Two-stage Budgeting as an Economic Decision-making Process for Spanish Consumers

José Alberto Molina

Department of Economic Analysis, University of Zaragoza, Spain

Two-stage budgeting as an economic decision-making process for consumers is illustrated by its application to new data. After showing that the Spanish observed behaviour is consistent with utility maximization, we estimate, for each stage, the elasticities of a dynamic AIDS model, which allow us to explain the economic decisions of consumers. The main findings show that all goods are normal and display decreasing demands, as theory predicts. In particular, transport, in the first stage, and the purchase of personal vehicles, in the second, show the highest expenditure effects. Moreover, transport and public transport display the highest Marshallian own-price elasticities. © 1997 by John Wiley & Sons, Ltd.

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INTRODUCTION

It is well known that the most important economic decisions taken by consumers correspond to the allocation of expenditure to specific consumption goods. In order to give a suitable response, consumers employ the two-stage budgeting process (Strotz, 1957; Gorman, 1959). This method postulates that agents allocate total expenditure first to broad groups of goods, based on a price index for each group, and then further allocate expenditure within each of these groups, based on group individual prices and group expenditures.

The objective of this paper is to apply the two-stage budgeting method as an economic decision-making process to a new data set. Specifically, we use Spanish annual time-series of expenditures and prices for the period 1964 to 1992. First, however, we carry out a nonparametric analysis, based on the revealed preference theory developed by Varian (1982, 1983), in order to show that the observed behaviour of Spanish consumers is consistent with the utility maximization hypothesis. We then choose, as the demand model for the parametric analysis, a dynamic version of the linear Almost Ideal Demand System, proposed by Deaton and Muellbauer (1980a) and later used, for example, by Blanciforti and Green (1983), Fujii, Khaled and Mak (1985) and Mergos and Donatos (1989). This model is first estimated using total expenditure disaggregated into five main groups of goods.We then estimate the same demand system, but now employing only data for one of these groups, dividing the expenditure in this group into three specific goods.

THE TWO-STAGE BUDGETING PROCESS: THE AIDS MODEL

Let us now assume a rational consumer who first decides with respect to the purchase of five aggregate consumption goods, namely, food, beverages and tobacco (F), clothing and footwear (C), housing (H), transport (T) and other goods and services (O); and, second, with respect to the three specific goods that are included in the transport group, that is, the purchase of personal vehicles (T1), the maintenance

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of personal vehicles (T2) and public transport (T3). In what follows q_i denotes the quantity demanded of ith good, p_i represents the corresponding nominal price and y denotes total expenditure (or income) on the five aggregated goods. Thus, the utility function corresponding to the two-stage budgeting process of the consumer can be written as $u = F[u_F(q_F), u_C(q_C), u_H(q_H), u_T(q_{T1}, q_{T2}, q_{T3}), u_O(q_O)]$, where $u_g(\cdot)$ are sub-utility functions that depend on a subset q_g of one or more goods. $F[\cdot]$ and the sub-utility functions $u_g(\cdot)$ satisfy the classical conditions of monotonicity and quasi-concavity.

The consumer first maximizes the utility function $u = F[u_F(q_F), u_C(q_C), u_H(q_H), u_T(q_T), u_O(q_O)]$, subject to the budget constraint and, second, once he or she has determined the quantity (q_T) and expenditure (y_T) destined to a particular aggregate good, in this case, transport, he should then allocate this expenditure among the specific goods which are included in the aggregate, thus maximizing $u = u_T(q_{T1}, q_{T2}, q_{T3})$.

To determine the functional form of the demand equations resulting from the constrained maximization of the utility functions for both stages, we use a dynamic version of the Almost Ideal Demand System (AIDS), following Deaton and Muellbauer (1980b), which specifies the initial constant parameter to be a linear function of the lagged endogenous variable and a time trend. Therefore, this dynamic specification generates the following demand equations:

$$
\begin{aligned}
w_{it} = {} & \alpha_i^* + \alpha w_{it-1} + \alpha_i^{**} t + \sum_j^n \gamma_{ij} \log p_{jt} \\
& + \beta_i \Bigg[\log y_t - \alpha_0 \\
& - \sum_k^n (\alpha_k^* + \alpha w_{kt-1} + \alpha_k^{**} t) \log p_{kt} \\
& - \tfrac{1}{2} \sum_k^n \sum_j^n \gamma_{kj} \log p_{kt} \log p_{jt} \Bigg] \quad (i = 1, \ldots, n) \qquad (1)
\end{aligned}
$$

where w_i is the budget share of the ith good and α_i^*, α, α_i^{**}, γ_{kj} and β_i are parameters. The basic demand restrictions are expressed in terms of the coefficients:

(1) adding-up:

$$\sum_i^n \alpha_i^* = 1 - \alpha; \sum_i^n \alpha_i^{**} = \sum_i^n \gamma_{ij} = \sum_i^n \beta_i = 0;$$

(2) homogeneity:

$$\sum_j^n \gamma_{ij} = 0$$

(3) and symmetry: $\gamma_{ij} = \gamma_{ji}$.

ESTIMATION PROCEDURE

The initial specification of model (1) generates equations that are non-linear in their parameters. To avoid the non-linear estimation, our paper follows Deaton and Muellbauer (1980a) and uses the Stone (1954) index. With this transformation, and adding an error term, u_{it}, that captures taste shifts, measurement errors in the dependent variable and the effects of omitted variables, the stochastic version of the dynamic linear AIDS is:

$$
\begin{aligned}
w_{it} = {} & \alpha_i^* + \alpha w_{it-1} + \alpha_i^{**} t + \sum_j^n \gamma_{ij} \log p_{jt} \\
& + \beta_i \left[\log y_t - \sum_j^n w_{jt} \log p_{jt} \right] + u_{it} \quad (i = 1, \ldots, n)
\end{aligned} \qquad (2)
$$

Due to the adding-up restriction, the covariance matrix is singular and the likelihood function undefined. The usual procedure followed in this study has been to omit one of the equations at each stage, to estimate the remaining system and to calculate the parameters in the omitted equation via the adding-up condition. In our case, the omitted equations are other goods and services in the first stage and public transport in the second.

Model (2) is technically a simultaneous equation system and, therefore, has been estimated by using the SURE method of Zellner (1962) employing the TSP. Because of the nature of our data (time series) we have tested the individual first-order autocorrelation (AR/MA1) by means of the Godfrey (1978) Lagrange multiplier test and the joint autocorrelation using the Harvey (1982) test. We have then tested for dynamic heteroscedasticity by means of the Engle (1982) test. Furthermore, the theoretical restrictions of the system have been tested using the Wald test.

As the estimated results from the model are presented in the form of elasticities, the expressions corresponding to the linear AIDS model (2) are: (1) expenditure:

$$e_i = 1 + \frac{\beta_i}{w_i},$$

and (2) uncompensated price:

$$e_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i w_j}{w_i}$$

where δ_{ij} is the Kronecker delta.

EMPIRICAL RESULTS

Before describing the parametric empirical results, our first purpose is to show that the Spanish observed behaviour is consistent with the utility maximization hypothesis. In order to achieve this, we use the nonparametric approach derived from the revealed preference theory. This procedure has the advantage over the parametric methods of not requiring *ad hoc* functional specifications for demand equations. On the basis of observed and measurable magnitudes, the nonparametric approach allows us to check whether a given data set is consistent with the neoclassical model of consumer behaviour. Nonparametric methods have been developed to test data for consistency with utility maximization by means of several axioms, with the most general of these being the so-called Generalized Axiom of Revealed Preference (GARP). By using the software routine described by Varian (1985), which is especially designed to directly test the GARP, we have shown that both data sets have been generated by a maximizing behaviour consumer.

The results of the estimation are reported in Tables 1 to 3. In Table 1 we show the Godfrey test, Harvey test and Engle test values. As can be seen, none of the equations, except clothing and footwear, exhibit first-order autocorrelation problems. In addition to this individual test, we have tested the joint autocorrelation by using the Harvey test, observing that the values of this test are clearly lower than the critical values. Therefore, we can reject the hypothesis of autocorrelation in both demand models at the conventional 5% level of significance. Moreover, we have also tested and rejected the dynamic heteroscedasticity problems. Hence, both specifications are clearly acceptable from an econometric point of view.

Table 2. Theoretical Hypotheses Tests

	Wald	$\chi^2_{0.05}$
First stage		
Homogeneity (4 d.f.)	48.84	9.49
Homogeneity and symmetry (14 d.f.)	77.23	23.68
Second stage		
Homogeneity (2 d.f.)	9.39	5.99
Homogeneity and symmetry (5 d.f.)	12.94	11.07

The test values of the theoretical hypotheses for both stages are reported in Table 2. The values for homogeneity and joint homogeneity and symmetry are greater than their critical values at the 5% level of significance. Both hypotheses are, therefore, rejected. These results are in accordance with those reported in other papers which have estimated the AIDS model (Deaton and Muellbauer, 1980a; Blanciforti and Green, 1983; Mergos and Donatos, 1989).

In Tables 3(a) and 3(b) we show the elasticities evaluated at the mean point of the explanatory variables. These values are reasonable in signs and magnitude and, for the most part, are individually significant. Table 3(a) reflects the expenditure and price effects for the first stage. With respect to the expenditure effects, we can note that all values are positive, that is, all commodities are normal goods, and statistically significant at the 5% level. Clothing and footwear and transport are luxuries; by contrast, food, beverages and tobacco, housing, and other goods and services (which include medical expenses and education, among others) are necessities. The expenditure effect on transport, 1.69, is the highest

Table 1. Specification Tests

	Autocorrelation				Dynamic heteroscedasticity	
	Godfrey	$\chi^2_{0.05}$	Harvey	$\chi^2_{0.05}$	Engle	$\chi^2_{0.05}$
First stage						
Food, beverages and tobacco	0.27	3.84			0.02	3.84
Clothing and footwear	5.08	3.84			0.42	3.84
Housing	3.45	3.84	4.24	9.49	3.15	3.84
Transport	2.37	3.84			0.08	3.84
Other goods and services	1.47	3.84			0.09	3.84
Second stage						
Purchase of personal vehicles	2.00	3.84			0.51	3.84
Maintenance of personal vehicles	2.67	3.84	1.37	5.99	0.17	3.84
Public transport	1.82	3.84			0.28	3.84

Table 3(a). Elasticities: First Stage

	Expenditure	Price				
		Food	Clothing	Housing	Transport	Other
Food, beverages and tobacco	0.772[a]	−0.264[a]	−0.096	−0.110[a]	−0.061	−0.169
	(10)	(−2.9)	(−1.7)	(−2.3)	(−1)	(−2.4)
Clothing and footwear	1.214[a]	−0.333[a]	−0.546[a]	−0.495[a]	0.092	−0.111
	(10)	(−2.1)	(−5.7)	(−6.3)	(0.9)	(−0.8)
Housing	0.953[a]	−0.244[a]	−0.152[a]	−0.194[a]	−0.142[a]	−0.116
	(12)	(−2.7)	(−2.5)	(−3.8)	(−2.3)	(−1.2)
Transport	1.697[a]	−0.465[a]	0.161	−0.046	−0.824[a]	−0.490[a]
	(9)	(−2.1)	(1.1)	(−0.4)	(−5.8)	(−2.9)
Other goods and services	0.919[a]	−0.462[a]	−0.045	−0.112[a]	0.032	−0.500[a]
	(13)	(−7)	(−0.8)	(−2.9)	(0.5)	(−7.4)

The figures in parentheses are *t*-values.
[a] Significant at the 5% level.

Table 3(b). Elasticities: Second Stage

	Expenditure		Price		
	Total	Specific	Purchase	Maintenance	Public
Purchase of personal vehicles	1.951[a]	1.150[a]	−0.082	−0.849[a]	0.086
	(16)	(16)	(−0.8)	(−5.8)	(0.5)
Maintenance of personal vehicles	1.732[a]	1.021[a]	−0.460[a]	−0.512[a]	−0.208[a]
	(28)	(28)	(−8.6)	(−6.7)	(−2.7)
Public transport	1.130[a]	0.666[a]	−0.266[a]	0.064	−0.530[a]
	(12)	(12)	(−3.6)	(0.6)	(−5.7)

The figures in parentheses are *t*-values.
[a] Significant at the 5% level.

among all values and more than twice as high as that for food, beverages and tobacco, 0.77.

Own-price elasticities are all negative, as the theory predicts, and significant at the 5% level. The values below one, in absolute terms, of all uncompensated own-price elasticities, indicate that the five demands are price inelastic, with food, beverages and tobacco appearing as the category which is most insensitive to its own price, −0.26; by contrast, transport is the good which is the most sensitive to its own price, −0.82. The final results of interest concern the cross-price values. We can observe that 10 cross-price elasticities are significant and, second, that all effects are weak, which is suggested by the fact that all values, in absolute terms, are smaller that one. Seventeen out of 20 values are negative, indicating complementary goods.

As regards the second stage, Table 3(b) shows the expenditure and price effects. First, we have obtained the specific expenditure elasticities, calculated with respect to total transport expenditure, rather than to total expenditure. These values indicate that the purchase and the maintenance of personal vehicles are luxuries, with public transport being a necessity good. Moreover, we can calculate the effects with respect to total expenditure by using $e_{i\mathrm{Y}} = e_{i\mathrm{YT}} e_{\mathrm{TY}}$, where $e_{i\mathrm{Y}}$ denotes total expenditure elasticity for the *i*th transport good, $e_{i\mathrm{YT}}$ represents the elasticity of the *i*th transport item with respect to total transport expenditure and e_{TY} denotes the expenditure elasticity of transport with respect to total expenditure or income. As $e_{\mathrm{TY}} = 1.69$, total effects for the purchase of personal vehicles, the maintenance of personal vehicles and public transport are 1.95, 1.73 and 1.13, respectively. Therefore, we can conclude that all three transport groups clearly behave as luxuries.

All uncompensated own-price elasticities are negative and two of them (the maintenance of personal vehicles and public transport) are significant at the conventional 5% level. Every transport demand is inelastic, with the purchase of personal vehicles being the most insensitive to its own-price, −0.08. As regards cross-price effects, both personal transport goods show complementary relations, significant at the 5% level. Further, we find asymmetric substitutability between private and public transport, that is, we observe that both relations, the purchase of personal vehicles–public transport and public transport–the maintenance of personal vehicles, exhibit substitutability.

SUMMARY AND CONCLUSIONS

This paper describes the two-stage budgeting process as an economic decision-making process for consumers, applying it to the Spainsh economy for the period 1964 to 1992. After showing, by means of the revealed preference theory, that the observed behaviour of Spanish consumers is consistent with the utility maximization hypothesis, we use a dynamic version of the linear Almost Ideal Demand System in order to estimate both stages of the two-stage budgeting process. We first divide total expenditure into five main groups of goods, and then disaggregate a particular expenditure into various specific goods.

As regards the first stage, we observe that all goods are normal and, in particular, the expenditure elasticity of transport has the highest value, being more than twice as high as that for food, beverages and tobacco. Every own-price effect is negative, as theory predicts, with transport appearing as the category which is most sensitive to its own-price.

The results of the second stage show that all specific transport goods are luxuries with respect to total expenditure, with the value corresponding to the purchase of personal vehicles being the most sensitive to income, whereas the most inelastic is public transport. All own-price elasticities are negative, with the purchase of personal vehicles being the most insensitive to its own-price. As regards cross-price effects, both personal transport goods show complementary relations and we detect asymmetric substitutability between private and public transport goods.

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