer 1984) and only the stock adjustment and Rotterdam models were regarded as adequate. The purchases adjustment models were rejected because, unlike these models, they had significant first order autocorrelation. Also, the explanatory power of the purchases adjustment models was lower than that of the stock adjustment models.

C tests were used for testing the linear against the semi-logarithmic consumer stock adjustment model. Both of those models had the same dependent variable. BM tests were used for testing the Rotterdam model against the stock adjustment models. The results of both types of tests of non-nested hypotheses are shown in Table 7 for Germany, Table 8 for France, Table 9 for Italy and Table 10 for the United Kingdom.

The consumer stock adjustment models did not (at the 5 per cent significance level) add to the explanation of the data relative to the Rotterdam model, for any of the four countries. The Rotterdam model added significantly to the explanation relative to the stock adjustment model for the United Kingdom, but not for the other three countries. The consumer stock adjustment models were therefore rejected in favour of the Rotterdam model for the United Kingdom, but the two classes of model were deemed of equal value for the other countries.

The results between functional forms of the stock adjustment model were not clear-cut. (The purchases adjustment models are not discussed in this respect, because their results are confounded by specification error.) For Germany neither the linear nor the semi-logarithmic model was rejected in favour of the other. For France, the linear model was rejected in favour of the semi-logarithmic model, while for Italy and the United Kingdom, the opposite occurred. Thus, neither form was preferred for all four countries. This finding is not of major importance, however, because the consumer stock adjustment models were in no case found preferable to the Rotterdam model.

Conclusions

The models based on partial adjustment to a desired rate of purchase of clothing and footwear were inadequate because they had significant first order autocorrelation, whereas the other models did not have this problem. Also, the explanatory power of the consumer stock adjustment models, as shown by the corrected R-squared statistics, was higher than that for the purchases adjustment models.

For the United Kingdom, the Rotterdam model was shown to be more acceptable than the consumer stock adjustment models by the BM test. The Rotterdam model is also preferable to the stock adjustment models for that country because its parameter estimates for price and total expenditure effects appear more precise, as shown by their t-statistics, and there are no implausible negative estimates of depreciation rates or stock adjustment parameters. For the other countries also, the parameter estimates from the Rotterdam model are apparently more precise than those for the stock adjustment models. However, caution is needed in comparing the t-statistics of the two models, because their parameters apply to different forms of the dependent variable, collinearity is lower in the Rotterdam model than in the stock adjustment models, and the stock adjustment models were estimated by nonlinear least squares regression. Despite possible differences in the precision of the estimates of elasticities from the stock adjustment and Rotterdam models, the estimates were similar. Those of the Rotterdam model were between the short term and the long term results for the stock adjustment models for six of the eight cases. The exceptions were the price elasticities for Germany and the United Kingdom, where the higher estimates of the Rotterdam model seem more intuitively plausible than those of the

TABLE 7

Tests of Non-nested Hypotheses of Alternative Model Structures for the Demand Equations for the Federal Republic of Germany (a)

	Alternative hypothesis: model number		
Null hypothesis: model number	(i) SPACS	(ii) LPACS	(vi) R
(i)	-	-0.23^{C}	0.22^{BM}
(ii)	1.07^{C}	-	0.53^{BM}
(vi)	-1.83^{BM}	-0.88^{BM}	-

(a) The figures presented in the table are t values of the null hypothesis for models (i), (ii) and (vi). The critical value for 19 degrees of freedom and a significance level of 5 per cent is 2.093. C, BM: type of test used.

TABLE 8

Tests of Non-nested Hypotheses of Alternative Model Structures for the Demand Equations for France (a)

	Alternative hypothesis: model number		
Null hypothesis: model number	(i) SPACS	(ii) LPACS	(vi) R
(i)	-	-0.94^{C}	1.87^{BM}
(ii)	1.72^{C}	-	1.71^{BM}
(vi)	-0.95^{BM}	-0.80^{BM}	-

(a) The figures presented in the table are t values of the null hypothesis for models (i), (ii) and (vi). The critical value for 19 degrees of freedom and a significance level of 5 per cent is 2.093. C, BM: type of test used.

TABLE 9

Tests of Non-nested Hypotheses of Alternative Model Structures for the Demand Equations for Italy (a)

	Alternative hypothesis: model number		
Null hypothesis: model number	(i) SPACS	(ii) LPACS	(vi) R
(i)	-	-2.52^{C}	-1.98^{BM}
(ii)	-0.98^{C}	-	-0.78^{BM}
(vi)	-0.38^{BM}	-0.88^{BM}	-

(a) The figures presented in the table are t values of the null hypothesis for models (i), (ii) and (vi). The critical value for 19 degrees of freedom and a significance level of 5 per cent is 2.093. C, BM: type of test used.

TABLE 10

Tests of Non-nested Hypotheses of Alternative Model Structures for the Demand Equations for the United Kingdom (a)

	Alternative hypothesis: model number		
Null hypothesis: model number	(i) SPACS	(ii) LPACS	(vi) R
(i)	-	-2.20^{C}	-3.01^{BM}
(ii)	-1.16^{C}	-	-2.53^{BM}
(vi)	-0.89^{BM}	-0.71^{BM}	-

(a) The figures presented in the table are t values of the null hypothesis for models (i), (ii) and (vi). The critical value for 19 degrees of freedom and a significance level of 5 per cent is 2.093. C, BM: type of test used.

consumer stock adjustment models (which are probably not statistically significant).

In summary, the Rotterdam model appears preferable to the stock adjustment models, and both of these types of model are preferred to the purchases adjustment models. In the preferred models, the absolute values of the long term elasticities of demand were not higher than those of the short term elasticities in any country. (Note that the stock adjustment models, which gave lower long term elasticities, did not show higher explanatory power than the Rotterdam model, which did not distinguish between long and short term elasticities). These findings are conditional on the validity of the hypotheses that current total consumer expenditure and current retail prices are exogenous and that current total consumer expenditure is a proxy for expected future income and current wealth. The findings are qualified by the fact that only a limited range of all possible dynamic and functional forms were estimated. However, this range encompassed the possibilities that the absolute values of the long term demand elasticities could be lower than, the same as, or higher than the corresponding short term values.

Estimates of elasticities of demand, depreciation rates and stock adjustment parameters differed between the countries. Depreciation and stock adjustment were more rapid for France and FR Germany than for Italy. This could be because real total expenditure was higher in France and Germany than in Italy, making replacement and adjustment of stocks to desired levels more affordable in France and Germany.

A policy implication of the finding concerning the dynamics of the elasticities is that if there is a reduction in the retail price of clothing and footwear - as, for example, may be brought about by changing trade restrictions on clothing under the Multifibre Arrangement - most of the increase in demand for the retail product (which will probably flow through to increased demand for Australian fibres, with a lag) will occur in the short term. At the retail level, the long term increase in demand will not be higher than the short term increase in demand.

Assuming that the same pattern of elasticities applies to purchases of wool garments as to purchases of all clothing and footwear, the adverse effects of high wool prices on retail demand should be felt mainly in the year in which retail prices of wool garments are raised. However, there is a lag between an increase in raw wool prices and in the price of wool garments, and there is likely to be a lag between the reduction in retail demand and reductions in the demand for Australian fibres at the auction level. These lags have not been fully quantified yet, and further research is needed before conclusions can be drawn with confidence.

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