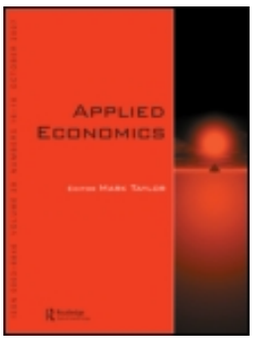

Applied Economics

ISSN: 0003-6846 (Print) 1466-4283 (Online) Journal homepage: https://www.tandfonline.com/loi/raec20

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To cite this article: Giannis Karagiannis & Kostas Velentzas (2004) Decomposition analysis of consumers' demand changes: an application to Greek consumption data, Applied Economics, 36:5, 497-504, DOI: 10.1080/0003684041000168220 5

To link to this article: https://doi.org/10.1080/00036840410001682205

Applied Economics, 2004, **36**, 497–504

Routledge
Taylor & Francis Group

Decomposition analysis of consumers' demand changes: an application to Greek consumption data

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A decomposition analysis for consumer demand functions is developed. Changes in Marshallian demand or expenditure shares functions over time are decomposed into a total substitution effect, an income effect, and a habit effect. This framework is applied to post-war Greek consumption patterns through a habit persistence version of the Quadratic Almost Ideal Demand System (QUAIDS). It is found that for all commodity categories (i.e., food, beverages and tobacco, footwear and clothing, settling and housing, and others) the income effect was the main driving force in explaining changes in both quantity demanded and expenditure shares, followed by habit and total substitution effects.

I. INTRODUCTION

Demand changes, reflected in both quantities consumed and expenditure shares, are most often due to simultaneous changes in commodity prices, total expenditure and tastes. As a result, observed changes in quantities consumed and expenditures shares over time account for all of these factors. For analytical purposes, however, it is useful to evaluate the effect of prices, expenditure and tastes separately and through them to identify the driven sources of demand changes. This in turn requires determining what portion of the observed changes in quantities demanded and in expenditure shares is attributed to changes in prices, expenditures and tastes. Needless to say that time-series data on quantities consumed and realized expenditure shares cannot by their own reveal the relative contribution of prices, expenditure and taste changes. Neither elasticity estimates could provide such information since by definition are only partial measures of changes. Then, an alternative framework is required to undertake a decomposition analysis of demand changes.

The main purpose of this paper is to develop a framework capable to analyse changes in the demand for goods over time. By appropriately adjusting Kako's (1980) approach from a production to a consumption framework, changes in the quantity demanded and/or the expenditure share of a particular good over time are decomposed into three effects: the total substitution effect, the income effect, and the habit effect. The total substitution effect captures the change in the quantity demanded or the expenditure share due to changes in commodity prices. This part consists of changes due to its own price as well as to the prices of the other goods included in consumers' bundles. The income effect corresponds to that part of the change in the quantity demanded or the expenditure share arising from changes in consumers' income, and the habit effect measures the part of the overall change in the quantity demanded or the expenditure share due to habit formation

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Applied Economics ISSN 0003–6846 print/ISSN 1466–4283 online
http://www.tandf.co.uk/journals
DOI: 10.1080/00036840410001682205

and taste changes. The proposed decomposition analysis provides quantitative measures of the above mentioned effects and thus gives new insights into explaining changes in consumption patterns.

In addition, the proposed framework is general enough to be applied to any demand system regardless of its specification, flexibility and parsimony, as long as the theoretical properties are satisfied. As is shown in the next section, the relationship for decomposing changes in quantity demanded or expenditure share is solely based on price and income elasticities that can be estimated from any demand system chosen. Thus, the decomposition analysis of both quantity demanded and expenditure share can be implemented in each study-case relying on either a duality-based (e.g., AIDS, translog) or a differential (see Barten, 1993) demand system. Aggregate Greek consumption data over the period 1950–1993 are used to provide an illustrative application of decomposition analysis, by econometrically estimating a habit persistence version of the Quadratic Almost Ideal Demand System (QUAIDS).

The rest of this paper is organized as follows: in the second section, the theoretical framework is developed. In the third section, the empirical model, the data and the estimation procedure are presented. The empirical results concerning Greek consumption patterns during the post-war period are analysed in the fourth section. In the fifth section, the usefulness of decomposition analysis in analysing policy issues is illustrated. Finally, in the last section, concluding remarks are presented.

II. THEORETICAL FRAMEWORK

Consider that the representative consumer's Marshallian demand function for the i*th* commodity, $x_i^M = x_i^M(p, M, z)$ is a function of commodity prices, total expenditures, and a variable describing habit formation. In this function, p is a $(n \times 1)$ vector of commodity prices, M is a scalar referring to total expenditures, and z represents habit formation, which, for the purposes of this paper, is specified as the previous period's quantity consumed.[1] By totally differentiating the equilibrium quantity demanded x_i^M, with respect to time t, gives:

$$\frac{\mathrm{d}x_i^M}{\mathrm{d}t} = \sum_{j=1}^{n} \frac{\partial x_i^M}{\partial p_j}\frac{\mathrm{d}p_j}{\mathrm{d}t} + \frac{\partial x_i^M}{\partial M}\frac{\mathrm{d}M}{\mathrm{d}t} + \frac{\partial x_i^M}{\partial z}\frac{\mathrm{d}z}{\mathrm{d}t} \qquad (1)$$

Then, by dividing through with x_i^M and rearranging terms, the following relationship is obtained:

$$G\left(x_i^M\right) = \sum_{j=1}^{n} \varepsilon_{ij}^M G\left(p_j\right) + \eta_i G(M) + \frac{\partial \ln x_i^M}{\partial \ln z} G(z) \qquad (2)$$

where $G(\cdot)$ is the growth rate of the corresponding variable, ε_{ij}^M refers to Marshallian demand price elasticities, and n_i refers to total expenditure elasticities. Equation 2 can be written by using Slutsky equation in elasticity form, as follows:

$$G\left(x_i^M\right) = \sum_{j=1}^{n} \varepsilon_{ij}^H G\left(p_j\right) + \eta_i\left(G(M) - \sum_{j=1}^{n} s_j G\left(p_j\right)\right) + \frac{\partial \ln x_i^M}{\partial \ln z} G(z) \qquad (3a)$$

where ε_{ij}^H are the Hicksian demand price elasticities, and s_j refers to the expenditure shares. An alternative version of Equation 3a can be obtained by using the relationship $\varepsilon_{ij}^H = \sigma_{ij} s_j$ where σ_{ij} is the partial elasticity of substitution:

$$G\left(x_i^M\right) = \sum_{j=1}^{n} \sigma_{ij} s_j G\left(p_j\right) + \eta_i\left(G(M) - \sum_{j=1}^{n} s_j G\left(p_j\right)\right) + \frac{\partial \ln x_i^M}{\partial \ln z} G(z) \qquad (3b)$$

The left-hand sides of Equations 3a and 3b represent the percentage change in quantity demanded of the i*th* commodity. The first term on the right-hand sides refer to the total substitution effect along a given indifference curve, while the second term represents the income effect and has to do with the shape of the income–consumption path and the proportional increase of prices and income. Linear income–consumption paths imply that the preferences are homothetic and that income elasticity is equal to one. Thus, a 1% change in income is translated into a 1% change in quantity demanded. On the other hand, the income effect becomes zero if $G(M) = \Sigma_j S_j G(p_j)$. The third-term, $(\partial \ln x_i^M / \partial \ln z) G(z)$, is zero if there is no habit formation in the consumption of the particular commodity.

Alternatively, by applying the same procedure to an equilibrium expenditure share, $s_i(p, M, z)$ yields:[2]

$$G(s_i) = \sum_{j=1}^{n} \frac{\partial \ln s_i}{\partial \ln p_j} G\left(p_j\right) + \frac{\partial \ln s_i}{\partial \ln M} G(M) + \frac{\partial \ln s_i}{\partial \ln z} G(z) \qquad (4)$$

By using the definition of expenditure share and by differentiating it once with respect to the logarithm of prices and then with respect to the logarithm of total expenditures and by converting the corresponding expressions into elasticity

[1] Most complicated forms of habit formation can also be used instead of the lagged quantity demanded (see for example Ray, 1985) even though this does not change the qualitative nature of the following analysis.

[2] This framework has previously been used by Karagiannis and Velentzas (1997) to explain food consumption patterns in Greece during the post-war period.

forms gives:[3]

$$\frac{\partial \ln s_i}{\partial \ln p_j} = \varepsilon_{ij}^M + \delta_{ij} \tag{5a}$$

$$\frac{\partial \ln s_i}{\partial \ln M} = \eta_i - 1 \tag{5b}$$

where δ_{ij} is the Kronecker delta ($\delta_{ij}=1$ for $i=j$ and $\delta_{ij}=0$ for $i\neq j$). Substituting Equations 5a and 5b into Equation 4, yields:

$$G(s_i) = \sum_{j=1}^{n} \left(\varepsilon_{ij}^M + \delta_{ij}\right) G\left(p_j\right) + (\eta_i - 1) G(M) + \frac{\partial \ln s_i}{\partial \ln z} G(z) \tag{6}$$

From Equation 6 and by using the Slutsky equation in elasticity form, the following relationship is obtained:

$$G(s_i) = \sum_{j=1}^{n} \left(\varepsilon_{ij}^H - s_j + \delta_{ij}\right) G\left(p_j\right) + (\eta_i - 1)\left(G(M) - \sum_{j=1}^{n} s_j G\left(p_j\right)\right) + \frac{\partial \ln s_i}{\partial \ln z} G(z) \tag{7a}$$

or

$$G(s_i) = \sum_{j=1}^{n} \left(s_j\left(\sigma_{ij} - 1\right) + \delta_{ij}\right) G\left(p_j\right) + (\eta_i - 1)\left(G(M) - \sum_{j=1}^{n} s_j G\left(p_j\right)\right) + \frac{\partial \ln s_i}{\partial \ln z} G(z) \tag{7b}$$

The first-terms on the right-hand sides of Equations 7a and 7b refer to the total substitution effect; the second terms refer to the income effect; and the last ones refer to the habit effect. Homothetic preferences or $G(M) = \Sigma_j s_j G(p_j)$ imply that the second term is zero; thus, the expenditure share is independent of income level. On the other hand, no significant habit formation implies that the third term is zero.

The relative contribution of the substitution, income and habit effect depends on the volatility of the exogenous variables (e.g. commodity prices, expenditure and lagged quantity consumed) and the magnitude of the corresponding elasticities. If, for example, commodity prices are stable over time, then the contribution of the total substitution effect has to be near zero regardless of the magnitude of the corresponding price elasticities. Alternatively, very inelastic demands bring the substitution effect near zero regardless of commodity price stability. On the other hand, relatively unstable prices and elastic demands result in a relatively large substitution effect. Similar arguments could be made for the income and habit effect.

III. EMPIRICAL MODEL, DATA AND ESTIMATION PROCEDURE

In order to give an empirical illustration of the above results, decomposition analysis is applied to Greek consumption patterns over the post-war period (1950–1993). For this purpose, the QUAIDS is used. The QUAIDS has the advantages of being an exactly aggregable demand system possessing the empirically necessary rank 3 property.[4] According to Banks *et al.* (1997), the indirect utility function (V) corresponding to the QUAIDS is of the form:

$$\ln V = \left\{\left[\frac{\ln M - \ln \alpha(p)}{b(p)}\right]^{-1} + \lambda(p)\right\}^{-1} \tag{8}$$

where

$$\ln \alpha(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j \tag{9a}$$

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i} \tag{9b}$$

$$\lambda(p) = \sum_{i=1}^{n} \lambda_i \ln p_i \tag{9c}$$

All $\alpha(p)$, $b(p)$ and $\lambda(p)$ are defined to be homogeneous functions of degree zero in prices. Thus, $\sum_i \alpha_i = 1$, $\sum_i \gamma_{ij} = \sum_j \gamma_{ij} = 0$, $\sum_i \beta_i = 0$ and $\sum_i \lambda_i = 0$.

For the purposes of the present study, a habit persistence version of the QUAIDS is proposed. Based on simple linear habit formation (Blanciforti and Green, 1983; Chen and Veeman, 1991), the parameters α_i in Equation 9a are specified as linear functions of previous consumption levels q_{it-1}. That is, $\alpha_i = \alpha_i^* + \delta_i q_{it-1}$. Then, by applying Roy's identity to Equation 8, the budget shares are given by

$$s_i = \alpha_i^* + \delta_i q_{it-1} + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{M}{\alpha(p)}\right) + \frac{\lambda_i}{b(p)}\left[\ln\left(\frac{M}{\alpha(p)}\right)\right]^2 \tag{10}$$

The adding-up and symmetry properties of budget shares (Equation 10) further require that $\Sigma_i \delta_i q_{it-1} = 0$ and $\gamma_{ij} = \gamma_{ji}$. From Equation 10 it is clear that the proposed dynamic QUAIDS nests to the linear habit version of AIDS, used by Blanciforti and Green (1983), under the assumption that

[3] In this procedure, it is implicitly assumed that the representative consumer has no monopsony power over the consumption commodity bundles and that minimum expenditure equals income (ignoring savings). Equation 5b is also proved by Silberberg (1992, p. 340).

[4] Lewbel (1990, 1991) defines the rank of any demand system to be the dimension of the space spanned by its Engle curves. The maximum possible rank of any exactly aggregable demand system is 3. Notice that both AIDS and translog demand systems are of rank 2.

$\lambda_i = 0$ for all i.[5] In such a case, Equation 8 reduces to the PIGLOG preference used by Deaton and Muellbauer (1980) to develop the AIDS.[6]

To derive the formulas of total expenditure and Marshallian demand elasticities, differentiate Equation 10 with respect to $\ln M$ and $\ln p_j$, respectively:

$$\eta_i = 1 + \left[\beta_i + \frac{2\lambda_i}{b(p)} \ln\left(\frac{M}{\alpha(p)}\right)\right] \Big/ s_i \tag{11a}$$

$$\varepsilon_{ij}^{M} = -\delta_{ij} + \left\{\gamma_{ij} - \left[\beta_i + \frac{2\lambda_i}{b(p)} \ln\left(\frac{M}{\alpha(p)}\right)\right] \times \left[\alpha_j^{*} + \delta_j q_{jt-1} + \sum_k \gamma_{jk} \ln p_k\right] - \frac{\lambda_i \beta_j}{b(p)} \left[\ln\left(\frac{M}{\alpha(p)}\right)\right]^2 \right\} \Big/ s_i \tag{11b}$$

The Hicksian demand elasticities are obtained through the Slutsky equation, namely $\varepsilon_{ij}^{H} = \varepsilon_{ij}^{M} - n_i s_j$. These elasticity estimates are used along with observed data on prices and total expenditure to measure the magnitude of the total substitution and the income effect.

Measures of the magnitude of the habit effect can be derived through Equations 3 or 7. For the latter, differentiate Equation 10 with respect to q_{it-1} to obtain:

$$\frac{\partial \ln s_i}{\partial \ln q_{it-1}} = \left[\delta_i + \beta_i \delta_i \ln p_i - \frac{2\lambda_i}{b(p)} \ln\left(\frac{M}{\alpha(p)}\right) \delta_i \ln p_i\right] \frac{q_{it-1}}{s_i} \tag{12}$$

For the former, take the logarithm of $s_i = p_i x_i^{M}/M$ and differentiate it with respect to q_{it-1}:

$$\frac{\partial \ln x_i^{M}}{\partial \ln q_{it-1}} = \frac{\partial \ln s_i}{\partial \ln q_{it-1}} + \frac{\partial \ln M}{\partial \ln q_{it-1}} \tag{13}$$

given that $\partial p_i / \partial q_{it-1} = 0$. The first-term in the right-hand side of Equation 13 equals to Equation 12. To calculate the second-term in the right-hand side of Equation 13, solve Equation 8 for $\ln M$ and then differentiate it with respect to q_{it-1} to obtain:

$$\frac{\partial \ln M}{\partial \ln q_{it-1}} = \left(\frac{\partial \ln \alpha(p)}{\partial q_{it-1}}\right) q_{it-1} = \delta_i \ln p_i q_{it-1} \tag{14}$$

A measure of the magnitude of the habit effect in Equation 3 is derived by adding Equations 12 and 14.

The system of Equations 10 is estimated for five aggregate commodity groups using data from Greece during the period 1950–1993. The five aggregate commodity groups are: food, beverages and tobacco, footwear and clothing, settling and housing (including heating, lighting, furniture and house equipment), and others (including education, health care and other services). These data are taken from National Accounts of Greece, published by the National Statistical Service. They include expenditures at current and constant (1970) prices. Commodity price indices are derived by dividing current by constant expenditures for each commodity groups. An implicit quantity index can be obtained through expenditures at constant prices.

The system of Equation 10 is estimated with nonlinear SUR and the budget share of the other commodities is excluded from the estimated system in order to avoid the singularity of the variance–covariance matrix. The system of remaining equations is estimated with iterative nonlinear SUR, which ensures that estimates are invariant to the excluded equation and they converge asymptotically to maximum likelihood estimates.

IV. EMPIRICAL RESULTS

The estimated parameters of the budget share Equations 10 are reported on Table 1. These estimates are obtained by imposing the restrictions of symmetry, linear homogeneity, and adding-up.[7] Nineteen out of 26 estimated parameters are statistically significant. All budget shares satisfy monotonicity at each data point, as predicted shares are found to be positive. In addition, the negative condition is satisfied, at the point of approximation, as the matrix $s_i[\varepsilon_{ij}^{H}]$ is negative semidefinite.[8] Finally, with respect to habit formation, the results indicate that only food and clothing-footwear are not found to be habit forming. Settling and housing appear to have persistence in consumption patterns while beverages and tobacco exhibit inventory implemented effects.

Estimates of Marshallian, Hicksian and total expenditure elasticities are reported in Table 2. In terms of Marshallian elasticities, all commodity groups except clothing and footwear and the group of others, are found to be price inelastic, with settling and housing, and food to exhibit the lower price sensitivity. In terms of total expenditure elasticities, food, and settling and housing are found to be necessities, while beverages and tobacco, clothing and footwear, and other commodities are found to be luxury goods. On the other hand, all Hicksian own-price

[5] For Greece, such a linear habit version of AIDS has been estimated by Mergos and Donatos (1989) and by Karagiannis and Velentzas (1993) using data for the periods 1960–1986 and 1958–1989, respectively.
[6] When $\lambda(p)$ is independent of commodity prices, the QUAIDS may be nested to a quadratic formulation of AIDS, used by Blundell *et al.* (1993).
[7] In order to identify the parameter α_0 in Equation 9a, Deaton and Muellbauer (1980) original discussion is followed and is chosen to be 0.95 of the minimum value of $\ln M$. Several other values have been used but this choice did not affect the results.
[8] The corresponding eigen values are −0.0029, −0.0009, −0.0006, −0.0001, and −0.00005.

Table 1. *Estimated parameters of the QUAIDS for Greek consumption, 1950–1993*

Parameter	Estimated value	*t*-statistic	Parameter	Estimated value	*t*-statistic
α_1	0.588	15.30	γ_{11}	0.154	4.26
α_2	0.101	14.84	γ_{12}	−0.023	−2.67
α_3	0.040	2.02	γ_{13}	−0.044	−2.33
α_4	0.183	10.43	γ_{14}	−0.094	−5.42
α_5	0.118	–	γ_{15}	0.007	–
β_1	−0.064	−1.27	γ_{22}	0.032	5.31
β_2	−0.049	−5.58	γ_{23}	0.049	4.43
β_3	0.084	3.29	γ_{24}	−0.034	−2.99
β_4	0.034	1.57	γ_{25}	−0.024	–
β_5	−0.005	–	γ_{33}	−0.049	−2.21
δ_1	−0.065	−0.97	γ_{34}	−0.002	−1.62
δ_2	−0.007	−1.64	γ_{35}	0.046	–
δ_3	−0.013	−1.03	γ_{44}	0.142	5.38
δ_4	0.039	2.58	γ_{45}	−0.012	–
δ_5	0.046	–	γ_{55}	−0.017	–
λ_1	−0.006	−0.49			
λ_2	0.017	4.80			
λ_3	−0.018	−2.55			
λ_4	−0.018	−1.94			
λ_5	0.025	–			

Notes: (1) Subscripts (1)–(5) refer to food, beverages and tobacco, footwear and clothing, settling and housing, and all other goods.
(2) Parameter estimates without *t*-statistic are calculated through the homogeneity and adding-up restrictions.

Table 2. *Compensated, uncompensated demand and expenditure elasticities, Greece, 1950–1993*

	(F)	(B-T)	(F-C)	(S-H)	(O)
Compensated price demand elasticities					
Price of					
(F)	−0.177	0.017	−0.035	−0.038	0.267
(B-T)	0.027	−0.546	0.800	−0.347	0.066
(F-C)	−0.129	0.537	−1.320	0.078	0.834
(S-H)	−0.061	−0.119	0.037	−0.208	0.351
(O)	0.380	0.047	0.361	0.300	−1.088
Uncompensated price demand elasticities					
Price of					
(F)	−0.466	−0.067	−0.112	−0.201	0.080
(B-T)	−0.417	−0.625	0.677	−0.604	−0.254
(F-C)	−0.585	0.459	−1.439	−0.177	0.554
(S-H)	−0.385	−0.175	−0.048	−0.390	0.147
(O)	−0.115	−0.039	0.227	0.018	−1.418
Expenditures elasticities					
Total expenses	0.767	1.222	1.188	0.851	1.328

Note: (F) refers to food; (B-T) to beverages and tobacco; (F-C) to footwear and clothing; (S-H) to settling and housing; and (O) to others.

elasticities are found to be negative, as is required by the economic theory. All commodity groups are substitutes to each other, except food and footwear and clothing, food and settling and housing, and beverages and tobacco and settling and housing.

The decomposition analysis results are based on Equations 3a and 7a, the elasticity estimates reported in Table 2 and the observed changes on exogeneous variables (i.e., prices, real expenditure, and previous year consumption) presented in Table 3. The magnitude of the habit effect is measured through Equations 12 and 14. Diewert's (1976) quadratic approximation lemma is used to convert the continuous time model developed in the second and the third sections to discrete variable calculations used in this section. The results of decomposition analysis are summarized on Tables 4 and 5. The first

Table 3. *Annual growth rates of expenditure shares, prices and quantities, Greece, 1950–1993*

Item	Expenditure share	Price	Quantity
(F)	−0.98%	10.12%	2.92%
(B-T)	0.08%	9.82%	4.54%
(F-C)	−0.72%	10.06%	3.41%
(S-H)	−0.05%	9.48%	4.56%
(O)	1.67%	9.85%	5.87%

Note: (F) refers to food; (B-T) to beverages and tobacco; (F-C) to footwear and clothing; (S-H) to settling and housing; and (O) to others.

column of these tables refers to the annual percentage change of quantity demanded and expenditure shares over the period 1950–1993. The second one captures the part of this change due to the total substitution effect. The third column represents the income effect and the fourth one refers to the habit effect. The last column is the difference between column one and the sum of columns two to four, which represents the unexplained residual.[9] The second row, in every commodity group, depicts the same changes in percentage terms.

Quantity demanded for each commodity category increased during the post-war era, with different though average annual growth rates. In all cases, the income effect is the main driving force in explaining changes of quantity demanded over time (see Table 4). Moreover, in all cases, except that of footwear and clothing, the total substitution and the income effect moved in the same directions. Nevertheless, in the case of footwear and clothing beverages, the income effect outweighs the negative substitution and habit effect.

The income effect is positive in all cases, as all commodities were found to be normal goods and real income increased during the post-war period (see Table 4). For any given real income increase, differences in the magnitude of the income effect among commodity categories is due to the magnitude of income (expenditure) elasticity. That is, the magnitude of the income effect increases with the magnitude of the income elasticity of the commodity under consideration. This is true for the absolute magnitude of the income effect (e.g., it is relatively greater for beverages and tobacco, footwear and clothing, and the category of other goods which are luxuries), whereas its significance in explaining demand changes depends on the (absolute) magnitude of the other two effects.

The total substitution effect, consisting of the own- and cross-price component, may be negative or positive depending on the evolution of relative prices. A negative sign of the total substitution effect, as in the case of footwear and clothing, means that relative prices did not favour the consumption of these goods, assuming that total expenditures are held constant. In contrast, a positive sign of the total substitution effect, as in the cases of all other good categories, implies that their prices became progressively relatively cheaper than the price of all other commodity groups, and thus the cross-price dominated the own-price effect, which was always negative.

The habit effect indicates quite strong habit persistence for only settling and housing, and the category of all other commodities. This implies that previous consumption levels positively affected their consumption, enhancing their quantity demanded over time. In contrast, the inventory depletion effect of habit on food, beverages and tobacco, and footwear and clothing consumption resulted in a decrease of its quantity demanded over time.

The results concerning the decomposition of expenditure shares are reported in Table 5. The expenditure shares of food, footwear and clothing, and settling and housing declined over time, while those of beverages and tobacco, and the category of other goods increased. Nevertheless, the observed changes in the expenditure shares of beverages and tobacco, and settling and housing were very small. As in the case of quantity demanded, the income effect was the main driving force in explaining changes in the distribution of consumers' expenditures in Greece. In all cases, except those of housing and settling and of other goods, the total substitution and the income effect moved in opposite directions.

In the post-war era, the annual decline of 0.98% on food share is mainly due to changes in consumers' income and to habit formation (see Table 5). As can be noted, the habit effect is relatively high indicating strong inventory depletion associated with changing food consumption patterns. On the other hand, the positive sign of the total substitution effect indicates that, in relative terms, the price of food increased faster than the price of all other commodities. This is evident from the annual growth rates of price increases reported in Table 3. Note also that the historical evolution of food expenditures in Greece is consistent with Engel's law, and it is expected to be so for any developing country.

During the same period, the changes in the expenditure shares of beverages and tobacco and footwear and clothing share a common feature: the dominant total substitution effect is in the opposite direction of those of income and habits. In both cases, the negative sign of the total substitution and the habit effect are respectively due to the movement of relative prices (see Table 3) and the inventory

[9] In all cases, the explained changes (i.e., the sum of the total substitution, the income and the habit effect) in quantity demanded and expenditure shares is greater than 87% of the corresponding observed changes, leaving the unexplained residual within a reasonable range.

Table 4. *Decomposition analysis of quantities demanded, 1950–1993*

Item	Observed change in quantities demanded	Total substitution effect	Income effect	Habits effect	Residual
Food	0.0292	0.0029 (10.01%)	0.0313 (107.34%)	−0.0084 (−28.86%)	0.0034 (11.51%)
Beverages & Tobacco	0.0454	0.0032 (7.08%)	0.0419 (109.94%)	−0.0083 (−18.35%)	0.0006 (1.28%)
Footwear & Clothing	0.0341	−0.0036 (−10.53%)	0.0484 (142.36%)	−0.0065 (−19.02%)	−0.0044 (−12.81%)
Settling & Housing	0.0456	0.0007 (1.57%)	0.0348 (72.26%)	0.0153 (33.51%)	−0.0052 (−11.34%)
Others	0.0587	0.007 (1.15%)	0.0543 (92.45%)	0.0076 (12.95%)	−0.0038 (−6.55%)

Table 5. *Decomposition analysis of equilibrium expenditure shares, 1950–1993*

Item	Observed change in expenditure share	Total substitution effect	Income effect	Habits effect	Residual
Food	−0.0098	0.0053 (−54.08%)	−0.0095 (96.94%)	−0.0046 (46.94%)	−0.0009 (8.84%)
Beverages & Tobacco	0.0008	−0.0007 (−87.50%)	−0.0091 (1137.50%)	−0.0075 (937.50%)	0.0001 (12.70%)
Footwear & Clothing	−0.0072	−0.0089 (123.61%)	0.0077 (−106.94%)	−0.0056 (77.77%)	−0.0004 (5.56%)
Settling & Housing	−0.0005	−0.0059 (1180.00%)	−0.0061 (1220.00%)	0.0115 (−2310.00%)	0.00005 (10.00%)
Others	0.0167	0.0030 (17.96%)	0.0134 (80.27%)	0.0160 (9.58%)	−0.0013 (7.79%)

depletion effect of habit in beverages and tobacco, and clothing and footwear. Nevertheless, the relative contribution of the habit effect is greater than that of the total substitution effect in the case of beverages and tobacco, while the opposite is true in the case of clothing and footwear.

On the other hand, the changes in the expenditure share of housing and settling and of all other goods share two common features. *First*, the total substitution and the income effect moved in the same direction, even though their signs are negative for settling and housing, and positive for the category of other goods. *Second,* the habit effect is positive indicating habit persistence for these two commodity groups. However, the relative contribution of the habit effect is greater than that of the total substitution effect in the case of housing and settling, while the opposite is true in the case of other goods. This may be due to the highly inelastic demand for settling and housing and its complementary relationship with most of the other commodity groups.[10] Furthermore, the strong habit persistence nature is primarily caused by the furniture and house equipment components of this category. During the post-war period, the modernization of Greek households was achieved primarily through a more extensive use of electrical house equipment although the relatively small contribution of the income effect is quite surprising. This, however, is probably due to low income (total expenditure) elasticity.

V. USE OF DECOMPOSITION ANALYSIS FOR POLICY ANALYSIS

The usefulness of decomposition analysis in considering policy issues relies on its ability to deal satisfactorily with simultaneous changes in many exogenous variables. This would be the case in consumer economics when more than one commodity price change at the same time. With multiple price changes, elasticity estimates cannot provide any accurate information about demand changes because they are only partial measures of change. That is, elasticities can appropriately measure changes in quantity demanded only in a *ceteris paribus* way. Furthermore, elasticity estimates cannot provide any information about redistribution of consumer expenditures whenever changes in income or commodity prices occur. This is an important matter

[10] A storage effect often makes the habit effect in consumer durables negative, i.e., a large consumption this period lowers the demand for the subsequent periods.

when the distributional effects of various policies would like to be considered along with the corresponding changes in demand.

In the following examples, our interest is restricted on the distributional effects of various scenarios of exogenous variables changes; that is, the analysis is focused on the percentage changes in expenditure shares induced by changes in either income or commodity prices. First, consider the case of total expenditure deterioration by 1%. Suppose further that habits continue to follow the same path as before in terms of both direction and magnitude. This is a quite reasonable assumption for short-run considerations. Then, by using Equation 7a and the elasticities estimates reported on Table 2, it may be argued that Greek consumers will reduce the expenditure share of food, beverages and tobacco, and footwear and clothing by 0.23%, 0.97% and 0.75%, respectively. At the same time, they increase the share settling and housing by 1.30%, and that of other goods by 1.27%. In other words, any reduction of total expenditures results in a redistribution of expenditures against food, beverages and tobacco, and footwear and clothing and towards other commodities.

As a second example consider the case of a 1% increase in the price of settling and housing. What are the distributional effects of such a change, given that habits continue to follow the same path as before in terms of both direction and magnitude? Using again Equation 7a and the elasticities reported on Table 2, it may be argued that the expenditure shares of food, beverage and tobacco, and clothing and footwear will decrease by 0.68%, 1.13%, and 0.78%, respectively. The share of settling and housing increases by 1.76% and that of other goods by 1.67%. The increase of the expenditure share of housing and settling is due to its inelastic demand and the complementarity and/or substitutability between housing and settling and the other commodity items can explain the rest of the changes.

VI. CONCLUDING REMARKS

In this paper, a decomposition analysis for consumer demand functions is developed. Changes in Marshallian demand or expenditure shares functions over time are decomposed into a total substitution effect, an income effect, and a habit effect. The proposed framework is general enough to be applied to any demand system regardless of its specification, flexibility and parsimony, as long as the theoretical properties are satisfied. As a result the decomposition analysis of both quantity demanded and expenditure share can be implemented in each study case relying on either a duality-based or a differential demand system. In addition, decomposition analysis could also be useful in considering policy issues since it can deal satisfactorily with simultaneous changes in prices, expenditures and tastes. With multiple price changes, elasticity estimates cannot provide any accurate information about either demand changes or redistribution of consumer expenditures. The latter is an important matter when the distributional effects of various policies would like to be considered along with the corresponding changes in demand. However, decomposition analysis is capable of handing satisfactory such cases.

The above framework is applied to post-war Greek consumption data through a habit persistence version of the Quadratic Almost Ideal Demand System (QUAIDS). It is found that for all commodity categories (i.e., food, beverages and tobacco, footwear and clothing, settling and housing, and others) the income effect was the main driving force in explaining changes in both quantity demanded and expenditure shares, followed by habit and total substitution effects. This was true for changes in both the quantities demanded and the distribution of expenditures, i.e., the evolution of expenditure shares over time.

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